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New Insights into the Iron Age Archaeology of Edom, Southern Jordan

Volume 1

Thomas E. Levy, Mohammad Najjar, and Erez Ben-Yosef

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New Insights into the Iron Age Archaeology of Edom, Southern Jordan

Volume 1

Surveys, Excavations, and Research from the University of California, San Diego–Department of Antiquities of Jordan, Edom Lowlands Regional Archaeology Project (ELRAP)

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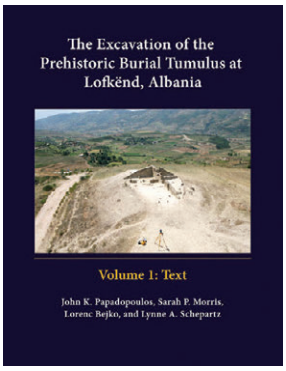

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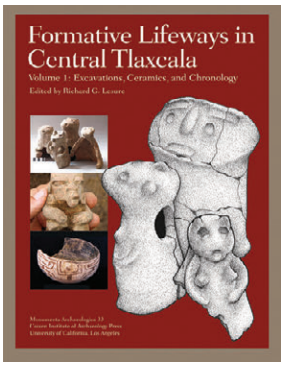

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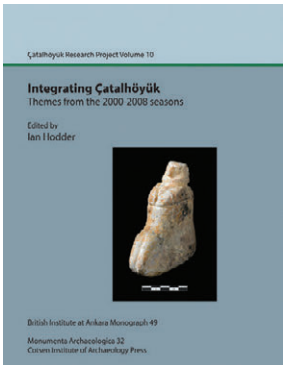

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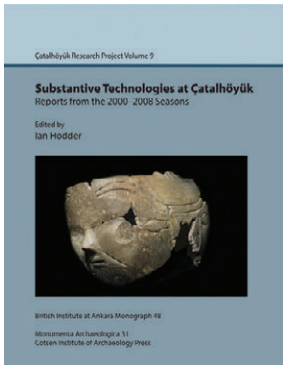

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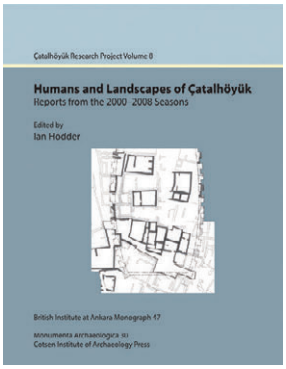

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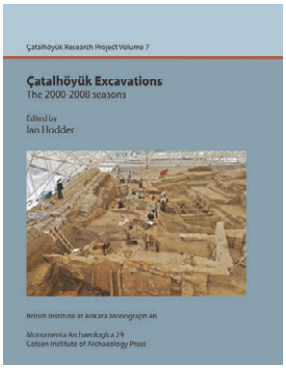

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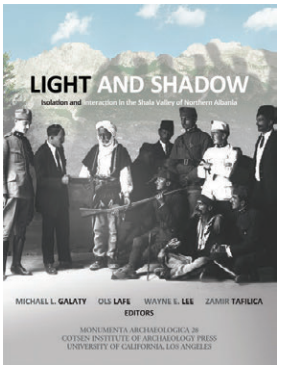

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New Insights into the Iron Age Archaeology of Edom, Southern Jordan

Volume 1

Surveys, Excavations, and Research from the University of California, San Diego–Department of Antiquities of Jordan, Edom Lowlands Regional Archaeology Project (ELRAP)

Thomas E. Levy, Mohammad Najjar, and Erez Ben-Yosef

with contributions by

Neil G. Smith, Marc A. Beherec, Adolfo Muniz, Thomas Higham, Kyle A. Knabb, Yoav Arbel, Aaron D. Gidding, Ian W. N. Jones, Daniel Frese, Yuval Goren, Stefan Münger, Craig Smitheram, and Christopher A. Rollston

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This book is dedicated to

Ghazi Bisheh, former Director General,
Department of Antiquities of Jordan

Pierre Bikai, former Director,
American Center of Oriental Research (ACOR),
Amman, Jordan

and the people of Jordan

In friendship and with sincere thanks for their help
and support in making this project possible

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These volumes are in memory of

Jerome S. Katzin and Miriam E. Katzin

Whose generosity, friendship, and love of learning
helped make this publication possible

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Preface

The work presented here represents the final publication of more than ten years of Iron Age field research in the biblical region of Edom in southern Jordan. The University of California, San Diego–Department of Antiquities of Jordan Edom Lowlands Regional Archaeology Project (ELRAP) focuses on studying the role of technology on the evolution of societies in Jordan's copper ore–rich Faynan region. The lens for this study is ancient mining and metallurgy. The interdisciplinary approach of ELRAP has led to new discoveries concerning the rise of social complexity in the southern Levant based on the rigorous control of time (through the application of high-precision radiocarbon dating) and space (i.e., the cultural context of material culture through precise recording of geospatial data). The latter was made possible by using the Iron Age excavations in Faynan as a test bed for developing cyber-archaeology, which represents the integration of archaeology, physical science, computer science, and engineering. To make our data freely available, the complete archive of digital photographs, geospatial databases, and other data presented in this volume is included with this volume in a DVD. The University of California, San Diego Library, through the Digital Library Collections and California Digital Library (https://libraries.ucsd.edu/digital), now hosts the digital data for the excavations at Khirbat en-Nahas described here.

Situated approximately 50 km south of the Dead Sea and 25 km northwest of the famous Nabatean capital of Petra high in the Shara mountains, the Faynan region covers an area of over 400 km^2 and has the largest deposits of copper ore in the southern Levant. Thus, ELRAP is a deep-time study of culture change in one of the Old World's most important locales for studying technological change on the land bridge that joins Africa and Southwest Asia. Beginning in 1997, our team carried out excavations and surveys that spanned the Neolithic through Early Bronze Age periods (ca. 7500–2000 BCE). By 2002, we were ready to expand our research into the next major phase of occupation in this part of southern Jordan—the Iron Age. The Iron Age (ca. 1200–500 BCE) represents the emergence of the first historical local state-level societies and, as we show in this volume, is when the first industrial revolution in the southern Levant took place.

This book explores how the production, control, and exchange of copper during this formative period contributed to the emergence of the polity of Edom—the "red land," known famously from the Hebrew Bible as one of ancient Israel's most important neighbors. ELRAP carried out the first large-scale excavation projects in the Faynan region, and the final reports are presented here. For the Iron Age, the excavations at the large copper production site of Khirbat en-Nahas provide the archaeological anchor for understanding the new social and technological developments that took root in the lowlands of Edom. Other large-scale excavations took place at Wadi Fidan 40—the largest Iron Age cemetery complex discovered to date in southern Jordan. Other sites excavated from the late second to early first millennium BCE in Faynan include copper smelting remains at Khirbat Hamra Ifdan, other copper smelting centers at Khirbat al-Jariya and Khirbat al-Ghuwayba, and a watchtower at Rujm Hamra Ifdan. To test the relationship between the highlands

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and lowlands of Edom, a series of small village settlements situated in the steppe zone were sampled by the Lowlands to Highlands Project led by Neil Smith at the sites of Khirbat al-Malayqtah, Khirbat al-Kur, Khirbat al-Iraq Shmaliya, and the previously excavated highland site of Tawilan situated near Petra. These stratified excavations provide a new source of hard data for investigating the nature of Iron Age settlement and society in southern Jordan. Many of the analyses published here are based on the doctoral research of Smith, Erez Ben-Yosef, and Marc Beherec. In fact, most of the work presented here is the result of the collaborative work of the University of California, San Diego faculty and graduate students.

The Edom Lowlands Regional Archaeology Project could not have succeeded without the dedication of hundreds of undergraduate students and tens of graduate students mostly from UC San Diego. Students from other universities also participated, and we thank all for their hard work. We are especially appreciative of the many Bedouin workers from different tribes who live in the Faynan region and have worked with us over the years—mostly from the Al-Ammarin, Azazmih, al-Manajah, al-Rashaidah, and Sa'idiyeen. In particular, we thank Mohammad Defallah, Uwayid Sa'idiyeen, Jum'a Ali Azazmeh, Mohammad al-Rashaidah, the late Abu Fawwaz al-Rashaidah, and Sheikh Salim Abu Shushi Al-Ammarin. At the Department of Antiquities of Jordan, we are grateful to the former Director Generals: Ghazi Bisheh, Fawwaz Al-Khraysheh (RIP), Ziad al-Saad and the current Director General, Monther Jamhawi; we also thank Jihad Haroun, Qutaiba Dasouqi, Khalil Hamdan, and Abulrahim Dwaikat. We are grateful to our friends Mohammad and Vania Mugrahbi for their hospitality and logistic support of many of our expeditions in Jordan. At the American Center of Oriental Research in Amman, we thank former director Pierre Bikai and Patricia Bikai, Director Barbara Porter, and Chris Tuttle for their logistic support. E.B.-Y. sincerely thanks Professor Lisa Tauxe for her help in various aspects of the research presented here as well as the editorial work. T.E.L. deeply appreciates his long-term collaboration with Lisa Tauxe since 2005 when their paleomagnetic dating project in Jordan began. T.E.L. is also grateful for the friendship and support of colleagues at the UC San Diego, California Institute of Telecommunications and Information Technology (Calit2—Qualcomm Institute): Ramesh Rao, Doug Ramsey, Tom DeFanti, Larry Smarr, Falko Kuester, Alex Hubenko, Yuki Marsden, and the UC San Diego Judaic Studies Program faculty, including David Goodblatt, William Propp, Richard Elliott Friedman, the late David Noel Freedman, and Deborah Hertz. Personally, T.E.L. sincerely thanks Norma Kershaw and the late Jerome and Miriam Katzin for their long-term support of his archaeological research in the Middle East. Finally, we especially thank Alina Levy for her logistical prowess in helping ELRAP through so many expedition seasons.

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The following is a list, more or less complete, of the many students, volunteers, and staff who participated on the Iron Age projects in the Faynan region of ancient Edom in southern Jordan. We are grateful to all of those who helped with our expeditions:

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A note of BCE vs BC in this volume: In the OxCal calibration program, there is the option to use BCE should one wish. There is no convention on using BC or BCE in the world of radiocarbon, so we have simply used BCE (Before the Common Era) throughout this volume.

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The DVD

Supplementary Digital Photography of Excavation, Survey and Artifacts, and Chapter Materials

The DVD included with this book has two parts in separate folders titled: "Cotsen Photography" and "Cotsen Supplementary Materials." These contain supplementary photography of excavation, survey and artifacts from all ELRAP projects, and additional chapter material associated with the text, including appendices, endnotes, photography, and tables, all referenced within the text for Chapters 2, 6, 7, 9, and 12.

The supplementary digital material includes more than 55,000 files organized in 1,726 folders. This represents the entire collection of ELRAP's digital photographs: 19,276 photos of excavated and surveyed sites, and 27,279 photos of artifacts. The photo files are provided in low resolution to allow easy access on a single DVD (total size ~7GB). The original high-resolution files (total size ~200GB) can be accessed with permission from T.E. Levy (tlevy@ucsd.edu) at the UC San Diego Levantine Archaeology Laboratory.

I. Cotsen Photography Folder

This folder contains one Microsoft Excel spreadsheet titled: "Description Legend for Excavations-Surveys and Collection of Artifacts from all ELRAP Projects" and two folders titled: "Photography of all ELRAP Excavation and Survey Sites" and "Photography of Artifacts from all ELRAP Excavations and Surveys." The Excel spreadsheet contains two separate tabs which detail the "Site-Survey Acronyms" for all ELRAP projects along with information about field seasons and supervisors. The second tab within the document is a list for all "Descriptor Codes" for artifact imagery.

These acronyms are used as folder titles when accessing the two folders containing all the photography for all ELRAP Excavations and Survey sites along with all associated artifact imagery. Below is a table explaining all the Site-Survey Acronyms for all ELRAP projects, seasons, and supervisors; for example, FBRS = Faynan Busayra Regional Survey.

JHI and ELRAP Projects: Field Directors - Thomas E. Levy and Mohammad Najjar
Iron Age Excavations and Surveys

Site-Survey Acronym	Site-Survey Name	Season(s)	Supervisor
FBRS	Faynan Busayra Regional Survey	2007	Erez Ben-Yosef
H2LE	Highlands to Lowland Edom Survey	2006	Neil G. Smith
JAJ	Jabal al-Jariya	2009	Erez Ben-Yosef
KAG	Khirbat al-Ghuwayba	2009	Erez Ben-Yosef
KAJ	Khirbat al-Jariya	2006	Erez Ben-Yosef
KAM	H2LE Khirbat al-Malayqtah	2006, 2007	Neil G. Smith
KEN-A	Khirbat en-Nahas, Area A	2002, 2006	Yoav Arbel
KEN-F	Khirbat en-Nahas Area F	2006	Adolfo Muniz

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Site-Survey Acronym	Site-Survey Name	Season(s)	Supervisor
KEN-M	Khirbat en-Nahas, Area M	2002, 2006	Elizabeth Monroe, Marc Beherec, Erez Ben-Yosef
KEN-S	Khirbat en-Nahas, Area S	2002	Lisa Soderbaum
KEN-R	Khirbat en-Nahas, Area R	2006, 2009	Yoav Arbel, Marc Beherec
KEN-T	Khirbat en-Nahas Area T	2006	Adolfo Muniz
KEN-W	Khirbat en-Nahas, Area W	2009	Adolfo Muniz
KIJ	H2LE Khirbat al-Kur	2007	Neil G. Smith
KIS	H2LE Khirbat al-Iraq Shmaliya	2007	Neil G. Smith
RAM	Ras al-Miyah	2006	Erez Ben-Yosef
RHI	Rujm Hamrat Ifdan	2004	Neil G. Smith
TW	H2LE Tawilan	2007	Neil G. Smith
WAGS	Wadi al-Ghuwayba Survey	2002	Lisa Soderbaum
WAJS	Wadi al-Jariya Survey	2002, 2007, 2009	Kyle Knabb
WFD40-A	Wadi Fidan 40, Area A	1997, 2004	Rula Shafiq, Adolfo Muniz
WFD40-B	Wadi Fidan 40, Area B	1997, 2004	Russell Petrovic, Sarah Malina
WFD40-C	Wadi Fidan 40, Area C	1997, 2004	Mike Homan, Elizabeth Monroe
WFD40-E	Wadi Fidan 40, Area E	2003	Neil G. Smith
WFS	Wadi Fidan Survey	1998	Thomas Levy
WFS	Wadi Fidan Survey	2004	Jim Anderson
WSMS	Wadi Salmina Mine Survey	2009	Erez Ben-Yosef
WF4	Wadi Fidan 4 IA Tombs	2003, 2004	Adolfo Muniz, Mohammad Najjar
KHI-E	Khirbat Hamra Ifdan, Area E	2007	Adolfo Muniz
KHI-F	Khirbat Hamra Ifdan, Area F	2007	Adolfo Muniz
KHI-H	Khirbat Hamra Ifdan, Area H	1999, 2000	Mike Homan
KHI-C	Khirbat Hamra Ifdan, Area C	1999	Craig Beardsley
KHI-L	Khirbat Hamra Ifdan, Area L	2000	Lisa Soderbaum
KHI-Y	Khirbat Hamra Ifdan, Area Y	1999, 2000	Yoav Arbel

***Photography of all ELRAP Excavations and Surveys Sites* Folder**

This folder contains all the photography of all ELRAP Excavations and Survey Sites with a Microsoft Excel document providing a list of all images found within the associated folders. The Excel spreadsheet has tabs for each site and provides the directory for all images within the Photography of all ELRAP Excavations and Survey Sites folder. The structure of the folder is based by site or survey name using the acronyms listed above. The general structure of each folder is constructed in the following format:

Site (acronym) / Season (year) / Supervisors / Area / Image

For example, if one wants to find an image of Khirbat en-Nahas 2002 Area A of the excavation; the following directory would look like this: KEN / 2002 / Supervisors / Area A/ Image

Most images can be viewed using this general directory; however, certain sites and surveys have multiple subfolders.

Khirbat en-Nahas (KEN) has three sub-folders within each season: PEOPLE, PROJECT MANAGER, and SUPERVISORS. The PEOPLE and PROJECT MANAGER subfolders contain images of volunteers and working photos during the excavations seasons. The SUPERVISORS subfolder will contain all the images of the excavation applicable to the final report.

Wadi Fidan 40 (WFD40) folder has subfolders within the Area folder that are labeled by Grave number containing all images associated with the specific grave.

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Photography of Artifacts from all ELRAP Excavations and Surveys **Folder**

This folder contains all the photography of artifacts from all ELRAP Excavations and Surveys with a Microsoft Excel document providing a list of all images found within the associated folders. The structure of the folder is based on the site or survey name using the acronym list above. The structure of the folder is constructed in the following format:

Site (acronym) / Season (year) / Area / Descriptor Code / Image

The images are organized by site name (acronym), season (year), Area and then Descriptor Code. All artifacts images will be placed under their corresponding descriptor code, for example: If one wants to find an image of a bead from Khirbat en-Nahas (KEN) season 2006, Area A, the following directory would be structured as such;

KEN / 2006/ Area A/ BD Bead / Image name

The image of the bead will have multiple angles and scale displayed.

II. Cotsen Supplementary Material Folder

This folder contains all the Chapter Supplementary Materials, which include: appendices, endnotes, photography, and tables referenced in the text associated with Chapters 2, 7,8, 9, and 12. Within the "Chapter Supplementary Materials" folder there are subfolders, which are labeled by chapter number and contain referenced materials from the printed text. The following is an outline for the information located within each folder.

CH 2 Supplementary Materials **Folder**

This folder contains supplementary materials for Chapter 2 in three separate subfolders. The folder "Chapter 2 Appendix" contains all appendix references from Chapter 2 in the printed text. Below is a description of the folder's contents.

The subfolder labeled "Chapter 2 Supplementary Figures Low Res" contains all images of the supplementary figures referenced in the printed text.

File Name	Description
Appendix 2.A.1.pdf	KEN AREA A 2002 Master Loci List
Appendix 2.A.2.pdf	KEN AREA A 2006 Master Loci List
Appendix 2.A.3.pdf	KEN AREA A 2002 Master Wall List
Appendix 2.A.4.pdf	KEN AREA A 2002 Master Room List
Appendix 2.A.5.pdf	KEN AREA A 2002 Small Finds List
Appendix 2.A.6.pdf	KEN AREA A 2006 Small Finds List
Appendix 2.A.7.pdf	KEN AREA A 2002 Harris Matrix
Appendix 2.A.8.pdf	KEN AREA A 2006 Harris Matrix
Appendix 2.F.1.pdf	KEN AREA F 2006 Master Loci List
Appendix 2.F.2.pdf	KEN AREA F 2006 Master Wall/Room List
Appendix 2.F.3.pdf	KEN AREA F 2006 Master Small Finds List
Appendix 2.F.4.pdf	KEN AREA F 2006 Harris Matrix
Appendix 2.M.1.pdf	KEN AREA M 2002 Master Loci List
Appendix 2.M.2.pdf	KEN AREA M 2006 Master Loci List
Appendix 2.M.3.pdf	KEN AREA M 2002 Master Wall/Room List
Appendix 2.M.4.pdf	KEN AREA M 2006 Master Wall/Room List
Appendix 2.M.5.pdf	KEN AREA M 2002 Master Small Finds List
Appendix 2.M.6.pdf	KEN AREA M 2006 Master Small Finds List
Appendix 2.M.7.pdf	KEN AREA M 2002 Harris Matrix

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File Name	Description
Appendix 2.M.8.xls	KEN AREA M 2006 Harris Matrix
Appendix 2.R.1.pdf	KEN AREA R 2006 Master Loci List
Appendix 2.R.2.pdf	KEN AREA R 2009 Master Loci List
Appendix 2.R.3.pdf	KEN AREA R 2009 Master Wall/Room List
Appendix 2.R.4.pdf	KEN AREA R 2006 Master Small Finds List
Appendix 2.R.5.pdf	KEN AREA R 2009 Master Small Finds List
Appendix 2.R.6.pdf	KEN AREA R 2006 Harris Matrix
Appendix 2.R.7.xls	KEN AREA R 2009 Harris Matrix
Appendix 2.S.1.pdf	KEN AREA S 2006 Master Loci List
Appendix 2.S.2.pdf	KEN AREA S 2006 Master Wall/Room List
Appendix 2.S.3.pdf	KEN AREA S 2006 Master Small Finds List
Appendix 2.S.4.pdf	KEN AREA S 2006 Harris Matrix
Appendix 2.T.1.pdf	KEN AREA T 2006 Master Loci List
Appendix 2.T.2.pdf	KEN AREA T 2006 Master Wall/Room List
Appendix 2.T.3.pdf	KEN AREA T 2006 Master Small Finds List
Appendix 2.T.4.pdf	KEN AREA T 2006 Harris Matrix
Appendix 2.W.1.pdf	KEN AREA W 2009 Master Loci List
Appendix 2.W.2.pdf	KEN AREA W 2009 Master Walls/Room List
Appendix 2.W.3.pdf	KEN AREA W 2009 Master Small Finds List
Appendix 2.W.4.pdf	KEN AREA W 2009 Harris Matrix
Appendix 2.2 14C ELRAP	Radiocarbon 14 list for ELRAP

The subfolder labeled "Chapter 2 Supplementary Material" contains two documents. The first document, CH 2 Supplementary Material.pdf, contains all the endnotes referenced in the printed text, supplementary figures with descriptions and supplementary tables. The second document labeled, CH 2 Supplementary Tables, contains all the supplementary tables referenced in the printed text.

***CH 6 Supplementary Materials* Folder**

This folder contains supplementary materials for Chapter 6 divided in two sub-folders labeled "FBRS Scanned Daily Maps" and "Regional Road High Resolution." The two folders contain scanned daily maps of the FBRS survey and high-resolution images regional roads.

***CH 7 Supplementary Materials* Folder**

This folder contains supplementary materials for Chapter 7 two files that list the site locations in both PDF and Microsoft Excel sheet.

***CH 9 Supplementary Materials* Folder**

This folder contains supplementary materials for Chapter 9 with two subfolders labeled: "CH 9 Supplementary Figures Low Res" and "CH 9 Supplementary Material." The CH 9 supplementary figures low res subfolder contains all the supplementary figures referenced in the printed text. The second subfolder CH 9 Supplementary Material contains several files in pdf format: Chapter 9 Supplementary Materials PDF contains all supplementary images with their descriptions and all the supplementary tables; the remaining four files contain individual pdf files for supplementary tables referenced in the printed text.

***CH 12 Supplementary Materials* Folder**

This folder contains supplementary material for Chapter 12 with a .tif file labeled "Appendix 12 _ 5.119_KHI07_Area_E_Harris-F.tif" which displays the Harris matrix from KHI Area E.

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1 The Iron Age Edom Lowlands Regional Archaeology Project

Research, Design, and Methodology[1]

Thomas E. Levy, Erez Ben-Yosef, and Mohammad Najjar

The Edom Lowlands Regional Archaeology Project (ELRAP) is rooted in an anthropological archaeology approach to study the role of technology in social evolution—from the prehistoric to historic periods in southern Jordan. The project began in 1997 as part of the Jabal Hamrat Fidan Project initiated by a team from the University of California at San Diego and the Department of Antiquities of Jordan. As a "deep-time" study, the project began by exploring the exploitation of copper ore in the Pre–Pottery Neolithic period and Early Bronze Age. By 2002, ELRAP crystallized, with a major focus on the role of mining and metallurgy on the rise of the Iron Age kingdom of Edom, known from historical sources—especially the Hebrew Bible. In this chapter, we present an overview of the ELRAP theoretical approach, research design, and methods. Both theory and method underlie all aspects of the research presented in each chapter of this volume.

Research Design: Theory and the Edomite Lowland Research Area

One of the important contributions of the "New Archaeology" was making the construction of a well-conceived research design a key component to successful archaeological fieldwork (Binford 1964; Flannery 1976). Underlying the research design described for our fieldwork in southern Jordan is the idea that culture is a system consisting of a web of interrelated subsystems. The main components include social organization, economy, subsistence, ritual and religion, and technology. The range of research questions asked by any archeological field project that aims to explain change in cultural systems through time depends on the interrelationship between the archaeological temporal setting, the function of sites in the study area, their environmental context, and the formation processes that affect cultural heritage preservation in the region. For the Edom Lowlands Regional Archaeology Project, the copper ore–rich deposits of the Faynan district make the role of mining and metallurgy (the technology subsystem) the key variable for studying culture change in the Faynan arid zone in southern Jordan. Based on these parameters, three generalized models are useful for the present study: tribal models of social integration, interaction models rooted in social and economic exchange,

Opposite: Model of parts of the ELRAP Cyber-Archaeology field recording system deployed at Khirbat en-Nahas: A) Laser scanner, B) Reflectorless total station, C) Helium balloon and Unmanned Aerial Vehicle (UAV) for low altitude photography and mapping, D) Tablet for metadata collection from excavation, E) Laptop for Wi-Fi real-time viewing of balloon cameras *Image: T.E. Levy and Scott Blair, Qualcomm Institute, UCSD.*

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and the *chaîne opératoire* anthropological approach for studying technology.

Models for Examining Social Change

In configuring models of social change for southern Jordan's Faynan district during the Iron Age BCE, two fundamental influences must be factored in: changes in both tribal social organization and modes of copper production and control. As the Iron Age spans approximately 700 years, it is crucial to consider that this is a dynamic period when fundamental changes in social organization and historical circumstances can occur rapidly at the century or even subcentury scale. Social interaction and production are central to understanding the role of segmentary societies and empires in the emergence of the historically documented secondary states or kingdoms in the southern Levant. When well-documented archaeological sources are coupled with textual and archaeological data, it should be possible to test a wide range of hypotheses that will enable researchers to build dynamic models of social evolution for historical archaeology. This pragmatic approach has been described elsewhere (Levy 2010a, 2010b). The sociopolitical structure and developmental trends linked to the emergence of Iron Age states in the southern Levant (Israel/Palestine/Jordan) are a highly contentious issue (Albright 1958; Ben-Tor 2002; Finkelstein 1998, 1999, 2000; Finkelstein and Silberman 2006; Halpern 1996, 1999; Holladay 1998; Joffe 2002a, 2002b; Knauf (Belleri) 1992; LaBianca and Younker 1995; Levy 2004, 2009; Levy, Najjar, van der Plicht, et al. 2005; Masters 2001; Rothenberg 1972; Routledge 2000; Stager 2003). The role of metal production in Levantine Iron Age societies is also a debated topic, but it has been primarily focused on the technological and typological aspects of production rather than the social context in which it took place (Finkelstein and Piasetzky 2008; Fritz 2002; Hauptmann 2007; Muhly 1999; Rothenberg 1990, 1998; Waldbaum 1999; Weisgerber 2006; Yahalom Mack 2009). The ELRAP project attempts to go beyond this by taking an anthropological archaeology approach to fieldwork that is rooted in the cyber-archaeology methods described below.

As described below, the desert landscape of the Edom lowlands in particular, and Transjordan in general, has made the role of segmentary (tribal) societies a key factor in understanding the evolution of complex societies from the Iron Age until the present (Bienkowski and van der Steen 2001; LaBianca 1999; LaBianca and Younker 1995; Levy 2009; Routledge 2004; Routledge and Porter 2007; van der Steen 2013; Younker 2003). As will be seen in this volume, the "tribal" roots and underpinnings of the Iron Age kingdom of Edom were foundational. Prior to the ELRAP expedition in 2002, it was assumed that Iron Age states in Ammon and Moab did not emerge until the ninth or eighth centuries BCE and, in Edom, even later in the seventh and sixth centuries BCE (Bennett 1966, 1977; Bennett and Bienkowski 1995; Bienkowski 1990a, 1990b, 1992b, 1992c, 1995, 2000a, 2001, 2002; Bienkowski and Adams 1999; Bienkowski and van der Steen 2001). With the publication of the first radiocarbon dates and Bayesian analyses of short-life organic samples from Khirbat en-Nahas (Higham et al. 2005; Levy et al. 2004; Levy, Najjar, van der Plicht, et al. 2005), our team challenged this accepted view by pushing the chronology of Iron Age Edom some 300 years.

The New Iron Age Chronology of Edom

Based on stratified excavations carried out primarily at Khirbat en-Nahas (and some other sites) in the lowland region of Edom, ELRAP has demonstrated that during the tenth and ninth centuries BCE, there was a large nomadic community in the Faynan district, that construction of monumental architecture (buildings and a fortress) occurred, and that the peak periods of industrial-scale copper production in Faynan happened during the Iron Age IIA period (Higham et al. 2005; Levy et al. 2004; Levy, Najjar, Muniz, et al. 2005; Levy, Najjar, van der Plicht, et al. 2005; Levy et al. 2008). These data are presented in final format in this volume. By pushing back the Iron Age chronology of biblical Edom some 300 years (Figure 1.1), ELRAP effectively brought the archaeology of this region back to the study of the historicity of many biblical narratives traditionally dated to the thirteenth to ninth centuries BCE dealing with topics such as the kings of Edom who reigned before there were kings over the Israelites (Genesis 36:2), to David having conquered and establishing garrisons in Edom (2 Samuel 8.14, 1 Chronicles 18:13) in the early tenth century BCE, to Solomon's rule in the region (1 Kings 11:1,14), to the social structure and ultimate revolt of Edom over the ninth-century BCE king of Judah (1 Kings 22:48, 2 Kings 8:20). Nelson Glueck and other early twentieth-century archaeologists had unquestioningly accepted the historical veracity of these biblical narratives concerning Edom (Albright 1971; Avishur 2007; Glueck 1940; Musil 1907), but this "maximalist" interpretation of the biblical sources and archaeology was challenged as a result

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of Crystal Bennett's extensive excavations in the highlands of Edom, where the earliest Iron Age remains were assumed to date from the seventh and sixth centuries BCE, resulting in the erasing of an early Iron Age (I–IIB) archaeological history of southern Jordan (Bennett 1966; Bennett and Bienkowski 1995; Bienkowski 2002; Pratico 1993). ELRAP's excavation results and radiocarbon dating research in the copper ore–rich Faynan district became a hotly debated issue, joining a much larger discourse on the nature of the tenth-century BCE history of the southern Levant, a period closely linked to the early Hebrew kings, David and Solomon, and whether they ruled over a kingdom (state)–level society. Our research attracted not only reactions from other scholars but also the international press and other media. These debates are summarized in a number of scholarly publications (Boaretto et al. 2005; Finkelstein 2005, 2010; Finkelstein and Piasetsky 2006, 2008, 2009, 2010, 2011; Finkelstein and Silberman 2001, 2006; Finkelstein and Singer-Avitz 2008; Frese and Levy 2010; Garfinkel and Ganor 2009; Gilboa et al. 2009; Gilboa and Sharon 2001; Levy et al. 2006; Levy and Najjar 2006a, 2006b; Levy, Najjar, and Higham 2005, 2007; Mazar 2005, 2010, 2011; Mazar and Bronk Ramsey 2008; Mazar et al. 2005; Sharon et al. 2005, 2007; van der Steen and Bienkowski 2005a, 2005b, 2006). While the historical "facts" concerning the existence and nature of the United Monarchy remain unanswered, the research presented in this volume builds on our earlier results and also enhances them by presenting conclusive evidence for the existence of local Levantine complex societies during the tenth and ninth centuries BCE in Edom capable of organizing a vast copper production system that centered on Faynan. This point cannot be minimized as there are still conflicting scholarly views that there were no local complex societies in Cisjordan or Transjordan during the tenth-century BCE (see Finkelstein and Silberman 2006:282–84). In Chapter 2 (this volume), new radiocarbon dates from our most recent stratigraphic excavations at Khirbat en-Nahas and other lowland sites are presented along with new Bayesian analyses consolidating the new Iron Age chronology of Edom graphically portrayed in Figure 1.1. The demonstration that local complex societies lived and produced copper metal during the tenth and ninth centuries BCE has profound implications for testing both anthropological and historical models of culture change in this part of the "Holy Land" or southern Jordan. The radiocarbon dating record established by our team for Edom represents the largest suite of Iron Age dates in Jordan, and those from Khirbat en-Nahas are the largest suite from any single Iron Age site in the southern Levant. Taken together, the ELRAP radiocarbon chronology for Edom supports what Amihai Mazar refers to as the modified conventional chronology (Mazar 2005, 2011; Mazar and Bronk Ramsey 2008). Many of the claims of the low chronology (see Finkelstein and Piasetsky [2011] and references therein), especially for the tenth-century BCE socioeconomic and history of the southern Levant are untenable and questioned by the radiocarbon dates discussed in Chapter 2 (this volume). The general chronological division of the Iron Age I–IIA in Israel/Palestine/Jordan and its relation to the Faynan study area is presented in Table 1.1. The following section describes some of the socioeconomic models and hypotheses that can be examined with the large Iron Age archaeological data sets throughout this volume.

Background to Theoretical Models

The geographic and paleoenvironmental data for Faynan and southern Jordan reviewed below highlight the centrality of two key variables for understanding cultural evolution over the past three millennia: the

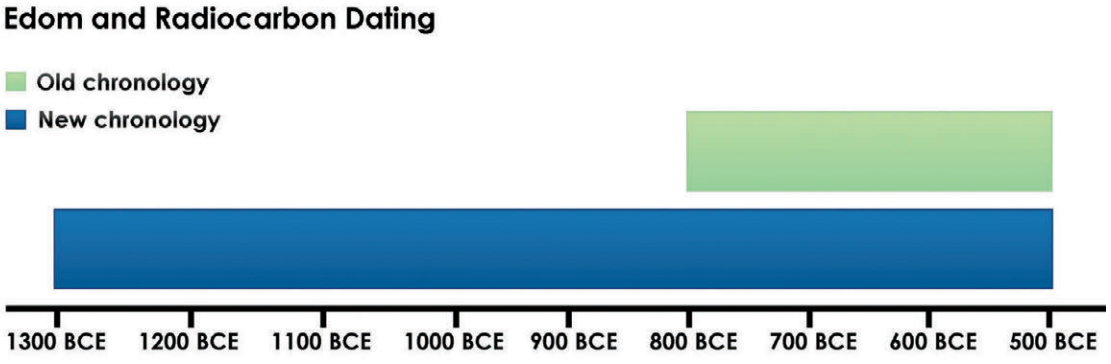

Figure 1.1 Model illustrating the new radiocarbon-based chronology of Edom compared with the previous one.

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Table 1.1 Chronological division of the Iron Age I–IIA in Israel/Palestine/Jordan based on the modified conventional chronology of Mazar (2011:11). The distinction between the two parts of the Iron Age IIA is not delineated here.

Sub-period	Dates BCE	Lowlands	Philistia	Central hill country, Shephelah, and the Negev	Transjordan
Iron IIA (early and late phases)	ca 830	Emergence of a new urban system with monumental architecture either at the second half of the tenth century or the ninth century (Megiddo IB–VA; Hazor X–VIII; Gezer VIII); Rehov VI–IV Red-slipped and burnished pottery	Late Philistine Painted Ware (= "Ashdod Ware"); period ends with the destruction of Gath	Samaria and Jezreel royal enclosures built during the ninth century Monumental architecture in Jerusalem Beth-Shemesh fortified Negev highland sites Khirbat Qeyafa (early phase of the period)	Copper production at Faynan at its peak (Khirbat en-Nahas)
Final Iron IB	ca 980?	Violent destructions of Megiddo VIA, Yoqneam XVII, Tel Hadar IV; Tel Kinneret	Destruction of Ekron IV, Tell Qasile X	Tel Masos II	
Iron IB		Iron IB urban centers along coast (Dor, Tell Keisan) and a few inland sites (Megiddo VI, Tel Rehov, Tel Beth-Shean); emergence of Phoenician culture at the end of the period	Expansion of Philistine settlement from the Yarkon River to Besor Brook; Bichrome Philistine pottery	Hundreds of settlement sites in the central hill country and Galilee; Shiloh V; Jerusalem settled	Fortified settlements in Moab Large settlements in Ammon Beginning of copper production at Faynan
Iron IA	1140/30 1200	Few Egyptian Twentieth Dynasty strongholds (Beth-Shean, Tel Sera'); few Canaanite cities survive, others in ruins.	Initial Philistine settlement at Ashkelon, Ashdod, Gath, and Ekron; Monochrome pottery in Aegean style		Tell el 'Umayri

arid environment and abundance of copper ore. From a cultural ecology perspective (Henry 1995; Hill 2000; Levy 1998; Stager 1988; Steward 1968), the long-term arid environment of Edom and much of Transjordan has created what may be termed a "nomadic imperative" for societies living in this region. The longevity of this process is attested for in Iron Age (and earlier) ancient Near Eastern textual data. During the Late Bronze Age (ca. 1500–1200 BCE), the Egyptian "Execration Texts" indicate that outsiders already knew the area as Edom

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(Kitchen 1992). According to Bienkowski (1992a), until the early 1990s, most scholars believed that Edom remained largely nomadic until the seventh century BCE, supporting biblical evidence (Bartlett 1989) that it was only in the eighth and seventh centuries BCE that biblical writers became aware of Edom as a state power. However, by the early twenty-first century, the Deutsches Bergbau-Museum, the University of California at San Diego (UCSD) ELRAP, and the Council for British Research in the Levant (CBRL) teams working in the Faynan region showed the complex interplay between nomadic, semi-nomadic, and sedentary life-ways during the Iron Age (Barker, Gilbertson, and Mattingly 2007a; Hauptmann 2007; Levy et al. 2012). To accurately interpret the changing social, economic, and subsistence organization of Iron Age societies in Faynan, the underlying tenet of segmentary or tribal societies (i.e., the continuous process of social fusion and fission) must be factored into all social modeling throughout the approximately 700-year Iron Age sequence.

Besides the debate concerning *when* the Edomite state emerged outlined above, the question of *how* it happened is also contentious. Prior to the ELRAP project, and even now among certain scholars today (Artzy 1994, 2003; Bienkowski and van der Steen 2001; Crowell 2004; Ephal 1982; Finkelstein 1988, 1992; Singer-Avitz 1999; Tebes 2007; van der Steen 1999), the catalyst for the emergence of the Edomite kingdom (state) has been closely linked to the Arabian trade. It has been assumed that Edom's geographical location as the outlet of the west Arabian "incense route" to the Mediterranean ports on the coast of Palestine and the control of those trade routes led to rise of the Edomite kingdom. The new comprehensive data sets presented here from the ELRAP explorations in northern Edom's Faynan copper ore resource zone attest that equally, if not more, important was the role of copper production in the rise of local social complexity during the early first millennium BCE. Now that our team has established a much longer Iron Age chronology for Edom that fits closely with Mazar's modified conventional chronology (Mazar 2011; see Table 1.1), it is essential to assess the Iron Age archaeological record as reflecting oscillations of socioeconomic change during this approximately 500-year period that spans the late thirteenth to seventh centuries BCE. Simply put, the Iron Age history of Edom was *not* a static process. As pointed out in other research by our team (Ben-Yosef 2010; Levy 2009; Levy et al. 2012; Levy et al. 2008; Smith 2009), Iron Age cultural and economic changes were part of a shifting process that were deeply linked to the changing control of copper in the Faynan region during this approximately 500-year period. Thus, the ELRAP Iron Age data collected and analyzed here are used to assess the following general issues: (a) the role of nomadic populations in the evolution of complex societies and metallurgy in Edom (Chapters 1, 7, 8, 9, and 15); (b) the structure of local versus outside control of metallurgy throughout the Iron Age sequence in Faynan (Chapters 1, 2, 5, 6, and 11–13); (c) trade routes that may have facilitated the movement of copper ore, metal, and other goods in the Faynan district and beyond (Chapters 1 and 6); (d) how the local social structure may have changed when the area came under the influence of the expanding Neo-Assyrian empire/core civilization in the eighth to seventh centuries BCE (Chapters 3, 5, 6, 10, 12, and 14) (Millard 1992; Na'aman 2004; Na'aman and Thareani-Sussely 2006); and (e) whether neighboring small-scale Iron Age polities from neighboring Cisjordan or northern Arabia had any control of metal production in the Faynan district in the eleventh to ninth centuries BCE or other Iron Age phases, as reflected in ancient historical texts (Chapters 1, 4–6, and 10–12).

Generic Models of Production, Interaction, and Society

Based on ancient Near Eastern texts and anthropological data, two generic diachronic models concerning the control of copper production in Edom by local versus foreign sociopolitical organizations can be used to explain the patterns of Iron Age mining and metallurgy revealed by our excavations and surveys in the Faynan district. These models function in two ways as they help test the historicity of different aspects of the ancient Near Eastern literature that touches on Edom (Bartlett 1989, 1992, 1999; Ehrlich 2009; Kitchen 1992, 2003, 2004; Millard 1992; Shortland 2005); they also contribute to more general anthropological archaeology research concerning social evolutionary processes responsible for the emergence, maintenance, and ultimate collapse of chiefdoms and states (Carneiro 1970; Earle 1991a, 1991b; Feinman and Marcus 1998; Flannery 1999a, 1999b; Gellner 1990; Kirch 1991; Knauf (Belleri) 1992; Levy 2006, 2009; Redmond 1998; Southall 1991, 1999; Stein 1991; Wright 1978). In what follows, the two general models are presented with a series of test implications that should hold true if the respective model is correct.

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Generic Model 1—Foreign Dominance of the Faynan Copper Ore District

Foreign dominance of Edom has been used to explain the rise of the Edomite kingdom/state from two different perspectives. As mentioned above, until the ELRAP project, from approximately 1966 to 2002, it was assumed that the emergence of the Edomite kingdom could be explained as a result of the expansion of the Assyrian empire into the southern Levant and the incorporation of this region as a tribute state (see, e.g., Bennett 1992; Bienkowski 2000b; Pratico 1985, 1993). This was due to the first systematic large-scale excavations at Iron Age sites carried out in the highlands of Edom. Prior to Crystal Bennett's work at sites such as Tawilan, Busayra, and Umm al-Biyara, locales that had been discovered by Nelson Glueck (1935, 1936b, 1937a, 1937b, 1938, 1940), Glueck's theories that linked the history of Edom tightly to the Hebrew Bible narrative were the accepted paradigm. From the mid-1930s until Bennett's fieldwork, most scholars assumed that the extensive evidence of Iron Age copper production in the Arabah Valley, especially around Faynan and Timna (Wadi Mene'iyeh), were directly tied to David, Solomon, and some of the later Judean kings. Glueck (1940:50–88) went so far as to describe the Arabah Valley Iron Age mining and metallurgy sites as "King Solomon's Copper Mines." Both the "Assyrian" model and the "Judean" control model for Edom may be subsumed under a generic "foreign dominance" or "core-periphery" model to explain the emergence of industrial-scale copper production in Faynan. Anthropologists and ancient historians can use a variety of core-periphery models to explain the intensification of production and social complexity in the archaeological record (Levy and van den Brink 2002). These models include diffusion (Childe 1936; Rouse 1958), world systems (Algaze 2005; Frank and Gills 1996; Sanderson 1995; Wallerstein 1974), colonialism (Goldstein 2005; Larsen 1976; Stanish 2001), imperialism (Ekholm and Friedman 1982), dependency theory (Frank 1967), trade diasporas (Cohen 1971), and distance-parity (Stein 1999). While all these models can best be conceptualized as core civilization or complex society-centered relations with their "underdeveloped" peripheries, they may all be applied to the issue of foreign dominance of the region of Edom—whether for the control of trade routes, copper ore resources, or some other factor. In this context, when examining the oscillating history of ancient Edom through its approximately 500-year Iron Age trajectory, the following test implications may be expected if foreign dominance underlies the control of production and social organization (see Levy 2004):

(a) There should be evidence of formal socioeconomic links between foreign polities and the Faynan copper production complex to enhance the expanding economy of foreign states/kingdoms through time. This could be identified through the discovery and analysis of epigraphic data (stamp impressions, ostraca, potters' marks, inscriptions, and standardized trade items from the core societies [ceramics, etc.]).

(b) The presence of officials or representatives of foreign complex societies could be recognized in the archaeological record by the presence of symbols of rank and power at central production sites such as Khirbat en-Nahas (the largest identifiable Iron Age site in the Faynan region) and its hinterland. These symbols could be reflected in architecture, items of personal adornment, and so on.

(c) There should be evidence of a well-established foreign state administrative hierarchy reflected in the spatial organization of sites in the periphery study area. One data source would be mortuary data from sites and cemeteries in the study area. Can foreign versus local burial practices be identified in the research area?

(d) An imposed foreign colony could be evidenced by monumental or administrative architecture imposed on the Faynan landscape by the "core" complex society. Support for this implication could be the presence of foreign state/kingdom-style tombs, architecture, segregated administrative complexes, and other architectural features.

(e) A colonial presence could be reflected by evidence of the establishment of foreign settlements such as trading posts, foreign fortress complexes, or administrative centers along trade routes and/or near resource concentrations in the study area.

(f) There should be evidence of differences in agro-pastoral production strategies between the resource concentration zone periphery and other settlement areas in the southern Levant or greater Near East indicating shifting patterns of economic specialization. Identifying the shifting role of pastoral societies in the study area through the Iron Age sequence could shed light on this implication (e.g., Henry 1992; Khazanov 1994; LaBianca et al. 1990; Muniz 2006; Zeder 1991).

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(g) Local elites at production centers such as Khirbat en-Nahas and its hinterland should emulate core complex society ideological systems through the acquisition or replication of prestige objects from the core regions.
(h) Foreign dominance of trade and exchange should be evidenced through the establishment of foreign state/kingdom administrative systems in the study area. This would be manifested through petrographic studies of pottery, seal impressions, metal and stone objects to identify patterns of exchange between regions, and foreign architectural "footprints" in the study area.
(i) "Colonists," whether they be Iron Age Egyptians, Israelites, Midianites, Assyrians, Babylonians, or Persians, should reside in the study area. This would be evidenced by domestic spatial patterns of consumption, discard, food preparation, and the use of living space that is different from local patterns.
(j) There should be evidence of increasing social complexity that is a direct result of contact with the foreign complex society resident in the research area.
(k) Although not a necessary condition for evidence of foreign dominance in the resource/study zone, there could be proof of military conquest or control (fortresses) in the study area.

Generic Model 2—Local Autonomy in the Faynan Copper Ore District

There are important alternatives to the core civilization or core complex society "centric" interaction models outlined above. In a penetrating critique of world systems theory and core civilization dominance models in general, Gil Stein (1999) has discussed the problems with these approaches and alternatives rooted in notions of trade-diasporas and distance parity models. According to Stein (1999:44), the main drawbacks of world systems theory rest on its problems as a theoretical construct, as a model originally meant to describe the development of modern European capitalism and its applicability for cross-cultural studies of the precapitalist archaeological record. Essentially, the alternative core models are those that highlight the centrality of local autonomy on the evolution of social complexity and increasing levels of production. For Stein, the importance of local autonomy in these developments is best reflected in trade-diaspora and distance-parity models. These interaction models (both foreign dominance and local autonomy) are important because they relate directly to the issue of the control of production—a critical factor when examining the role of craft production in social change (Costin 1991, 2001; Costin and Wright 1998). Trade diasporas provide a socioeconomic solution to the problem of trade across cultural boundaries, which can be risky. As the complexity of exchange between producers and consumers increases, specialized intermediaries who travel between regions or take up residence in a resource/production zone can facilitate trade (see Stein 1999:46, 62–64). With regard to Stein's distance-parity model of interregional interaction, distance from core/complex society centers can work against the establishment of dependency relationships with the periphery. Thus, increasing distance from core civilization/complex society centers can result in (1) the decline in core control over trade, leading to symmetric rather than asymmetric exchange, as assumed in world systems theory; (2) a decrease in long-distance exchange; (3) a reduction in the exchange of surplus versus prestige goods (such as metal); (4) a progressive reduction in core economic pressure to produce specialized crafts; (5) a decrease in the effective ability of the core to project military, economic, and political power on the periphery; and (6) a progressive decline in the ability of the core to affect sociopolitical development on the periphery. We would expect to confirm a number of test implications when local autonomy was the primary sociopolitical environment that dominated the Faynan copper ore resource zone during the Iron Age. Some of these test implications include the following:

(a) The local Khirbat en-Nahas–Faynan hinterland economy should be geared toward a general subsistence base with little evidence of specialization and trade of surplus from other regions.
(b) Local elites should emulate foreign ideology but display evidence of their independence.
(c) Evidence for changes in social complexity should not display rapid or "punctuated" abrupt changes in the local archaeological sequence of the study area that feature the introduction of large quantities of the foreign core civilization/complex society material culture.
(d) Exchange between foreign polities and Khirbat en-Nahas and its hinterland should be of low volume. Following Stein (1999), the only foreign goods should be those with high ratios of value to weight (or bulk).

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(e) There should be symmetry in exchange relations with little evidence of foreign domination.
(f) In the periphery societies, there should be no major changes in the intensity of production in agropastoral or craft specialization accompanied by large quantities of the foreign core civilization/complex society material culture.

The Faynan, Jordan Study Area

To highlight the centrality of the environment and resources that confronted Iron Age societies that carried out mining and metallurgy in the Faynan copper ore resource zone, the following discussion outlines the major environmental variables that characterize this part of the southern Levant. In addition to current environmental data, brief discussions of the historical-cultural boundaries of Edom and the paleoenvironmental data are also considered.

The Environmental Setting of Faynan

During the Iron Age, primary copper production (smelting of copper minerals to produce copper metal) took place in the vicinity of the ore bodies of the southern Levant and was a direct continuation of the mining activities. The extracted copper, after processing, was most probably exported from the mining areas as a final product consisting of pure copper ingots. The entire *chaîne opératoire* of copper manufacture with its associated infrastructure took place in a rather limited area determined by the location of the mines (Ben-Yosef 2010). The physical characteristics of the mining environment, as well as those of the ore bodies themselves, are fundamental for understanding the nature of the local Iron Age societies that interacted with these resources. In the Saharo-Arabian desert environment of the Arabah Valley, the exploitation of copper ore was the *raison d'être* of Iron Age settlement in Faynan and Timna. Like mining and metallurgy during the Early Bronze Age in Faynan, these interactions directly influenced both social processes and the social structure of those societies associated with the organization of metal production. Factors such as the ore quality, fuel and water resources, accessibility to mines, trade routes, food, and building material supplies were fundamental in shaping social features as well as technological choices, installations, and products.

In addition to the interactions between society and natural resources, the geographic setting of the mining areas in the southern Levant, and in particular Faynan, is also a key for interpreting social boundaries and ethnicity, an elusive definition in archaeological research (e.g., Emberling 1997 and references therein; Smith 2009). In the case of Iron Age southern Jordan, the archaeological evidence (including inscriptions) coupled with historical sources suggests the dominance of the Edomites, although the exact extent of their territory throughout the Iron Age is not clear and seems to have oscillated. Moreover, the dramatic landscape of the Arabah Valley and the high western slopes of the Jordanian plateau took part in shaping the local society, as well as its perception by other social groups and polities in the southern Levant. It is therefore critical to consider the environmental background in the interpretation of the archaeological evidence of this region. Detailed surveys of the nature and geography of Faynan are available in Hauptmann (2007, chap. 3) and Palmer et al. (2007) and, more generally for the Arabah Valley, in Bruins (2006) and MacDonald (1992).

Geography

The copper ore district of Faynan is located approximately 40 km south of the Dead Sea and around 130 km north of the Gulf of Aqaba, along the eastern margin of the Arabah Valley and in the foothills of the Jordanian plateau (Figures 1.3 and 1.6). Approximately 100 km south of Faynan and along the western margin of the Arabah Valley is the smaller copper ore district of Timna that also contains important Iron Age remains of copper production (see below). The Faynan district is named after the major archaeological site of Khirbat Faynan (not to be confused with the small, mainly Pottery Neolithic site of Tel Wadi Faynan found in the 1980s), located on the confluence of Wadi Dana and Wadi Ghuweir and identified as biblical Punon (Figure 1.4; Num.33:42f., 1 Chron. 1:52 and see also "Pinon" in Genesis 36:40–43) (first by Zeetzen in 1854; see Edelman 1995).[2]

The Faynan region is located on the eastern margins of the Dead Sea–Wadi Arabah rift system, a major geological feature that is responsible for the dramatic morphology of the landscape and the distribution of different rock formations and ore outcrops. The rifting process resulted in the creation of the deep Gulf of Aqaba, the elongated Arabah Valley, the depression of the Dead Sea (as is well known, the lowest place on Earth), and an uneven lifting of both sides of the Rift Valley. While the Negev hills to the west rise gradually above the Arabah to an elevation of a few hundred meters above sea level, the Edomite Mountains to the east rise abruptly

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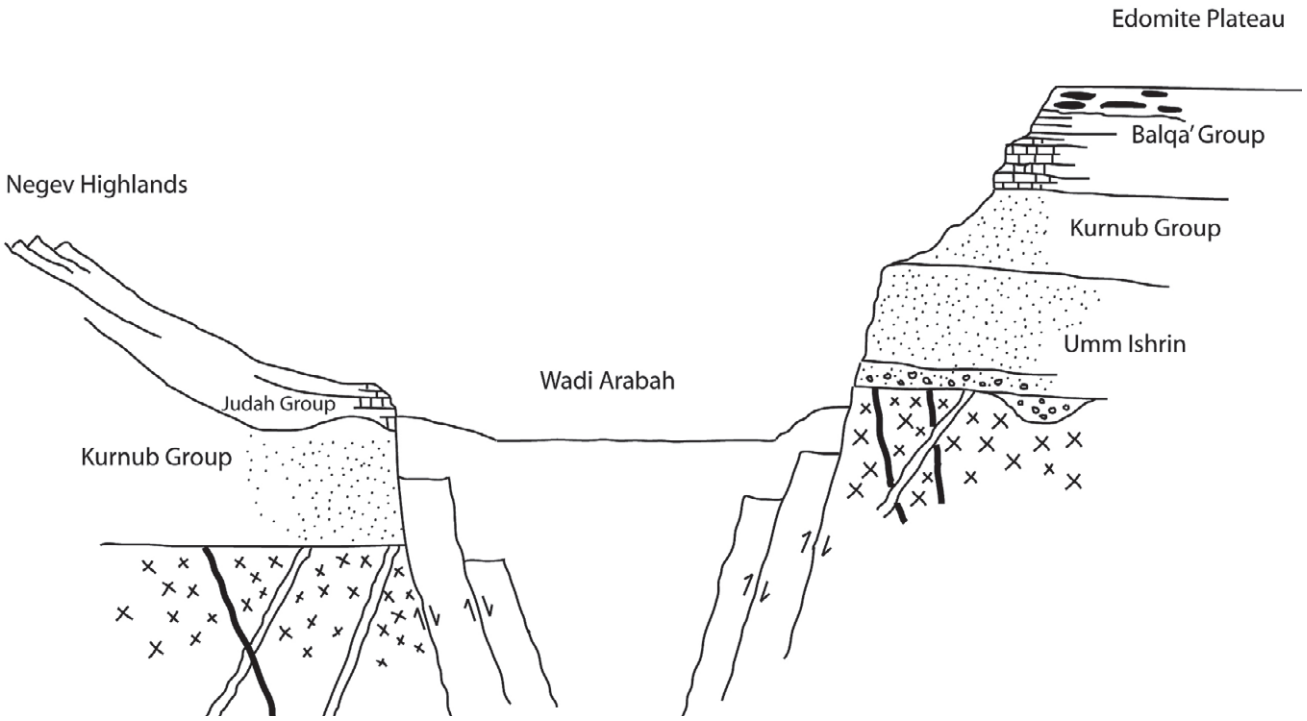

Figure 1.2 Schematic cross section of the Dead Sea–Arabah rift system around Faynan, showing the main geological units. The topographic terrain is much more difficult and dramatic on the eastern side of the rift, and the slopes of the Edomite plateau are a natural barrier (revised after Ravek and Shemida 2000).

to an elevation of almost 2,000 m above sea level and create a substantial topographic obstacle (Figure 1.2). Approximately 1,000 m in elevation separate Faynan and the late Iron Age administrative center of Busayra. This elevation difference, over a distance of less than 15 km as the crow flies, was overcome by well-built routes (see Chapter 6, this volume).

The considerably greater uplifting of the eastern side of the Arabah Valley resulted in the exposure of deep rock formations that represent the slopes of the Edomite Mountains and generally are not exposed on the western side (the Negev). Among these formations is the Umm Ishrin, whose red sandstone characterizes the Edomite landscape and constitutes the physical background of important sites such as Umm al-Biyara and Sel'a, and the Burj formation, the principal ore-bearing horizon (see below).

The Faynan area covers approximately 300 km^2 and includes two major wadi basins (separate water catchments zones) that are part of the Wadi Arabah and the Dead Sea drainage system (Figure 1.3). The wadi basins from north to south are Wadi al-Ghuwayba (Arabic for "little grove," probably after the one at the oasis of 'Ain al-Ghuwayba) and its tributaries and Wadi Fidan and its pronounced tributaries of Wadi Dana and Wadi Ghuweir, along which many of Faynan's important sites are located, including Khirbat Faynan and Khirbat Hamra Ifdan. The wadis are dry valleys or canyons, carrying water on rare occasions of strong local rains during the winter or the transitional seasons, usually in the form of flash floods. However, in each of the major wadi basins, permanent springs support small oases and are reliable water sources in the desert region of southern Jordan and the Arabah ('Ain al-Ghuwayba and 'Ain Fidan, respectively; *'Ain* is Arabic for "spring"; Figure 1.3). In addition to the well-known oases, the Faynan-Busayra Regional Survey (see Chapter 6, this volume) recorded other water sources in the area that mostly include *thmilat*, dug depressions into high water tables in wadi beds, representing additional water sources possibly available in antiquity as well. A traveler or a caravan passing through the landscape of southern Jordan and in particular its lowlands is entirely dependent on such water sources.

Geographical Boundaries of Edom

One of the most difficult challenges regarding Iron Age copper production in the region of Faynan (and also in

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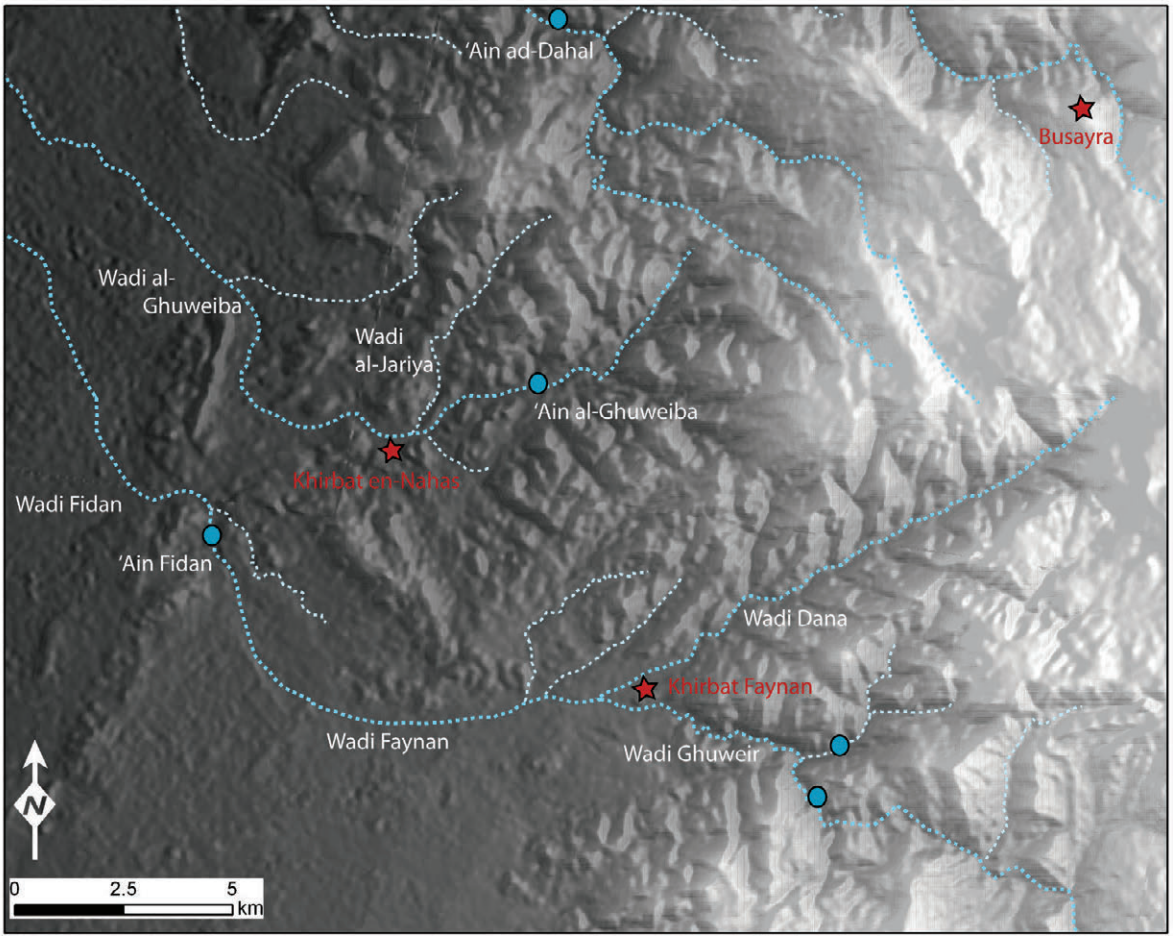

Figure 1.3 Major wadi basins and springs in the area of Faynan, Jordan. The wadis are part of the Dead Sea catchment and drain through the Wadi Arabah to the northwest. Wadi Ghuweir is a perennial stream that fed agricultural fields in the vicinity of Khirbat Faynan in different periods.

Timna) is identifying the ethnicity of the workers and the social group that had control over this enterprise. Lacking written evidence found in the local archaeological record (i.e., in the mining and smelting sites themselves), the primary source for identifying ethnicity is the material culture, and in particular ceramic studies, with all the serious problems these studies imply (e.g., Jones 1997 and references therein). In Faynan, a major ceramic study with a detailed discussion on social boundaries and ethnicity was published recently (Smith 2009; Smith and Levy 2008; Chapters 4 and 5, this volume). The results of this study are presented and discussed in Chapters 2 to 15 (this volume).

In addition to the archaeological record and the material culture (Chapters 2, 3, 5, 6, and 13, this volume), another source for reconstructing social boundaries includes historical accounts regarding the geographic region of Faynan in the Iron Age. The most important, albeit difficult, source is the Old Testament or Hebrew Bible (Figure 1.4; e.g., Bartlett 1989, 1992, and references therein), referring to the kingdom of Edom in the mountainous region of southern Jordan and the Negev highlands (Avishur 2007). Edom appears also in earlier Egyptian (Kitchen 1992) and Assyrian (Millard 1992) texts, as well as in late Iron Age ostraca found in some of the Negev sites (Beit-Arieh 1995).

The extent of the biblical/Iron Age kingdom of Edom fluctuated throughout the twelfth to sixth centuries BCE and is poorly delineated in biblical and other historical accounts (Figure 1.4). It is generally accepted that the mountain region of southern Jordan was the heart of this polity (Bartlett 1989; Edelman 1995), with Bozrah (Gen. 36:22; Isa. 34:6, 63:1; Jer. 49:13,22; Amos 1:12), one of its few securely identifiable settlements (modern Busayra), as its administrative center at least during the late Iron Age (Bienkowski 1995, 2002). It is also widely accepted that the term *Edom* referred initially to a distinct geographic region (e.g., 2 Sam. 8:14) and only later

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designated a polity or people. This is exemplified by the earliest known reference to Edom in the Egyptian source of Papyrus Anastasi VI[3] (referring to an event in the late thirteenth century BCE) (Bartlett 1989) and maybe by the descriptive nature of the term *Edom*, meaning "red" in Hebrew and probably referring to the prominent red sandstone cliffs of the mountain slopes of southern Jordan (Edelman 1995). A few other geographic terms in the Bible are associated with Edom, including Se'ir, Gebal, and Teman. Se'ir was suggested to represent the wooded land of southern Jordan following the Hebrew word meaning "hairy," the area south of Shawbak following the modern Arabic district name of "es-Shera," or areas in the Negev following the reading of Egyptian texts[4] (see in particular Bartlett 1989; Edelman 1995; Zucconi 2007); Gebal is perhaps the area north of Shawbak following the modern Arabic district name of el-Jibal, with a Eusebius reference to Gebalene and a Josephus reference to Gobolitis (Bartlett 1989; Freeman-Grenville et al. 2003); and Teman is probably a territory in southern Edom and not a specific settlement, as suggested before (Bartlett 1989; de Vaux 1969).

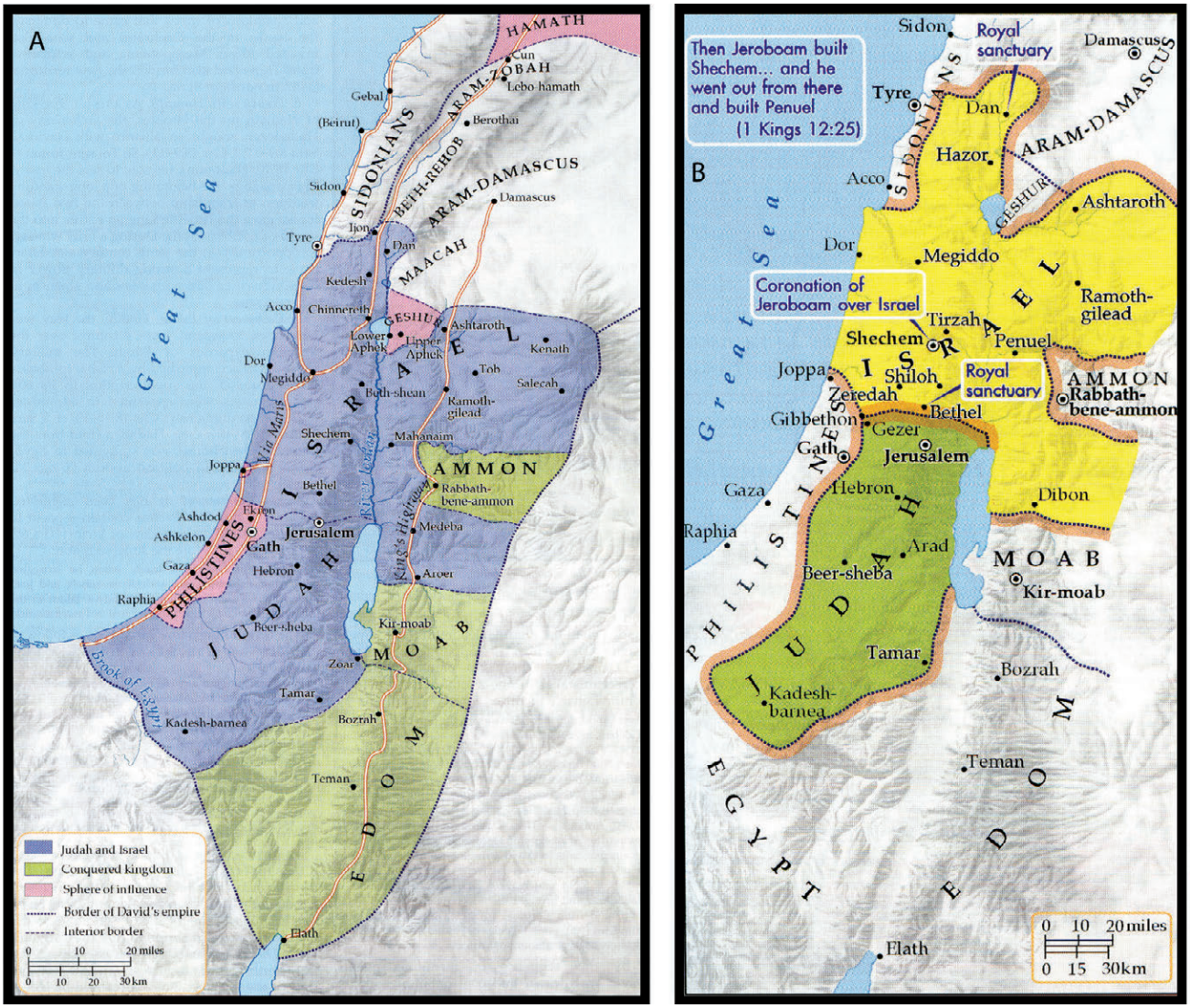

Figure 1.4 (*a*) The territory of Edom in the days of David's kingdom, as depicted in Rainey and Notley's *Atlas of the Biblical World* (2006). Edom extends over both sides of the Arabah Valley, and its territory includes Timna and the southern Negev. Although the authors are conservative about their interpretation of the biblical accounts, the wide geographic extent of Edom is widely accepted by biblical scholars and archaeologists (see text). (*b*) The territory of Edom in the days of the Divided Monarchy (according to biblical historiography, after 931 BCE), as depicted in Rainey and Notley's *Atlas of the Biblical World* (2006). The enmity between Edom and Judah lasted for centuries and is well documented in the biblical accounts (Bartlett 1989; Dicou 1994).

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Glueck (1936a:141–158) concludes that "the western boundary of Edom during the period of its independent political existence was formed by the 'Arabah valley, and never extended west of the 'Arabah. However as a result of Nabataean pressure, many Edomites infiltrated into southern Palestine, the territory occupied by them becoming known as Idumaea." According to Glueck, the idea that an independent Edom ever occupied both sides of the Arabah Valley is derived from biblical texts that are all postexilic (sixth century BCE or later). Glueck accepted Wellhausen's dating of the biblical sources, and thus he interpreted the biblical passages as a projection of a postexilic geography (i.e., the boundaries of Idumaea). In a recent paper, Zucconi (2007) summarizes the arguments against this approach, based on archaeological and textual data, and concludes that independent Edom, already in the early Iron Age, extended on both sides of the Arabah Valley.[5] Most scholars today accept that Edom's territory included the southern Negev already in the early Iron Age (e.g., Rainey and Notley 2006) (Figure 1.4). However, issues such as when in the Iron Age Edom expanded, the nature of the geopolitical situation in the early part of the period (twelfth to ninth centuries BCE), and the territorial battles and arrangements with the neighbors to the west and northwest (the United Monarchy and Judah; see Figure 1.4), are still open to debate. Although Faynan is located in the lowlands of southern Jordan, it is part of the accepted territory of Iron Age Edom in the highlands, and high-resolution radiocarbon dates published by ELRAP recently and in this volume support our claim that this economically significant region was the initial core of the Edomite polity, while only later the center moved to the highlands (Chapter 10, this volume; Ben-Yosef et al. 2010; Hauptmann et al. 1985; Knauf (Belleri) 1995; Levy et al. 2004).

Local and Regional Trade Routes

Faynan is located in the arid land on the margins of the populated zones of the Levant. During the Iron Age, export of copper products from the mining and smelting areas was based on caravans of draft animals, most probably camels and donkeys that traversed the desert of the southern Levant toward the hill country of Judah, the coast of the Mediterranean Sea, or the northern states along the Transjordanian plateau. At this time, Faynan was probably connected to the regional road network of incense trade from the southern parts of Arabia (e.g., Finkelstein 1988; Jasmin 2006), and commercial traffic was at the core of the economy of the local Iron Age society. Here we present a snapshot of trade routes as these are central for understanding the movement of people and goods in the southern Levant during the Iron Age. An in-depth study of trade routes, Faynan, and northern Edom is presented in Chapter 6 (this volume).

In a recent study of regional and local Iron Age roads in the Faynan region, a reconstruction of the road network is suggested based on finds of a regional survey and topographic and textual analyses by the Faynan Busayra Regional Survey (FBRS) (Ben-Yosef 2010 and Chapter 6, this volume). The course of the trade routes was mostly dictated by geographical features. The Faynan region has a few local routes connecting the clusters of mines and smelting centers to the highland plateau to the east and to the central road station on the other side of the Arabah Valley at 'Ain Hazeva (Arabic = 'Ain Hosb). The regional roads pass only through the outskirts of Faynan, and the Iron Age copper production centers of Wadi al-Ghuwayba were not part of any important route; the main east-west crossing road, connecting Busayra to the Wadi Arabah, passed through Wadi ad-Dahal to the north of Faynan and the main south-north road passed through the western margins of the region (see Chapter 6, this volume). It is therefore untenable to explain any of the architectural features of the Iron Age sites of Wadi al-Ghuwayba as primarily related to road stations detached from the copper production enterprise, as has been suggested recently by Finkelstein and Singer-Avitz (2009).

Geology

A detailed overview of the geology of Faynan and its copper mineralization is available in Hauptmann (2007, chap. 4), Palmer et al. (2007), Heitkemper (1988), and Al-Shorman (2009). Although not examined in depth in this volume, a detailed description of the geology of Timna Valley is available in Segev (1986), and its copper mineralization is explained in Segev and Sass (1989), Shlomowitz (1995), and Keidar (1984). For the diagentic connections between the copper mineralization of Faynan and Timna, see in particular Segev et al. (1992). A comprehensive volume covering the geology of the Levant (Hall et al. 2005) presents a good overview of the stratigraphy and structural features of the region. As the history of Iron Age metallurgy in the Arabah Valley must take into consideration all the areas with copper mineralizations, our overview considers the data from this holistic perspective.

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The geological history of the eastern Mediterranean is complex and relates to processes along various tectonic boundaries. The area comprises the African-Arabian shield (or the Arabian-Nubian Massive) of Precambrian crystalline rocks exposed in the south and sedimentary rocks of increasing thickness toward the north. An important boundary is the contact zone between the African-Arabian plate and the Taurides and Iranides in eastern Anatolia. This folding area is part of the Tethyan Eurasian metallogenic belt (TEMB) (after Jankovie 1997) and contains numerous ore deposits that were exploited in antiquity. The "metallogenic belt" was formed in two major folding episodes, one in the Upper Cretaceous, connected to the obduction of ophiolitic rocks (Yilmaz 1993), and the other in the Eocene-Miocene, linked to the collision of the Arabian plate and the Eurasian continent. Ophiolitic rocks occur in the Troodos mountain range in Cyprus, throughout the Taurides, and along the Zagros Mountains in Iran and Oman. Copper ores embedded in these rocks were rich metal resources in antiquity (see Ben-Yosef 2010; Hauptmann 2007, Fig. 2.6).

The geological landscape of Faynan and Timna is primarily the result of the Dead Sea transform, a left strike-slip fault system between the Arabian plate and the Levantine platform (Freund 1965). This fault system is responsible for the morphological rift valley of the Arabah, the uplift of the Jordanian plateau, and the uplift of the Timna region, resulting in the exposure of various rock units and the copper ore mineralization. The transform fault is a relatively young phenomenon, starting in the Miocene and demonstrating a lateral movement of approximately 105 km (Garfunkel 1981). The Rift Transform stretches over 1,200 km from the Zagros-Tauros subduction zone in southern Turkey; it is a northern (and younger) feature of a 6,000-km geological structure that begins in the south in East Africa and is related to the formation and opening process of the Red Sea.

Due to the difference in uplifting between the eastern and western sides of the Arabah, the basement crystalline rocks are exposed on the eastern side along an approximately 50-km continuous strip (Figure 1.5). A faulting

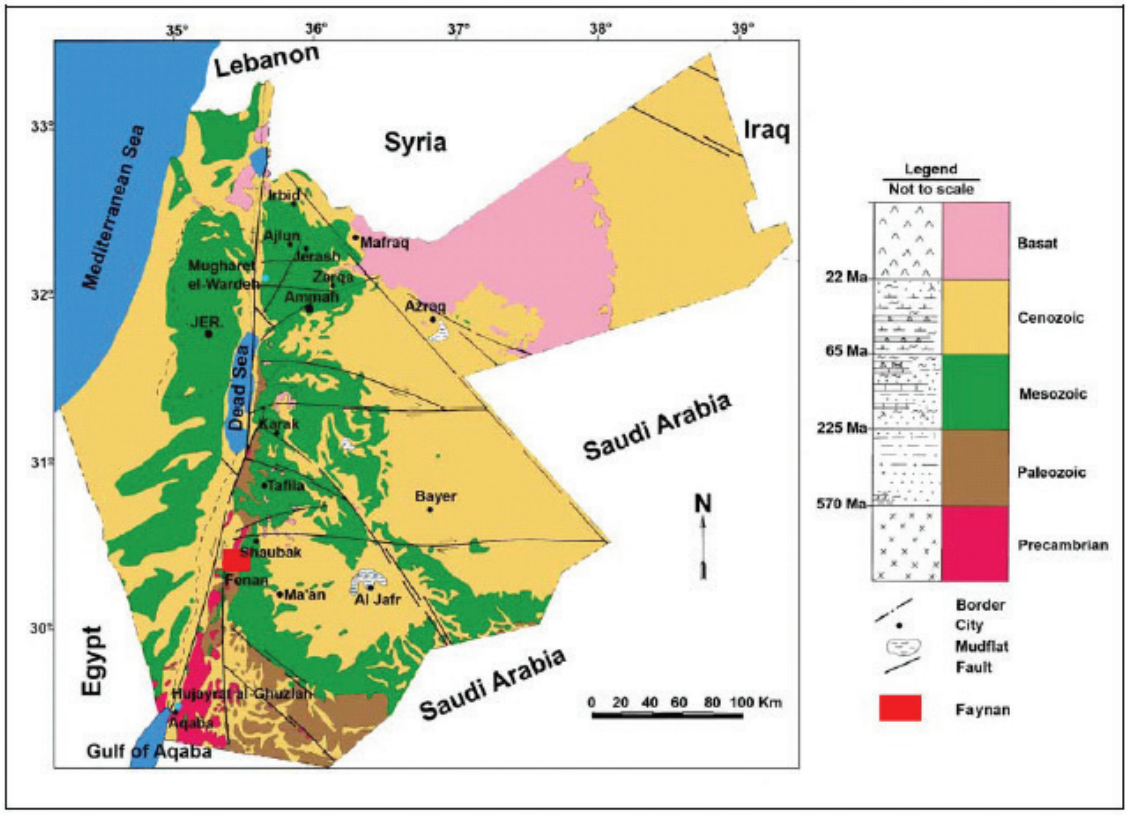

Figure 1.5 A simplified map of the geology of Jordan and Israel (Faynan is indicated in red). The basement crystalline rocks are exposed, together with other sedimentary layers of the Paleozoic, mostly along the eastern margins of the Arabah Valley (through Al-Shorman 2009, from Natural Resource Authority 1996).

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system of a geological horst in Faynan is responsible for one of the largest and northern-most outcrops of basement rocks in the Arabah Valley (Rabba' 1991, 1994). The Faynan horst consists mostly of andesitic rocks that have partly undergone zoned alteration. Various granitic rocks can be found in the wider surroundings of Faynan, which are covered by Cambrian and Cretaceous sediments in the north, south, and east. A series of basaltic and andesitic-rhyolitic dikes cross the basement rocks and are related to volcanic activities at the end of the Precambrian and early Cambrian. These dikes and volcanic rocks (the latter are exposed in several locations along the eastern margins of the rift, including in the Abu-Khusheibah region) contain copper mineralizations and are regarded as the primary source of ore deposits in the Arabah and the western part of Sinai (see below).

The sequence of sedimentary rocks covering the basement andesites and granites span (not continuously) the Cambrian to Quaternary and are up to 1,900 m thick (e.g., Neev et al. 1976). In general, the stratigraphic sedimentary sequence can be divided into three main units, according to rock types and occurrences (note that it is not a division by unconformities). The lower unit consists mostly of sandstones, commonly known as the "Nubian Sandstones" (Hirsch et al. 2005), including Cambrio-Ordovician to Early Cretaceous clastics of fluviatile and shallow marine origin. The sandstones are described by Weissbrod and Perath (1990). The lower part of this unit (Lower Cambrian and in Timna probably also Lower Cretaceous) is where the copper ore deposits are located. The second unit is composed of marine deposits. During the Cenomanian, a transgression took place

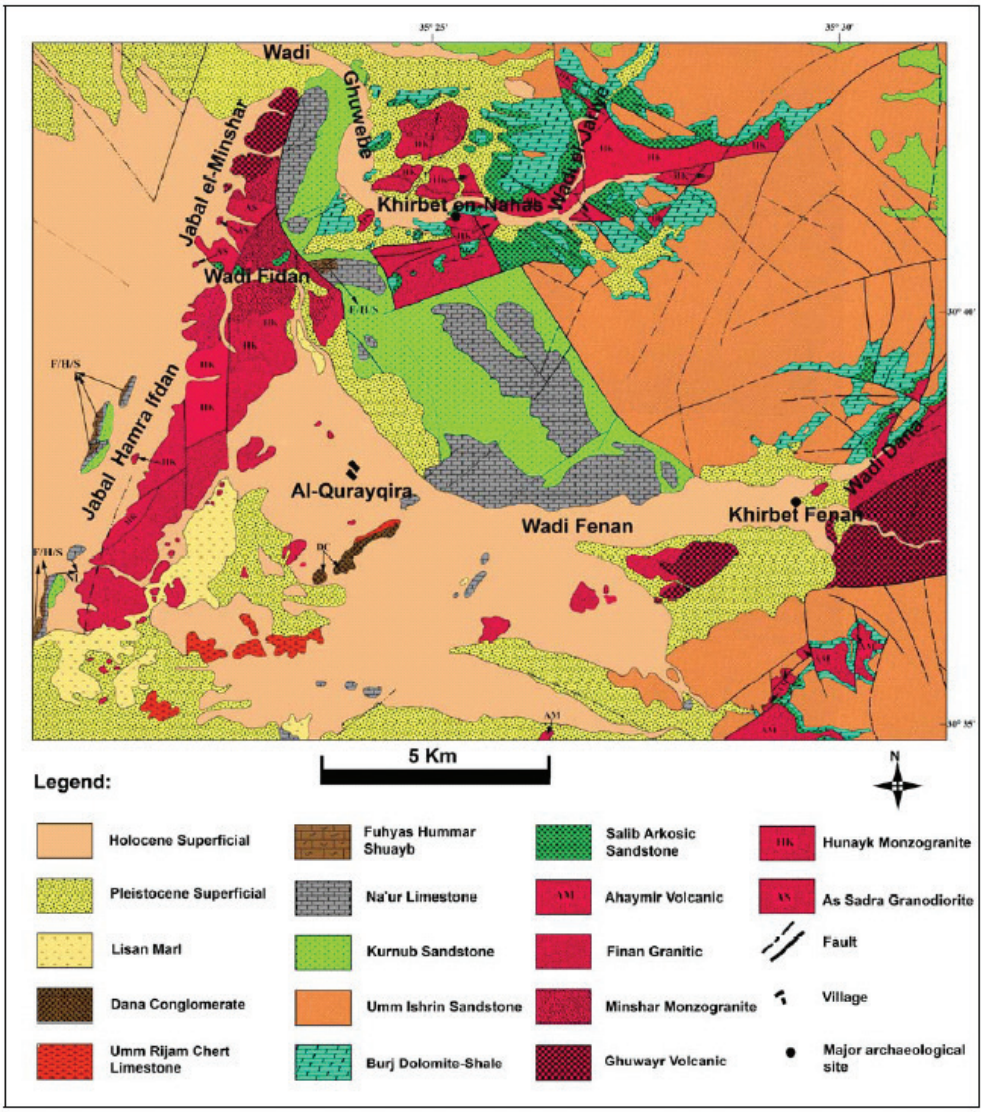

Figure 1.6 Simplified geological map of the Faynan area (from Al-Shorman 2009). The map is based on the 1:50,000 geological map sheets of Al Qurayqira (Rabba' 1991) and Ash-Shawbak (Barjous 1988). Note especially the rich variety of rock types and the distribution of the Burj dolomite-shale formation, the principal copper ore–bearing unit. See also a more detailed map and Iron Age sites in Figure 11.1 in Chapter 11, this volume.

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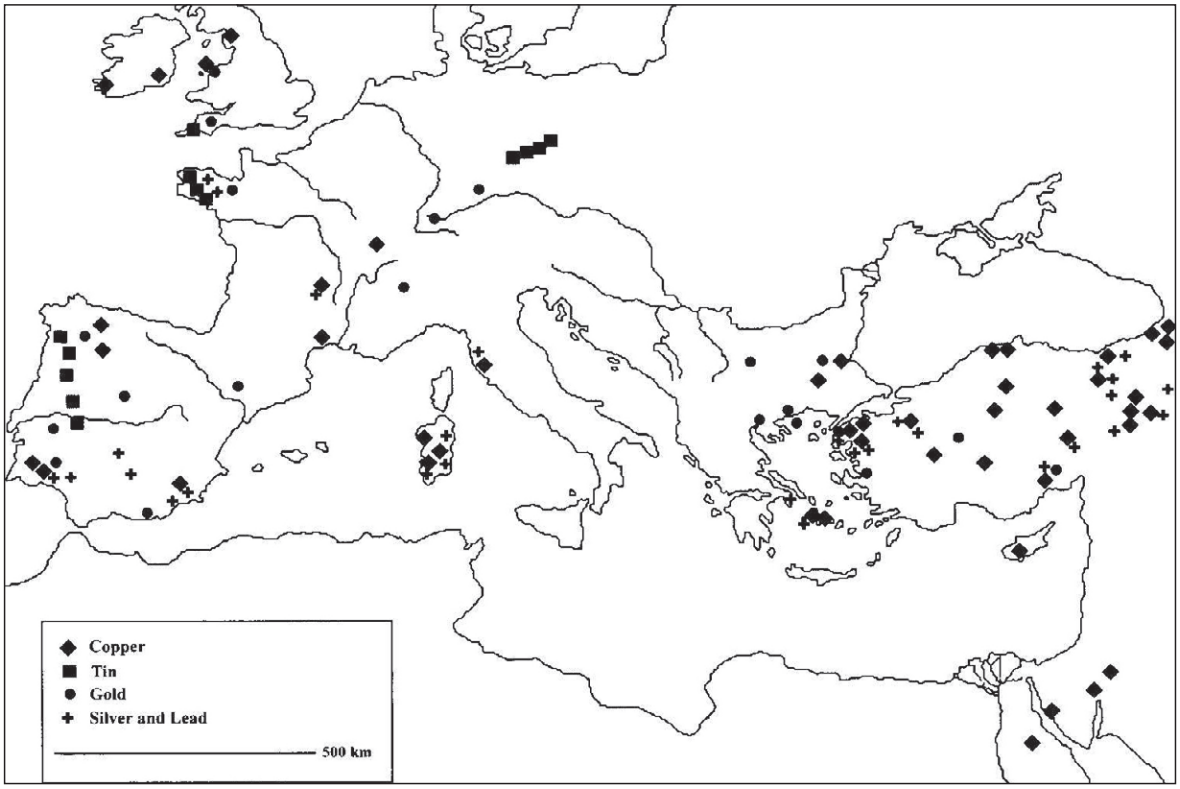

Figure 1.7 Distribution of major ore deposits in Europe and the Mediterranean (Kassianidou and Knapp 2005, map drawn by V. Kassianidou). Note that the controversial tin mines in Anatolia, a possible source of tin in the Early Bronze Age, are not shown on the map (e.g., Muhly et al. 1991; Yener 2000).

and limestone, dolomite, chalk, and marl accumulated in a shallow marine environment; in the Negev and the area of modern Amman, phosphate deposits formed. The marl and limestone form the upper slopes of the Jordanian plateau (Figure 1.6). The uppermost stratigraphic unit is composed of conglomerates, sandstones, and claystone formed during the Neogene. This includes the sediments that were deposited in the brackish water of the Lisan Lake. These deposits occur in patches along the Arabah and its margins, and in Faynan, it is represented by Pleistocene terraces along Wadi Fidan and Wadi al-Ghuwayba and sand dunes in the southern part of the region (Barker, Hunt, et al. 2007; el-Rishi et al. 2007; McLaren et al. 2007) (Figure 1.6). The wadis in Faynan drain an extensive region of the Jordanian plateau and contain various rock types of different sizes from sand and gravel to boulders in the alluvium of the wadi beds. This assortment of stone types (chert, limestone, dolostone, sandstone, granites, andesites, basalts, etc.), resulting from the exposure of numerous stratigraphic units along the mountain slopes, was a readily available rich resource of ground stones for various grinding and crushing activities in the smelting sites and is reflected in the archaeological record (see Chapter 12, this volume).

General Overview of the Copper Ore Deposits of the Eastern Mediterranean and the Southern Levant

Copper ore deposits are relatively abundant around the Mediterranean (Figure 1.7), and a few of the major ones are located in the eastern part of the region.

The copper ore bodies of the Arabah and Sinai are significantly different from most of the other ore sources. While the common appearance of copper minerals is associated with basic and ultrabasic rocks of ophiolite formations, and usually they are part of massive sulfide deposits,[6] the copper minerals of the southern Levant are a secondary deposition associated with sedimentary rocks and are overwhelmingly oxidic. This difference has direct implications on the ancient smelting process, as it is much easier to smelt oxidic copper minerals than sulfides (and see below).

The largest copper ore deposits in the eastern Mediterranean are located in Cyprus and eastern

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Anatolia. In Cyprus, more than 30 major copper ore outcrops make the island the most important regional source of copper in antiquity. These ore deposits were intensively exploited from at least the Middle Bronze Age (early second millennium BCE; see Muhly et al. 1982), with one of the peaks of copper production between 1600 and 1200 BCE. Following the collapse of the major civilizations at the end of the Late Bronze Age in the eastern Mediterranean (Bachhuber and Gareth Roberts 2009), this peak was followed by a considerable decline in the following Iron Age period. Cyprus has a multitude of slag mounds (Bachmann 1982; Koucky and Steinberg 1982), estimated to contain four million tons of slag material (cf. ca. 200,000 tons of slag in Faynan; Hauptmann 2007; Zwicker 1986). The slag deposits in Cyprus are mostly located near the mining areas. In most cases, they are not dated properly as the focus of archaeological research has been the coastal settlements, and future research may shed new light on the archaeometallurgical history of the island, including the poorly understood Iron Age. The ore deposits contain massive sulfides of volcano-sedimentary origin associated with the formation of the mid-oceanic ridge (Sillitoe 1972). They were tectonically moved together with the oceanic crust, forming an ophiolite that comprises the Troodos Mountains. Ore mineralization, associated with (ultra-) basic rock, occurs in all lithologic units in the Troodos and date to the Cretaceous period. However, the most important copper ore deposits are associated with the pillow-lava unit, exposed as a belt around the Troodos ridges. The mineralization of this unit is rather monotonous and consists predominantly of pyrite (FeS_2) with erratic occurrences of Cu-Fe sulfides and occasionally sphalerite ((Zn,Fe)S) (Hauptmann 2007). Cyprus has important field evidence of ancient smelting of sulfidic copper ore, providing a "model case" for studying the technology of smelting such minerals (e.g., Kassianidou 1999; Kassianidou and Knapp 2005). This technology, consisting of multiple smelting cycles and the production of matte ("matte smelting"; e.g., Craddock 1995), is still not well understood. The copper ore deposits of Cyprus are also associated with bright red gossans ("iron cap," a secondary deposition of the weathered ore body, above the ore body itself) that were extensively mined in antiquity. The gossans and cementation zones have rich copper sulfides (covellite [CuS], chalcocite [Cu_2S], bornite [Cu_5FeS_4], or cuprite [Cu_2O]), sometimes containing up to 30 percent copper or more (Stos-Gale and Gale 1994). Some of the other mineralization zones of the Troodos, especially those associated with the gabbros and periodotites underneath the volcanic rocks, were also exploited in antiquity at least since the Hellenistic-Roman period, although it is not clear to what extent (Hauptmann 2007). The Cypriote copper ores contain only traces of nickel, arsenic, cobalt, and lead (Constantinou 1980).

Another important region of copper ore deposits in the eastern Mediterranean is eastern Anatolia, especially Ergani Maden, which, until 1994, was the largest active modern copper mine in Turkey. The geological situation is similar to Cyprus; the copper mineralization also occurs in association with ophiolitic rocks, and the ore bodies have similar geochemistry, making it difficult to differentiate between the two sources by means of lead isotope analysis. The minerals of the ore body of Ergani Maden are also monotonous, with pyrite, pyrrhotine, chalcopyrite, magnetite, hematite, and sphalerite (Hauptmann 2007). The expansive modern exploitation of the mines destroyed almost the entire evidence of ancient mining and exposed outcrops, and thus it is hard to assess the quality of the ore body as it was in antiquity and the intensity and chronology of human activities at the site. Nevertheless, it has been suggested that Ergani Maden is the most important prehistoric copper source in Anatolia, based mostly on its central location between eastern Anatolia and Mesopotamia and the rich occurrence of native copper and oxidic copper ores (Tylecote 1970). Some peripheral archaeological evidence of ancient mines does exist, but their dating is not secure (e.g., Seelinger et al. 1985). The suggestion by Tylecote (1976) that Ergani Maden was a source of arsenic and nickel copper ores for the production of arsenic bronzes in the Early Bronze Age is debated (Hauptmann 2007).

Minor copper ore deposits in the eastern Mediterranean include a series of outcrops between Lake Van and the upper Euphrates in eastern Anatolia that may have been the source of native copper during the Neolithic (Seelinger et al. 1985), the lead-silver deposit of Keban in the upper Euphrates that possibly may have been a source of arsenic-containing copper and gold (Palmieri et al. 1993), and some small copper mining operations in northwestern Hijaz. The latter region is known primarily as a source of gold (Kisnawi et al. 1983), but traces of early copper production were reported, according to

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Hauptmann (2007), from three different sites associated with small sedimentary ore deposits in sandstones: Shim at-Tasa (Shanks 1936), Imsayea, and az-Zuwaydiyah at al-Disa (Kisnawi et al. 1983). The ore-rich region of the Hijaz is poorly studied and probably contains much more archaeometallurgical evidence relevant to the history of metallurgy in the southern Levant. Another copper ore deposit close to the southern Levant is in the eastern desert of Egypt (Figure 1.7). This ore deposit was probably exploited briefly in the Early Bronze Age with furnaces operated by wind on the local hills (Castel et al. 2008). Except from this evidence, no primary copper smelting activities are known thus far from Egypt during its long history (Ogden 2000).

Most of the copper ore deposits of the southern Levant are fundamentally different from the common occurrences of copper ores such as those described above. Their copper minerals are usually oxidic, sulfides are rare, and they appear as secondary mineralization in sandstones or ore pockets in paleokarst. The most important of these deposits occur in Cambrian and Cretaceous sandstone and dolomite, and the most extensive outcrops are those of Faynan and Timna. In southwestern Sinai, similar ore deposits are in the vicinity of Umm Bogma and Serabit el-Khadim. The deposits of Umm Bogma, which were mined in antiquity, contain manganese ores, oxidic copper ores, and very low concentrations of trace elements (Hauptmann 2007). The site of Bir Nasib, the largest smelting site in the Sinai peninsula, is near Umm Bogma and contains approximately 100,000 tons of slag (Hauptmann 2007; Rothenberg 1987). The Egyptian mining activities in Wadi Maghara and Serabit el-Khadim (Beit-Arieh 1985; Weisgerber 1991) were focused mostly on the extraction of turquoise, although evidence of smelting is present and dated to at least the New Kingdom (turquoise mining started as early as the beginning of the Old Kingdom; Petrie 1906). Small ore deposits in southern Sinai, located in andesitic dikes and hydrothermal veins in the Precambrian basement, were also exploited in antiquity (Early Bronze Age; see Beit-Arieh 2003). A unique ore deposit with an ancient prospecting trench has been reported in Wadi Tar in southeastern Sinai. It contains copper-arsenic mineralization, native copper, and copper-arsenides and was suggested as a possible source for the arsenic copper alloys of the Chalcolithic and Bronze Age Levant (Ilani and Rosenfeld 1994). However, results of lead isotope analysis ruled out this possibility (Segal, Ilani, and Rosenfeld 2000), and the exploitation of this deposit, as well as the origin of arsenic copper in the Levant, is still enigmatic (see also a good overview of early mining in Sinai in Avner 2002). Currently, there is no evidence of any copper mining and smelting in Sinai later than the New Kingdom period. However, the limited studies of the evidence in Sinai, uncertainties in dating methodologies (see Ben-Yosef 2010, chaps. 4 and 6), and a dominance of the "Egyptian paradigm" (core civilization "centric" in the archaeological research; see Ben-Yosef 2010:Section 3.2.2) suggest that further research may shed new light on the history of metallurgy associated with these deposits.

Although some other isolated occurrences of copper ores exist in the Negev and the margins of the Arabah Valley (Itamar 1988) (Figure 1.8), only the ones of Faynan, Wadi Abu Khusheibah, Timna, and Wadi Amram were exploited in antiquity.[7] In Wadi Abu Khusheibah (and the nearby Wadi Abu Qurdiya), sedimentary copper ores appear in sandstones of the Lower and Middle Cambrian, and evidence of some local mining and smelting exists in the form of large caves with pillars (*Umm al-Amad* in Arabic, meaning "The Mother of Pillars"), a few galleries, and scatters of slag (Kind 1965; Najjar and Levy 2011). The entire archaeological evidence is dated to the Roman-Nabataean period without any earlier activities, an observation corroborated with a visit by the present authors in March 2009.[8] The region of Wadi Abu Khusheibah has been reported to have about 40 μg g^{-1} gold in felsic volcanic rocks, including visible pieces in heavy washed minerals (http://www.nra.gov.jo). These occurrences of gold, together with historical descriptions from the Byzantine period of gold mining in the Arabah, were the basis of a recent suggestion to see some of the ancient mines, particularly those of the "Umm al-Amad" type, as gold mines from the Late Antiquity (Meshel 2006). This interesting suggestion is still based on speculative evidence.[9]

The copper ore deposits in the Cambrian sandstones and dolostones of Faynan are the richest in the Arabah Valley (Figure 1.9). They are diagenetically related to the smaller copper deposits of Timna and Wadi Amram (and the nearby Nahal Roded), located on the west side of the Arabah Valley, approximately 105 km to the south. Both copper ore deposits were formed in the same paleogeographic location prior to the tectonic movement of the Rift Valley (Figures 1.8 and 1.9). The origin of the copper ore deposits in Faynan and

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Timna is complex, with gradual enrichment of copper and manganese through secondary deposition (Segev et al. 1992; Segev and Sass 1989). The primary source of copper is copper-iron sulfide mineralizations in the late Precambrian volcanic rocks (part of the basement complex, 510–560 Ma). During the lower Cambrian, erosion of the volcanic rocks led to synsedimentary (stratiform) enrichment of copper in sandy or clayey dolostones in shallow marine environments. Migration and redeposition of copper occurred mainly as chlorides, and here also synsedimentary manganese ore mineralizations were formed. The next stage of mineralization, epigenetic remobilization, was connected to the formation of the Rift Valley, subsequent development of karst associated with faults and fractures at the top of the dolostone unit, and enriched concentration of secondary copper and manganese ores (the DLS unit; see below). The occurrences of copper ore deposits in the sandstone cliffs above the dolomite unit, the lower Umm-Ishrin formation in Faynan, and the Amir/Evrona formation in Timna are also related to the young epigenetic remobilization associated with the Rift Valley (Keidar 1984) and/or to Lower Cretaceous volcanism evident in Timna (Beyth and Segev 1983; Segev et al. 1992) or younger (13–15 Ma) hydrothermal alteration of the Cambrian sediments

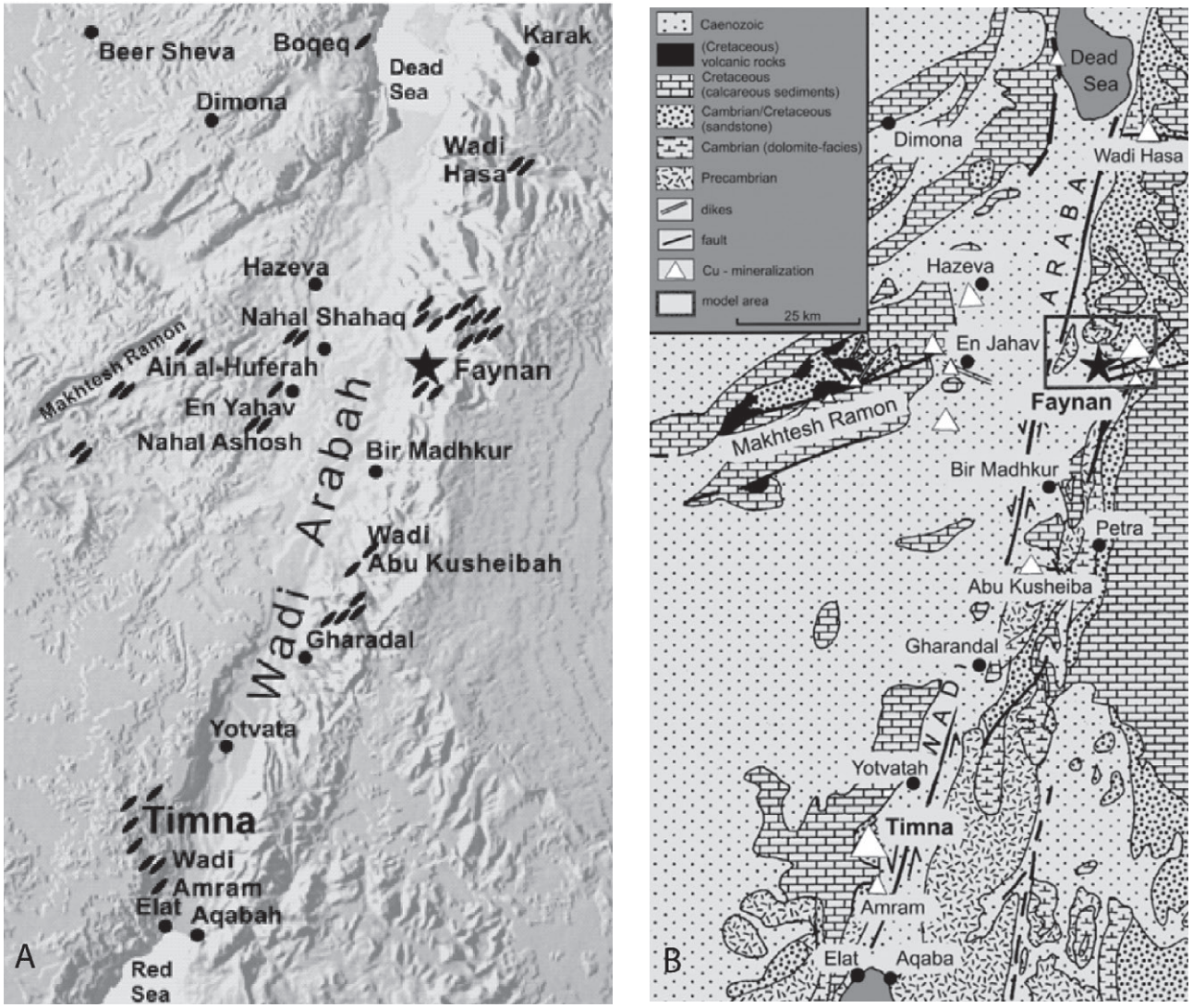

Figure 1.8 Locations of copper ore mineralizations along the Arabah Valley and in the Negev desert, on a shaded-relief map (*a*) and a schematic geological map (*b*) (Hauptmann 2007). Only the ore deposits of Faynan, Wadi Abu Khusheibah, Timna, and Wadi Amram were exploited in antiquity (see text).

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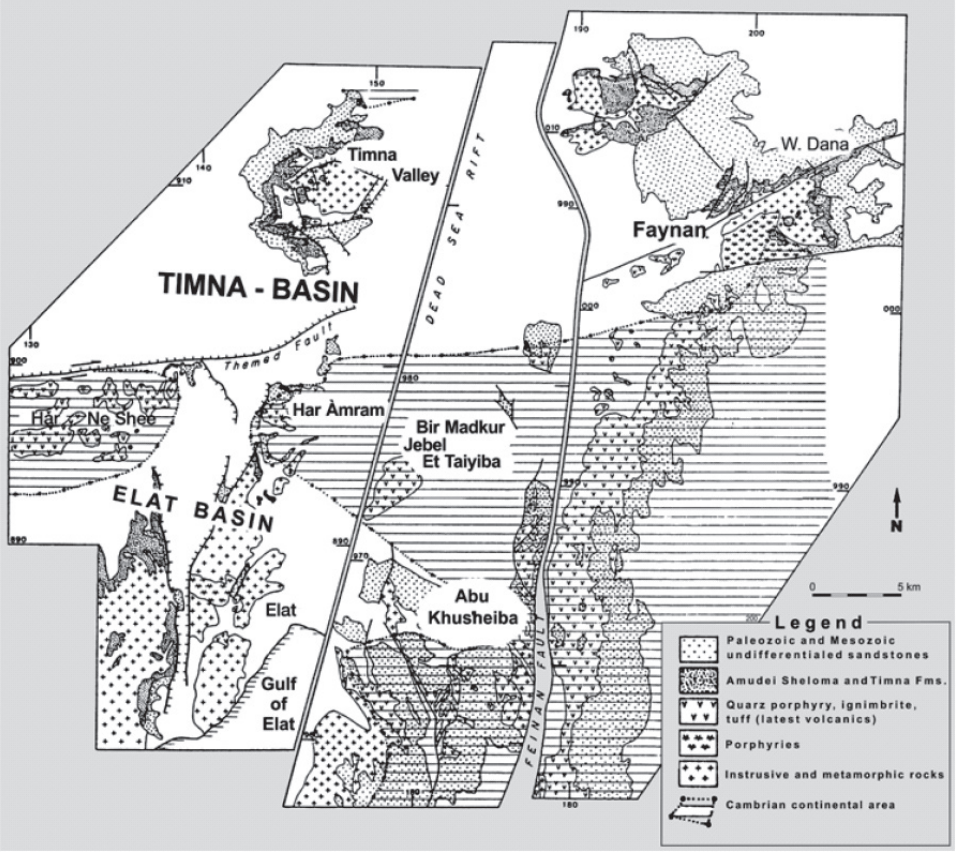

Figure 1.9 A reconstruction of the paleogeography of the Arabah region in the Cambrian. The reconstruction is based on shifting the Levantine and Jordanian blocks by approximately 105 km. The copper mineral deposits of Faynan, Timna, and Abu-Khusheiba are shown (via Hauptmann 2007, after Segev et al. 1992).

associated with the rift (Beyth et al. 1997). Some of the finds of the current research have the potential to shed new light on the relations between rich copper mineralizations of the sandstone units and volcanic/hydrothermal activities in the geological history of the Arabah (Beyth et al. 1997; Beyth and Segev 1983; Ilani et al. 1987; Segev et al. 1992). During the 2007 FBRS survey (see Chapter 12, this volume), we discovered extensive pit mine fields that probably were one of the richest culluviatile ore deposits in Faynan (Ben-Yosef et al. 2009). The mine fields are associated with the young dike and volcanic plug that cross the Salib and Burj formations (thus they are Cambrian or younger). Rock samples from the dike are currently being measured for argon/argon (Ar/Ar) dating in the laboratory of Oregon State University. According to the regional geological history, the age of the dike is probably either Lower Cretaceous or Miocene and younger, and the results will help to correlate field evidence in Faynan and Timna and to further understand processes related to ore formation and/or the rifting. Further description and discussion appear in Ben-Yosef (2010:Section 5.2.9).

The Host Rock Formations and the Copper Minerals of Faynan and Timna

The raw material for copper production in Faynan and Timna occurs in two major geological units with specific characteristics and minerals. The lower and richest unit is the Cambrian dolomite-shale formation, known as the DLS ("dolomite-limestone-shale unit," although in Faynan and Timna, limestone is not present) or Burj formation in Faynan, and the Timna formation in southern Arabah. The upper unit is part of the so-called Nubian sandstone formations and is known as the massive brown sandstone (MBS) unit in Faynan, where it is part of the Cambrian Umm-Ishrin formation, and as the Amir/Evrona (of uncertain age, but probably Lower Cretaceous) formations in Timna (Figure 1.10). Although the diagenesis of copper mineralizations in Faynan and Timna is similar (see above), the exposure of the host rock formations is different, and consequently, there is a difference between the two areas regarding the main ore sources exploited in antiquity.

According to Hauptmann (2007), the copper ore of the Arabah can be precisely characterized because most of the outcrops were not destroyed by modern mining

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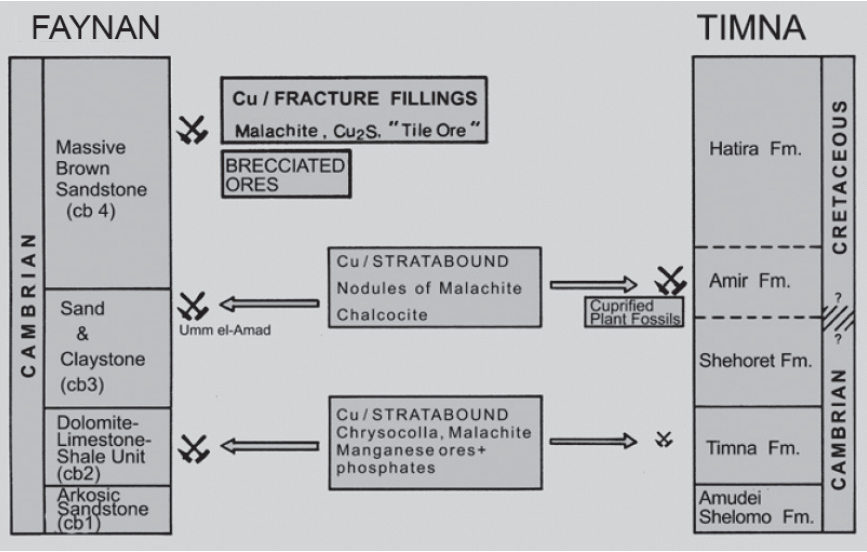

Figure 1.10 Simplified lithostratigraphy and copper mineralizations in Faynan and Timna (from Hauptmann 2007). Note that the correlation shown here is of the ore deposits and not of the lithostratigraphic units. In Faynan, the Arkosic Sandstone (cb1) is also known as the "Salib formation," the "Dolomite-Limestone-Shale" as the "Burj formation," and the sandstone units cb3 and cb4 as the lower part of the "Umm-Ishrin formation." During the Iron Age in Faynan, the main source of copper was the DLS unit, while during the Late Bronze–Iron Age in Timna, the main source of copper was the mineralizations in the sandstones of the Amir/Evrona formations. Geochemically, the ore mineralizations are very similar and currently the only secure difference is the presence of cuprified plant fossils in the Timna ores (see Ben-Yosef 2010:Section 2.2.3).

(as is the case in most ancient mining areas around the world), and prospection works done by the Natural Resource Authority of Jordan during the 1960s and 1970s exposed fresh deposits that most probably represent the ore quality as it was available in antiquity. Nevertheless, new evidence described here and in Ben-Yosef (2010:Section 5.2.9) indicates exhaustive mining activities in specific regions that may imply the presence of higher quality ores than those present today in locations where the ore was not exhausted. In any case, as in any of the ancient mining regions, the ore present today should be considered as representing the minimum quality of the available ore in antiquity.

The copper ore deposits of the Cambrian dolomite-shale unit (Burj and Timna formations in Faynan and Timna, respectively) are located stratigraphically above approximately 60 m of nonmineralized arkosic sandstones (Salib and Amudei-Shlomo formations in Faynan and Timna, respectively). The dolomite-shale unit is 20 to 40 m thick and is easily recognizable in the landscape by its prominent cliffs, terraces, plateaus, and dark-gray color. The 1- to 1.5-m-thick upper portion of the dolomite-shale unit is the ore-bearing layer, mostly composed of silt, clay, and shales. The ore is located in pockets, as matrix mineralization and as vein fillings, and includes copper and manganese minerals (Hauptmann 2007 and references therein). In Faynan, this unit was the principal copper ore source in most of the archaeological periods; in fact, according to the research of the Deutsches Bergbau-Museum (DBM) group (e.g., Hauptmann 2007; Weisgerber 2006), only in the Chalcolithic and the Roman periods was the other mineralization in Faynan (namely those of the MBS; see below) exploited. During the Iron Age, the ores of the dolomite-shale unit were the primary source of raw materials for copper production in Faynan. The current research has found that the mining techniques in Iron Age Faynan were probably more varied than those described by the Deutsches Bergbau-Museum (DBM) researchers. Our new work has identified a previously undocumented major source that included ore nodules mined from culluvial/alluvial deposits derived from the DLS unit; this complemented mining of ore from the Burj rock unit itself (see descriptions in Ben-Yosef 2010:Section 5.2.9 and discussion in Section 9.1.1).

The copper ore deposits of the upper sandstone units (MBS unit in Faynan and Amir/Evrona formations in Timna) are located between other sandstone units, approximately 50 m stratigraphically higher than the DLS unit (the intermediate sandstone and claystones include some local copper and manganese ores, without almost any evidence of mining, probably because of their conspicuous hardness). In Faynan, the copper ore–bearing unit is up to 250 m thick and has extensive mining evidence around Wadi Khalid and Qalb Ratiye (see Table 12.1 and associated figures in Chapter 12, this volume). The copper mineralizations occur in fractures and veins and in places where it is associated with iron mineralization. This unit was the principal source of copper ore in Timna throughout the entire history of copper production there. In Faynan, it was exploited only to a limited extent during the Chalcolithic and the Roman periods (e.g., Weisgerber 2006) with possible

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mining also in the Late Islamic period according to recent finds reported by the present author from Wadi Salmina (Ben-Yosef 2009a). Here we discuss in some detail the different minerals found in the major geological units of the Arabah Valley because of their relevance to understanding some of the dynamics of copper production presented in Chapter 13 (this volume), as well as analytic studies presented in Ben-Yosef (2010, chap. 8) that will be published elsewhere, and because the mineral composition has a direct implication on the smelting technology used in antiquity to extract metallic copper.

The predominant ores of the southern Levant are oxidic and silicate copper minerals that can be reduced to metal in a one-step smelting process (without roasting and multistep smelting as in the case of sulfide ores, the dominant ores in Cyprus and Anatolia). Sulfides are rare and native copper is not present in the southern Levantine deposits.

The minerals present at the DLS unit are follows (after Hauptmann 2007 with references therein [primarily Heitkemper 1988; Wurzburger 1970]):

- Malachite, $Cu_2(CO_3)(OH)_2$
- Paratacamite, $Cu_2(OH)_3Cl$
- Chrysocolla, $CuSiO_3 \cdot H_2O$
- Dioptase, $Cu_6[Si_6O_{18}] \cdot 6H_2O$
- Planchéite, $Cu_8[(OH)_2/Si_4O_{11}]_2$ (in shiny blue crystals)
- Pseudo-malachite, $Cu_5[(OH)_2/PO_4]_2$

The minerals listed above are usually "masked" by abundant malachite. The following minerals were observed only under the microscope:

- Bornite, Cu_5FeS_4
- Chalcocite, Cu_2S
- Pyrite, FeS_2

The copper ores of the DLS unit appear as fist-sized hard nodules and chunks. They are intensively intergrown with oxidic manganese ores (averaging 41 to 43 percent in manganese content). The manganese minerals include the following:

- Pyrolusite, β-MnO_2
- Hydroxy-manganomelane (psilomelane, $(Ba, H_2O)Mn_5O_{10}$)
- Cryptomelane, $K_2Mn_8O_{16}$
- Hollandite, $Ba_{1-2}Mn_8O_{16}$
- Coronadite, $Pb_{1-2}Mn_8O_{16}$
- Ramsdellite, γ-MnO_2
- Manganite, MnOOH

The manganese ore contains a considerable amount of iron. Analytical work on the ore showed an average of 8 to 10 percent Fe_2O_3. Enrichment of iron oxides and hydroxides (hematite, goethite) in the metallurgical remains of the Late Islamic site of el-Furn in Faynan even raised the possibility of iron smelting activities there (e.g., Hauptmann 2007). However, the results of our recent analytical studies (Ben-Yosef 2010, chap. 8) show clearly that iron was an undesired by-product of advanced copper smelting technologies, even when the primary ore source was manganese rich (and not iron rich, such as in Timna; see Gale et al. 1990 and Merkel 1990 for further details on iron in copper in the southern Arabah).[10] Further evidence and discussion about iron by-products in advanced smelting of copper are presented in Ben-Yosef (2010:Section 7.2.7).

The minerals present at the MBS unit (and similarly in the Amir/Evrona formations in Timna) are as follows (Hauptmann 2007):

- Malachite, $Cu_2(CO_3)(OH)_2$
- Cuprite, Cu_2O
- Chalcocite, Cu_2S and covellite, CuS
- Paratacamite, $Cu_2(OH)_3Cl$

The cuprite appears mostly intergrown with iron-hydroxides. Some morphological appearances of the minerals are unique to Faynan (cuprite with relics of chalcocite and quartz as "tile ore," brecciated fragments cemented with malachite) and made it possible for Hauptmann (1989) to identify the source of ore from the Chalcolithic site of Abu Matar in the Beer-Sheva Valley. In Timna, cuprified plant remains were uniquely observed in the Amir/Evrona formation (they are missing in the MBS unit in Faynan), which made it possible for Hauptmann et al. (2009) to identify the source of ore from the Chalcolithic/Early Bronze I site of Tall Magass near Aqaba (for further discussion about sourcing, see Ben-Yosef 2010:Section 2.2.3). Both the DLS and MBS copper ores are of a high quality and have a copper content between 15 and 45 percent (Hauptmann et al. 1992). Similar quality was reported for the copper ore of Timna (Bartura et al. 1980). These rather high concentrations of copper imply no need for a complex beneficiation process besides manual sorting (a variety of processes whereby extracted ore is separated into mineral and gangue, the former suitable for further processing or direct use).

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Climate and Vegetation

The climate of the Arabah Valley has had a direct impact on local societies that have inhabited the region throughout history, making pastoral-based subsistence a key factor in successful human adaptation to the region. Subsistence resources, living conditions, and some cultural customs are related to environmental factors determined primarily by the climate, especially in extreme environments such as the deserts of the southern Levant. For societies engaged in the copper production enterprise in Faynan and Timna, climate conditions were crucial as they determined the availability of two critical resources: water and fuel sources. Water and fuel provided the essentials to sustain large numbers of laborers and energy to power the pyrotechnology needed for industrial-scale copper production.

The region of Faynan and southern Arabah is part of the hot and dry climate of the Saharo-Arabian desert belt (Figure 1.11). It is separated from the Mediterranean climate zone by a distance of more than 100 km (and by the morphological barrier of the Rift Valley). Significant local variations exist, especially between the lowlands of the Arabah and the relatively high Jordanian plateau to the east (Figures 1.2 and 1.11). While the Arabah Valley is the driest and hottest area in the entire region of the Negev and southwestern Jordan, the higher parts of the

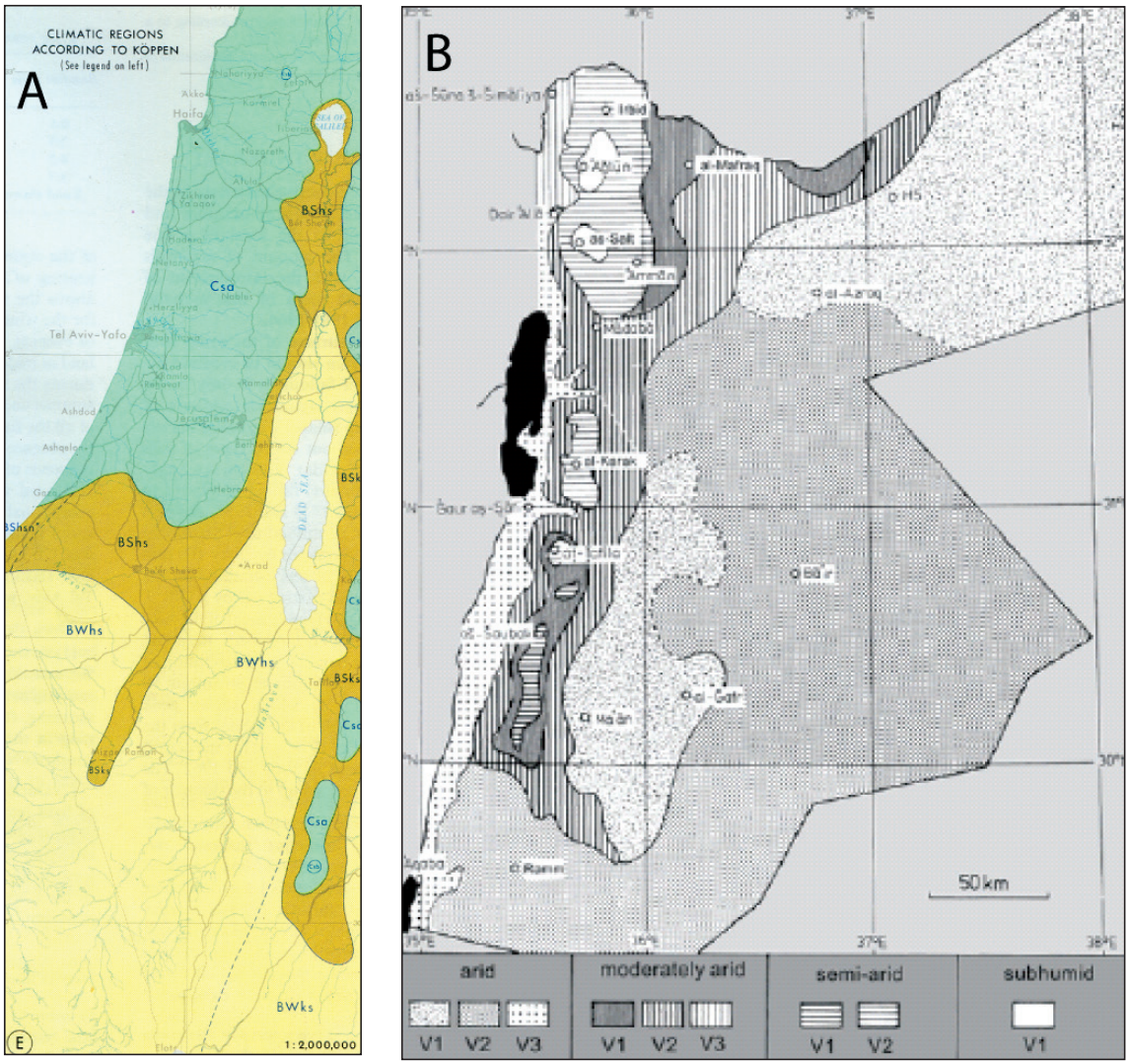

Figure 1.11 Bioclimatic zones in Israel and Jordan. (*a*) The classic division of Koppen (1931; Koppen and Geiger 1953), showing three major bioclimatic regions: desert (BW, yellow), steppe (BS, ochre), and Mediterranean (Cs, green) (from Amiran et al. 1970); note the variability between the Arabah and the southern Jordanian plateau. (*b*) More detailed bioclimatic zones of Jordan (from Hauptmann 2007, after Kurschner 1986).

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Jordanian plateau have a more moderate Mediterranean climate. The mean annual temperature is 23°C to 24°C in the lowlands (the Arabah) and 14°C to 16°C in the highlands. In Faynan during the summer, maximum temperatures are around 45°C, and during the winter, lowest temperatures at night may drop below zero (Bruins 2006). The region is characterized by frequent western winds that are occasionally very strong (Rabba' 1994). Most rain in Faynan falls between December and March, and there is no precipitation between June and September. The annual rainfall is around 50 mm in Faynan and even less in the southern Arabah (30 mm in Aqaba; Bruins 2006). In the plateau, the annual rainfall exceeds 200 mm (Amiran et al. 1970; Aresvik 1976) (Figure 1.12). Rainfall in the Arabah is also extremely variable, ranging from 150 mm in a wet year to 0 mm in a dry year (Amiran et al. 1970; Bolle 2003; Cohen and Stanhill 1996). This interannual variability, common in arid zones, presents problems for societies in the region; precipitation is unpredictable, and it is difficult to prepare for droughts. Often the rain falls in short intervals, causing flash floods in the local wadis.

The vegetation of the Faynan area was studied in detail by a group of botanists from the Free University of Berlin (Baierle et al. 1989; Frey and Kurschner 1992, 1994; Kurschner 1986), as part of the extensive

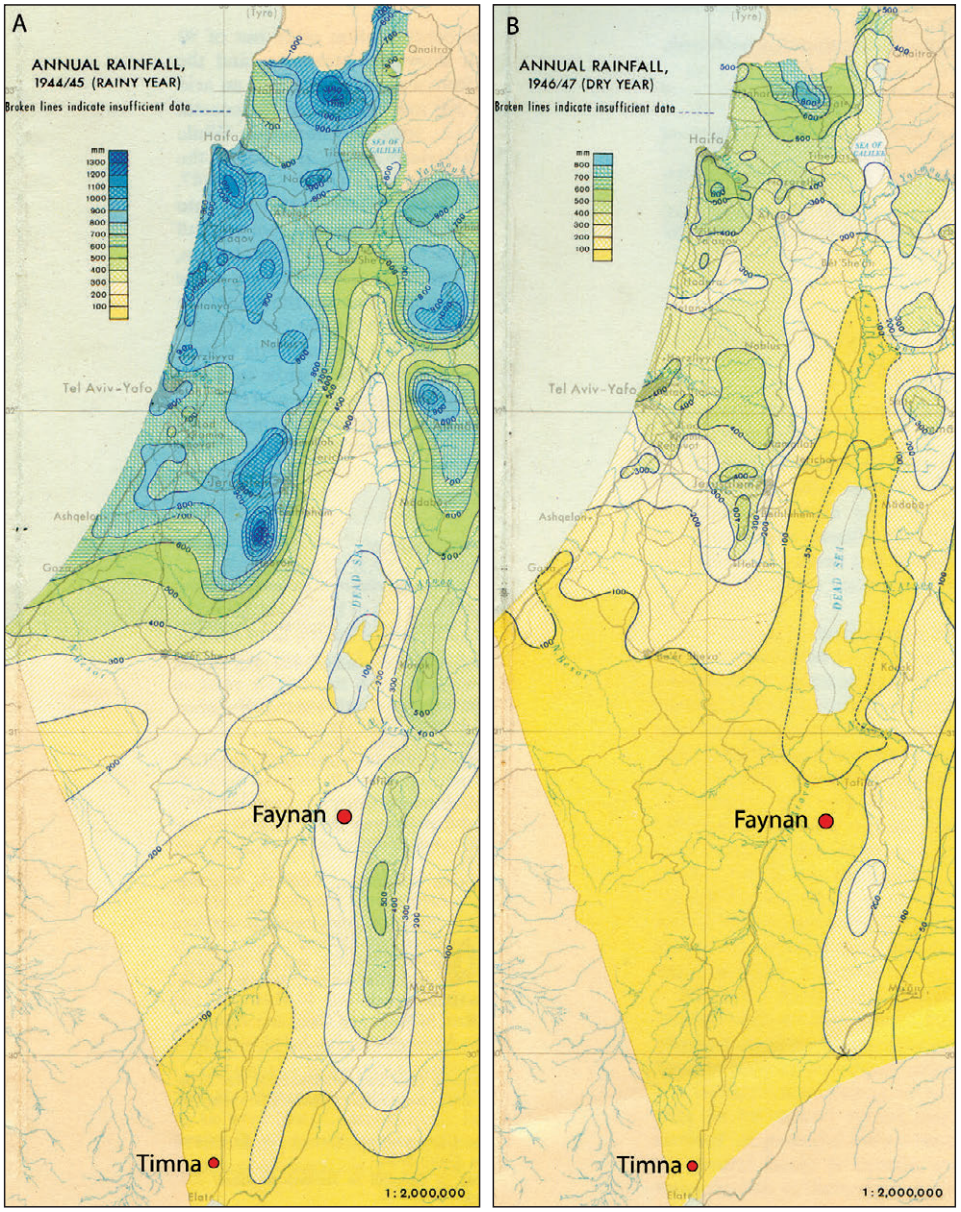

Figure 1.12 Annual rainfall in Israel and Jordan in rainy (*a*) and dry (*b*) years. Faynan is located between the 0 and 300 isopleth (note that 300 is very rare), while Timna between 0 and 100 (from Amiran et al. 1970).

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archaeometallurgical research in the region headed by the Deutsches Bergbau-Museum (see Ben-Yosef 2010:Section 3.2.5). One of the principal aims of these studies was to evaluate sources of fuel for the ancient smelting operations (Engel 1993; Engel and Frey 1996). This issue, together with new data and insights regarding fuel supply in the Iron Age in Faynan and Timna, is discussed in more detail in Chapter 13, this volume).

The bioclimatic zone maps (Figure 1.11) show the contrast between the relatively homogeneous desert environment of the southern Arabah and the varied environments in the vicinity of Faynan, with rapid changes toward the Jordanian plateau to the east. In addition, local springs and oases that create niches of hydrophilic vegetation are absent in the Timna Valley itself (and the wadis to the south), and thus the vegetation near the mines of the southern Arabah is typical to the extreme steppe deserts and include mostly acacia trees, ratema shrubs, and other small bushes in the wadi beds. The variety in vegetation in Faynan and its vicinity is mostly the result of the substantial elevation differences, coupled with unique geological conditions. Figure 1.13 presents the distribution of major vegetation units in the Faynan region, and Figure 1.14 shows a cross section from the lowlands in the west to the highlands in the east with the corresponding vegetation units, elevation, and precipitation; for detailed descriptions of the species represented in each vegetation unit, see Baierle et al. (1989).

Previously, it was assumed that the local vegetation of the desert units (Figure 1.14) could not provide a

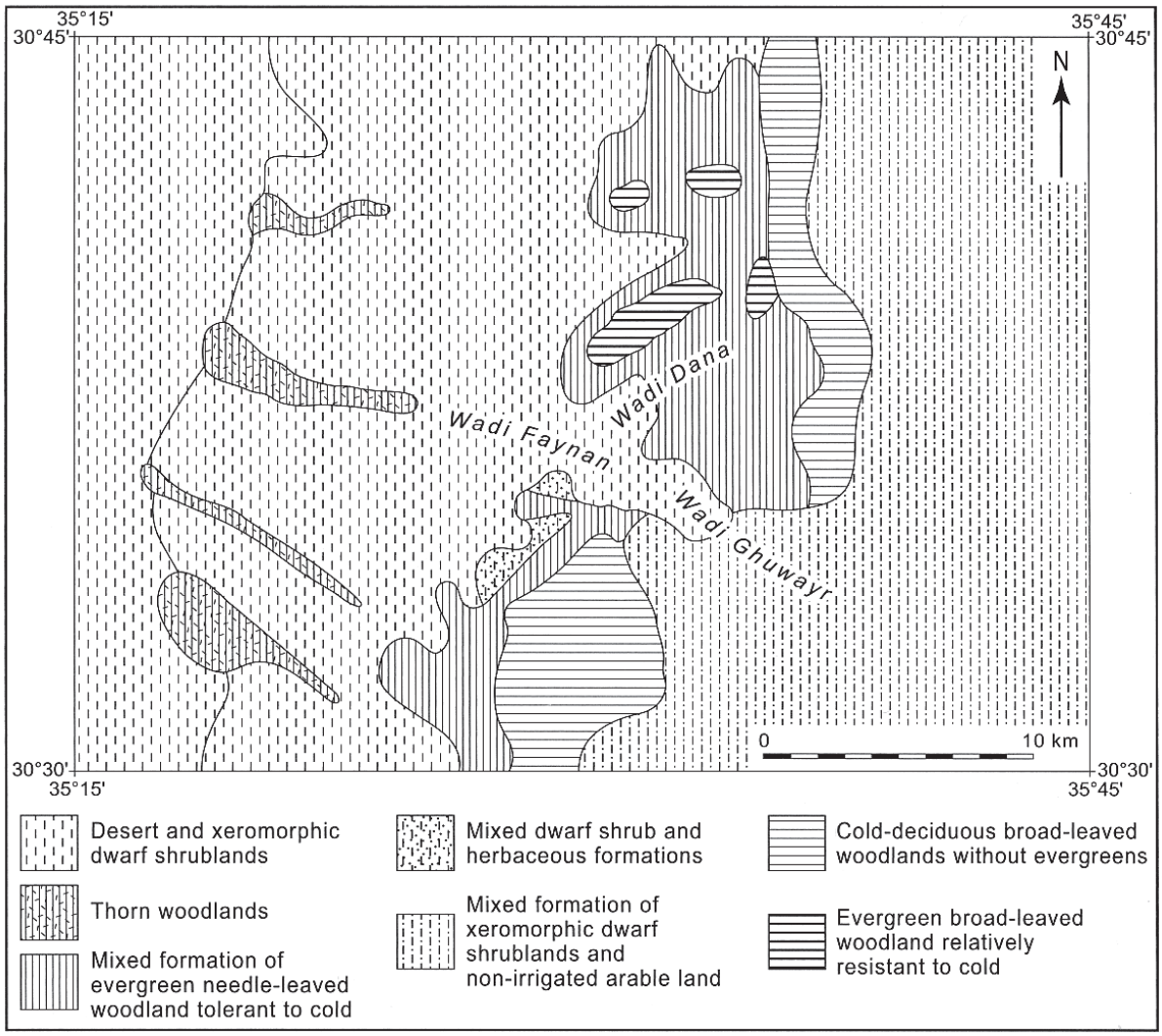

Figure 1.13 Distribution of vegetation units in the area of Faynan, Jordan (from Palmer et al. 2007). Note the high variability and the relative proximity of the woodland zones to the smelting sites in the lower Wadi Faynan.

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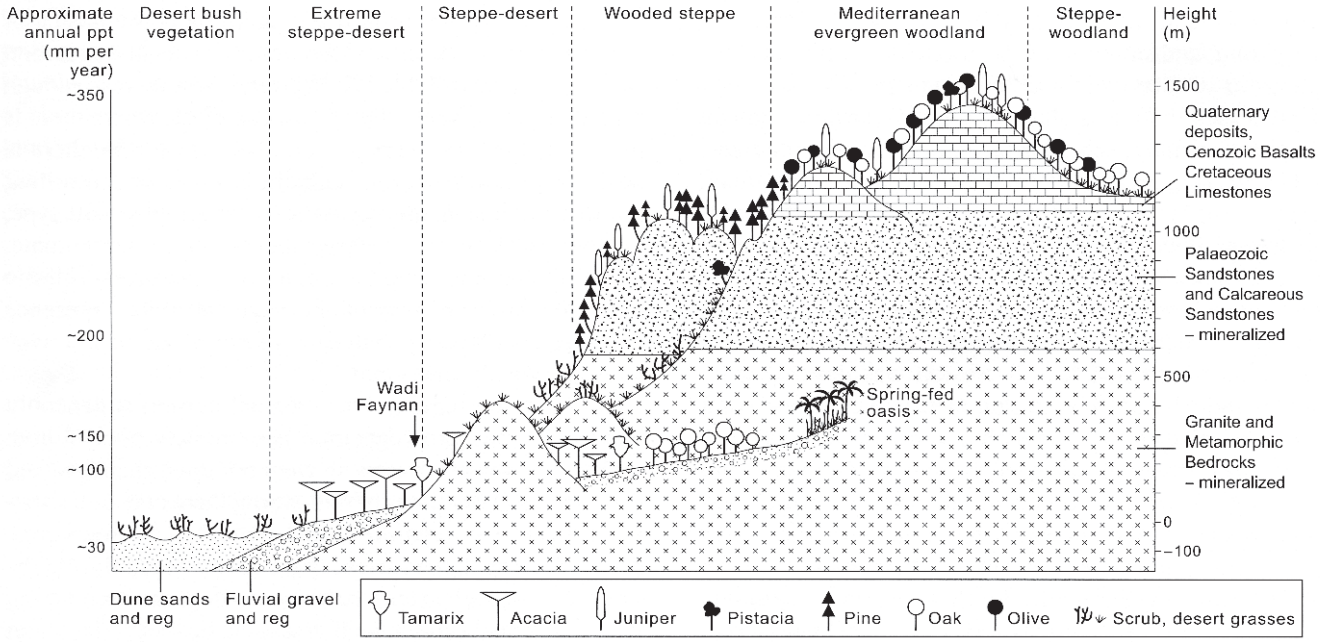

Figure 1.14 A cross section from the lowlands to the highlands in the region of Faynan showing vegetation units, approximate annual precipitation, and elevation change (from Baierle et al. 1989; Palmer et al. 2007). For further details about the different species, see Baierle et al. (1989).

sufficient supply of fuel for smelting on the scale evident in Faynan and Timna, and the question of fuel sources has been debated since the beginning of research in the study area (e.g., Glueck 1940). While in Faynan, the (mostly juniper) trees of the wooded land on the slopes of the Jordanian plateau were available as a source for charcoal, in Timna the only wood available was from the desert vegetation. The study of charcoal from the smelting sites of the Arabah provides further insights regarding this question.

The arid vegetation units can sustain seasonal grazing of herds of sheep and goats. The local societies in the Arabah region during the past few centuries have been semi-nomadic Arab Bedouin tribes (Bienkowski and van der Steen 2001; Palmer et al. 2007), engaging in pastoralism with seasonal migration between the lowlands of the Arabah (winter) and the highlands of the Jordanian plateau (summer). Only very limited agriculture has been practiced near local springs, and in a few places, orchards of olives and pomegranates still exist (such as the fields of the Mana'ja tribe near 'Ain al-Ghuwayba). The social structure of the local Bedouin tribes, which is well adapted to the physical environment of the Arabah, was the basis of (or an influence on) some models for the Iron Age societies in the region below and the concept of tribalism in Bienkowski and van der Steen 2001; Gellner 1990; LaBianca and Younker 1995; Levy 2009; van der Steen 2013).

Paleoclimates: The Arabah during the Iron Age

Paleoclimate reconstructions are complicated and based on various scientific methods such as isotopic analyses, reconstruction of lake levels and vegetation history (usually using palynology), and geomorphological studies. Any reliable interpretation of the published data, which appear more frequently in recent years, must take into consideration the shortcomings and drawbacks of each specific method. It is even more complicated when trying to correlate between climate changes and cultural processes, and often such interpretations have been published hastily and without in-depth evaluation of the issues, usually by groups of scientists uninformed by anthropological research. For the southern Levant, two important syntheses were published recently by Rosen (2007) and Issar and Zohar (2007) (references to some additional studies in Jordan can be found in Cordova 2007). The interpretation of data available for the Iron Age is still somewhat ambiguous, and some of the main data sets for climate reconstruction do not agree with each other. However, the general conditions and some trends can be identified.[11]

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Two main methods for reconstructing the climate of the southern Levant during the late Holocene are oxygen isotope analysis in cave sediments (Bar-Matthews et al. 1998) and modeling of the Dead Sea levels through sedimentary sequences (Bookman [Ken-Tor] et al. 2006; Frumkin and Elitzur 2002). The results of the two different methods show relatively good agreement, particularly the oxygen isotope record in speleotherms published for the Soreq cave (Bar-Matthews et al. 1998) and the Dead Sea levels published by Frumkin (1991), based on lake sediments in salt caves at Mount Sedom (Figure 1.15). Published climatic reconstructions for the Iron Age are slightly different, especially in regard to the Iron Age I (ca. 1200–1000 BCE), although they are based on the same records. Issar and Zohar (2007) reconstruct a colder and more humid climate during the Iron Age I and more warm and dry climate during the Iron Age II (Figure 1.15):

> "An abrupt change to a colder global climate took place towards the end of the second millennium BCE. The cold began around 1200 and peaked by 1100 BCE causing waves of people from Eurasia trying to settle down in new territories. … With the increasing cold, Egypt experienced a series of environmental calamities, most probably due to the weakening of the monsoon and penetration of most uncommon northwesterly rainstorms into Lower Egypt. … The paleo-climatic proxy-data show that after the spell of cold and humid climate around 1000 BCE came a warm and dry period with a low peak of humidity around 850 BCE. Then it steadily improved reaching favorable conditions from ca. 300 BCE until the 3rd century CE [Issar and Zohar 2007:182–208]."

Their interpretation of climate and cultural interaction is extremely deterministic. For example, following

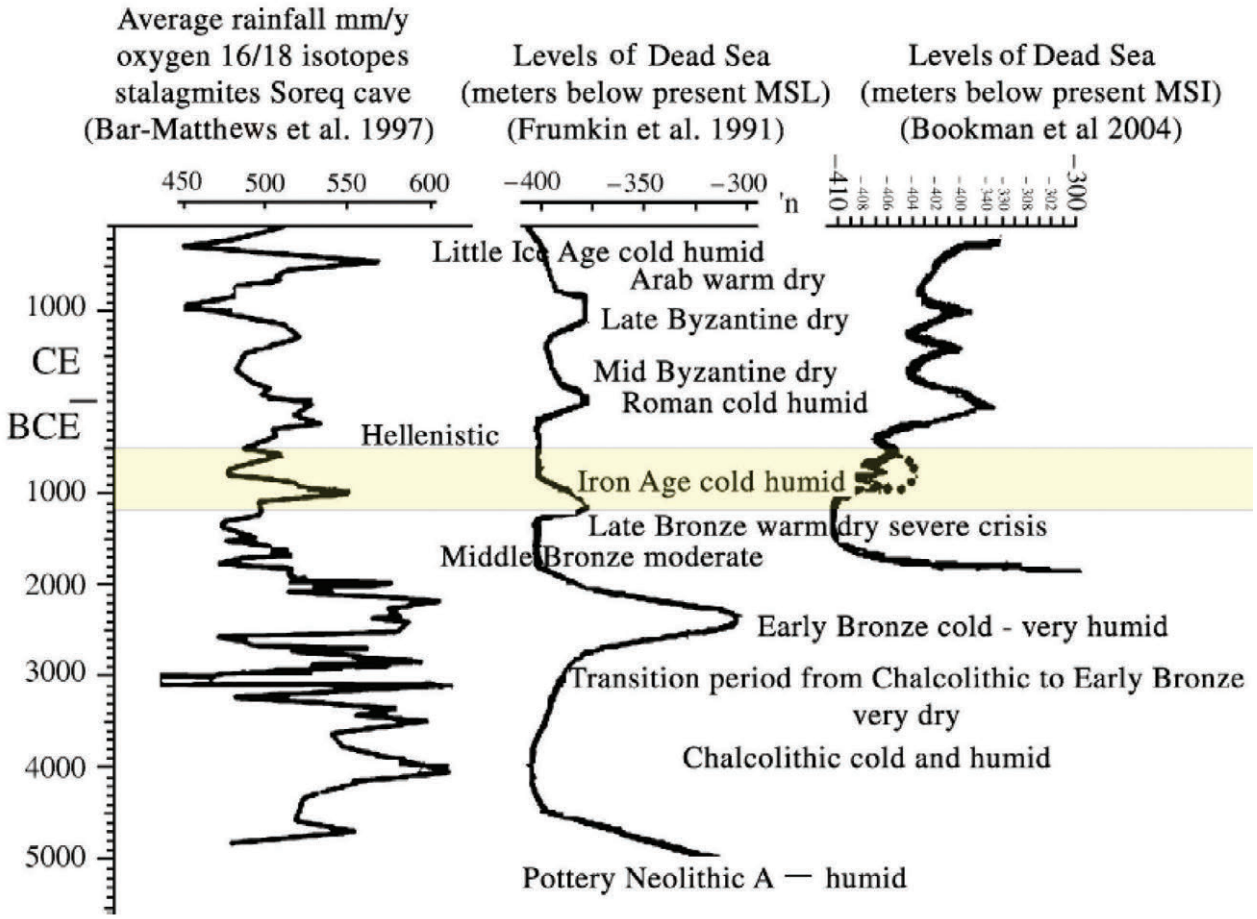

Figure 1.15 Three data sets based to reconstruct the climate of the late Holocene in the southern Levant. The interpretation presented here (modified from Issar and Zohar 2007) suggests a cold and humid climate in the first part of the Iron Age (see text for details).

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Herzog (1990), researchers attribute the flourishing of Iron Age I settlements in the northern Negev to the amelioration of climatic conditions:

> "The passage from a pastoral to an agricultural society can be seen in the nature and pattern of buildings at Tell Masos. From the end of the Late Bronze to the beginning of the early Iron Age, i.e. from 1250 to 1200 BCE, the people lived in tents or sheds … Herzog found that the favorable climate conditions of the 11th century BCE had promoted the expansion of farming communities into the Negev's more arid highlands. He also attributes the desertion of these posts in the 10th century to the worsening of the climate, rather than to the anthropogenic causes suggested by Meshel and Cohen. Indeed, the Soreq Cave curve shows a steep decline in humidity at the end of the 10th century, but its impact in the Negev may have started earlier [Issar and Zohar 2007:183–184]."

We believe that such a deterministic approach ignores substantial anthropogenic factors in the interpretation of social processes. Specifically regarding the Beersheva Valley in the Iron Age I, the flourishing mines of Faynan and the economic opportunity the copper trade provided to local societies were probably an important catalyst for the new settlement pattern in the region (see Chapters 2, 6, 7, and 12, this volume). Especially because the climatic record is not very decisive in this period, any climatic-based interpretation of major social changes should be viewed as hasty.

Rosen (2007) also indicates a moist interval around 1200 BCE, without exact interpretation of duration and intensity. Rosen is also much more careful in connecting climatic trends to social changes, especially in periods when complex societies inhabited the region. Frumkin and Elitzur (2002) interpret the entire Iron Age (1200–500 BCE) as relatively dry, with low levels of the Dead Sea throughout the period and a completely dry southern basin at least between 1000 and 700 BCE.[12] This reconstruction concurs with the one published by Enzel et al. (2003), based on a detailed study of the Dead Sea levels (Bookman [Ken-Tor] et al. 2006). The latter suggests gradual improvement of climatic conditions (more humid) throughout the Iron Age, after a severe drought at the end of the Late Bronze Age (Figure 1.16) but in general a dry phase in the entire period (Figure 1.17) (see also Bruins 2006). The interpretation of climatic impact on social processes published on the basis of the reconstruction of

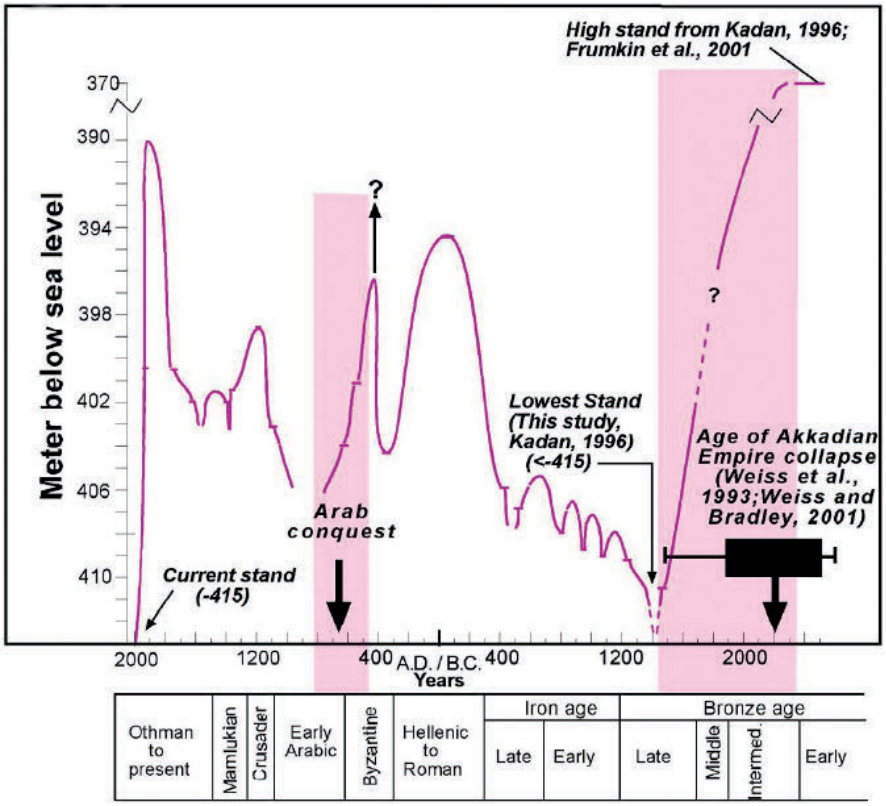

Figure 1.16 Reconstruction of Dead Sea levels based on ^{14}C-dated sequences of marine sediments (from Enzel et al. 2003, based partially on Kadan 1997). In principle, as the Dead Sea is a terminal lake, high levels indicate more humid periods.

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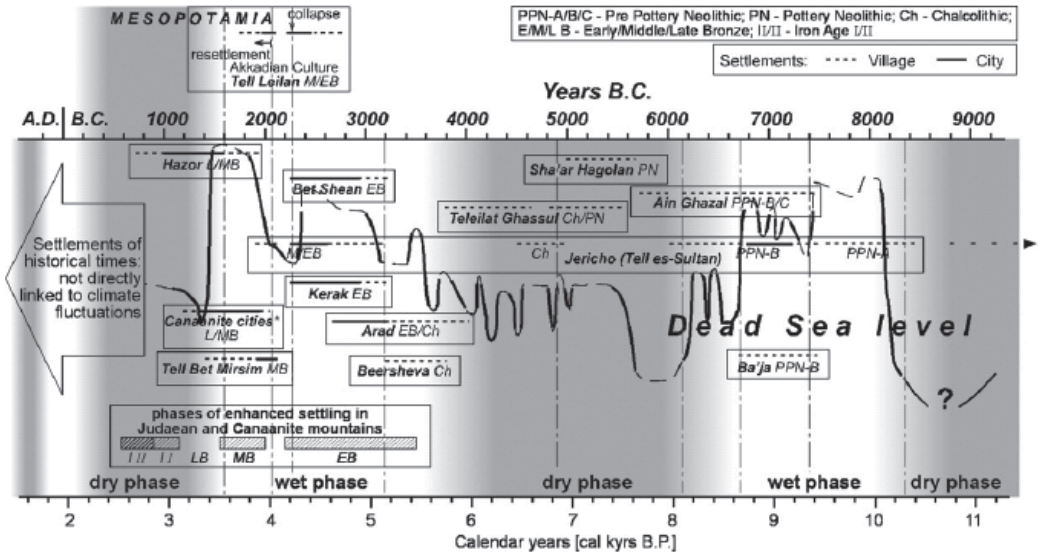

Figure 1.17 Dead Sea levels and cultural archaeological periods in the southern Levant (Migowski et al. 2006). According to Migowski et al. (2006:427), "The establishment of favorable climate conditions appears to parallel the expansion of villages into cities and the spread of farming communities into the Negev Desert. Deteriorating climate conditions are generally characterized by fewer settlements confined to the vicinity of water resources along the Jordan valley." Note that the Iron Age appears as a "dry phase."

the Dead Sea levels (Migowski et al. 2006) (Figure 1.17) also presents a very deterministic approach.

Reconstruction of the Iron Age climate of the Arabah is important for evaluating the physical conditions that the local societies experienced, especially regarding availability of water sources, possibility of agricultural practice and its scale, seasonality of smelting operations, and availability of fuel sources. Even a small change in humidity can affect the hydrophilic vegetation in the wadi beds around the smelting sites, the main source of fuel in Faynan during the Iron Age (see Chapter 13, this volume). From the data outlined above, there is supporting evidence of slightly better climatic conditions in the early Iron Age, during the resurgence in mining activities in the area. However, it seems that during the tenth and ninth centuries, the peak in copper production in Faynan, the climate was similar to today if not even slightly worse. Even with the available climatic data, it is still very hard to assess the availability of water in the local wadis. A higher water table will support more vegetation for fuel and a water sources such as *thmila* (dug depressions into the wadi gravel, exposing water for drinking and herds), wells, and small springs.

Descriptions of early travelers in the Faynan region (see Chapter 6, this volume) demonstrate the variation of water sources throughout time, probably as an impact of slight climatic changes. Glueck (1935:29) visited the region in March 1934 and described the area



Figure 1.18 An early Iron Age well near Khirbat en-Nahas (excavated in 2002) suggests a higher water table in this period (note person for scale; photo by T. E. Levy).

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of Khirbat en-Nahas: "At the present time there is very little water in the immediate vicinity of Kh. En-Nahas. There is a small spring on the north side of Wadi al-Guwayb opposite it, which was, however, insufficient for our own needs." Today, there is no evidence of any spring or high water table in the close vicinity of the site. Evidence for a higher water table near Khirbat en-Nahas in the early Iron Age is available in the form of an Iron Age well found by Levy and excavated in 2002 by ELRAP (Figure 1.18). In addition, some of the extensive remains of field terraces along Wadi Faynan near Khirbat Faynan recorded by the British projects (Barker, Gilbertson, and Mattingly 2007b; Wright et al. 1998) may represent extensive Iron Age agriculture based on water from springs in lower Wadi Ghuweir. Although these fields were published mostly as Early Bronze Age, the area is abundant with small Iron Age sites (pottery scatters, etc.) that, together with the inherent difficulty in dating terraces and fields, suggest the possibility of Iron Age agriculture in this area. The extensive fields near Khirbat Faynan suggest that the region could attract people to settle around its oases, in addition to the mining activity or without direct connection to it (such as the Nabataean occupation of Khirbat al-Ghuwayba that still supports local orchards; see Chapter 12, this volume).

Paleoclimate "insights" for the northern Arabah were published based on chronological patterns of plant species used as charcoals in the smelting sites of Faynan (Baierle et al. 1989; Hauptmann 2007). For example, according to these studies, the presence of juniper trees in the charcoal record of the Early Bronze Age implies a more humid climate during this period, and the absence of acacia in the charcoal record of the Iron Age implies that still the wadis carried more water than they do today. This approach ignores the anthropogenic quality of the record and presumes simplistic relations between societies and their natural environment based strictly on pragmatic activities. Juxtaposing the patterns observed in Faynan with the paleoclimate records of the southern Levant, we believe that the differences in charcoal used for smelting reflect different social choices and values rather than climatic changes. In fact, the charcoal record in Faynan is an important source for insights regarding local societies and their structure (Ben-Yosef 2009b and see Chapter 7, this volume for further details and discussion). It is against this environmental background that the new research concerning Iron Age mining and metallurgy in the Arabah Valley is presented in the following chapters.

Chaîne Opératoire and Technical Systems

Chaîne opératoire (Balfet 1991; Cresswell 1983; Edmonds 1990; Pelegrin et al. 1988) is an analytical method growing in popularity across the "practical–cultural reason" divide (Dobres 2010), providing an objective tool for researchers from a wide range of theoretical orientations—from processual to postprocessual. Behavioral archaeologists use a similar tool called "behavioral chain analysis" (Schiffer 1975, 2004, 2010). Accordingly, behavioral chains reflect the "life history" of a class providing extraordinary detail of the sequence of physical actions and bodily gestures ancient technicians employed to make, use, and repair objects. In turn, this sequence is embedded with social relations and reasons that are easier to extract out of the structured observations.

In the ELRAP, we use the concept of *chaîne opératoire* as formulated by the work of Lemonnier (e.g., 1986, 1989b). The "French school" was the first to apply this analytical technique to archaeological inquiry, with the pioneering work of André Leroi-Gourhan (1943, 1957). Building on the work of Leroi-Gourhan and under the broad "system view" approach, Lemonnier developed the concept of the *technical system*, in which technique and technology consist of five elements: (1) matter—the material acted upon; (2) energy—forces of movement and transformation of that matter; (3) objects—tools or means of work (e.g., a hammer or factory); (4) gestures—which "move" the object and are organized into linear operational sequences called the *chaîne opératoire*; and (5) specific knowledge—know-how (*savoir-faire*), the end result of all perceived possibilities and choices concerned with the technological action. The fundamental quality of these elements is demonstrated by Lemonnier's (1989a:156) own words: "without gestures that move it, without matter on which it acts, without the knowledge involved in its use, an artifact is as strange as a fish without water"; however, these five elements are only the base of a much wider approach to the anthropology of technology, in which the reciprocal effects of a technological system and social system have to be considered as well as the physical aspects themselves (matter and energy) combined with stylistic traits. In other words, the basic elements of the *technical system* are only the bricks in a wider discussion, used to (re)construct social meanings relevant to the seam between acts and social identities and structure. For ancient metallurgical studies, we can incorporate five generalized stages in the *chaîne opératoire*. These include market forces, ore

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Table 1.2 JHI and ELRAP Projects: Field Directors—Thomas E. Levy and Mohammad Najjar Iron Age Excavations and Surveys

Site Survey Acronym	Site Survey Name	Season(s)	Supervisor
FBRS	Faynan Busayra Regional Survey	2007	Erez Ben-Yosef
H2LE	Highlands to Lowland Edom Survey	2006	Neil G. Smith
JAJ	Jabal al-Jariya	2009	Erez Ben-Yosef
KAG	Khirbat al-Ghuwayba	2009	Erez Ben-Yosef
KAJ	Khirbat al-Jariya	2006	Erez Ben-Yosef
KAM	H2LE Khirbat al-Malayqtah	2006, 2007	Neil G. Smith
KEN-A	Khirbat en-Nahas, Area A	2002, 2006	Yoav Arbel
KEN-F	Khirbat en-Nahas, Area F	2006	Adolfo Muniz
KEN-M	Khirbat en-Nahas, Area M	2002, 2006	Elizabeth Monroe, Marc Beherec, Erez Ben-Yosef
KEN-S	Khirbat en-Nahas, Area S	2002	Lisa Soderbaum
KEN-R	Khirbat en-Nahas, Area R	2006, 2009	Yoav Arbel, Marc Beherec
KEN-T	Khirbat en-Nahas, Area T	2006	Adolfo Muniz
KEN-W	Khirbat en-Nahas, Area W	2009	Adolfo Muniz
KIJ	H2LE Khirbat al-Kur	2007	Neil G. Smith
KIS	H2LE Khirbat al-Iraq Shmaliya	2007	Neil G. Smith
RAM	Ras al-Miyah	2006	Erez Ben-Yosef
RHI	Rujm Hamrat Ifdan	2006	Neil G. Smith
TW	H2LE Tawilan	2007	Neil G. Smith
WAGS	Wadi al-Ghuwayba Survey	2002	Lisa Soderbaum
WAJS	Wadi al-Jariya Survey	2002, 2007, 2009	Kyle Knabb
WFD40-A	Wadi Fidan 40, Area A	1997, 2004	Rula Shafiq, Adolfo Muniz
WFD40-B	Wadi Fidan 40, Area B	1997, 2004	Russell Petrovic, Sarah Malina
WFD40-C	Wadi Fidan 40, Area C	1997, 2004	Mike Homan, Elizabeth Monroe
WFD40-E	Wadi Fidan 40, Area E	2003	Neil G. Smith
WFS	Wadi Fidan Survey	1998	Thomas Levy
WFS	Wadi Fidan Survey	2004	Jim Anderson
WSMS	Wadi Salmina Mine Survey	2009	Erez Ben-Yosef
WF4	Wadi Fidan 4 IA Tombs	2003, 2004	Adolfo Muniz, Mohammad Najjar
KHI-E	Khirbat Hamra Ifdan, Area E	2007	Adolfo Muniz
KHI-F	Khirbat Hamra Ifdan, Area F	2007	Adolfo Muniz
KHI-H	Khirbat Hamra Ifdan, Area H	1999, 2000	Mike Homan
KHI-C	Khirbat Hamra Ifdan, Area C	1999	Craig Beardsley
KHI-L	Khirbat Hamra Ifdan, Area L	2000	Lisa Soderbaum
KHI-Y	Khirbat Hamra Ifdan, Area Y	1999, 2000	Yoav Arbel

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procurement, smelting, processing, and export (Figure 1.19). For the archaeologist, it is crucial to parse out the archaeological record, period by period, to clarify how the *chaîne opératoire* at a given point in time relates to socioeconomic forces.

At the core of a technical system and associated interpretive analyses lies the basic and detailed investigation of *chaînes opératoires*. This "skeleton" of technological practice allows isolation of what Lemonnier (1989a:156) calls *strategic moments*: technological operations that are essential and unalterable if the given result is to be achieved. Identifying *strategic moments* is key to parsing the technical system into its different social components and revealing technological variants (i.e., different actions or ways leading to the same result). Those variants "often designate different social realities" (Lemonnier 1986:155) and can represent social choices.

The advantage of having *chaîne opératoire* at the core of the current study is the introduction of an empirically-valid new data set of one of the major and most influential technologies in the southern Levant during the Iron Age (ca. 1200–500 BCE). Structuring, contextualizing, and detailing this technology, from the level of site and raw materials distributions to the instrumental, artifactual, and environmental reconstructions, is key to understanding the social context and a solid reference for further studies. Furthermore, recognizing diachronic changes in *chaînes* of the same technology is one of the strongest and more empirical arguments for social and political changes. As social insights are subjected to theoretical orientation of the researcher (see above), we consider the *chaîne opératoire* as a more "solid" contribution of the current research. The entire work presented here is oriented toward establishing and detailing the changing *chaînes* of Iron Age copper production in southern Jordan; the environmental background is detailed in Chapter 13; the site's typology, distribution, chronology, and internal organization are presented in Chapters 2 and 12; the material culture of Iron Age archaeometallurgy is presented in Chapter 13; and a synthesis of the entire data set is presented according to the flow of the basic *chaîne opératoire*, with references to diachronic and synchronic spatial differences and interpretative models, in Chapter 15.

The ELRAP Cyber-Archaeology Methodology

In 1998, when we made a commitment to "go digital" to record all our field measurements on excavations in Jordan related to the role of ancient metallurgy on social evolution, we had no idea that our twentieth-century data would be "preadapted" to the growing field of three-dimensional visualization. This first application may be referred to as On-Site Digital Archaeology (OSDA) 1.0 (Levy, Anderson, et al. 2001). Being based in far-away San Diego with only periodic access to the

Analyzing Copper Technology in Faynan — General *chaîne opératoire* Model

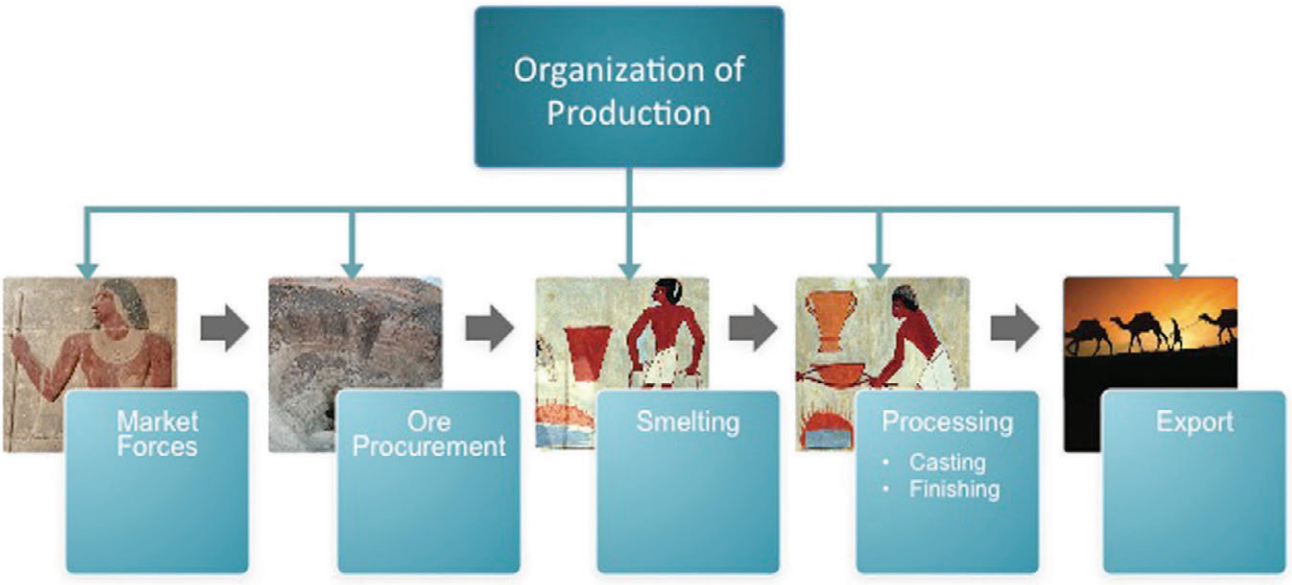

Figure 1.19 Generalized model of the *chaîne opératoire* related to ancient copper production.

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field and many of the artifact collections left behind in the Middle East at the end of each excavation season, we wanted to develop a recording system that would enable us to take our entire data set home with us for analyses. In this case, as Plato (ca. 427–347 BCE) wrote in *The Republic*, necessity was indeed the "mother of invention" and the driving force for abandoning the old analog paper recording system we had used for more than 25 years (Levy 1987). Over the years, as computers have become more portable and more powerful, OSDA 2.0 emerged, which, like version 1.0, has Geographic Information Systems (GIS) at its nexus (Levy and Smith 2007) to facilitate the spatial analyses of archaeological data.

Here we review the basic aspects of the ELRAP data recording system and summarize the most important new developments in OSDA 3.0 that make it a much more versatile system (Figure 1.20) that takes advantage of both off-the-shelf technologies and also includes new computer programs and hardware developed specifically to solve archaeological/cultural heritage problems that face researchers working around the

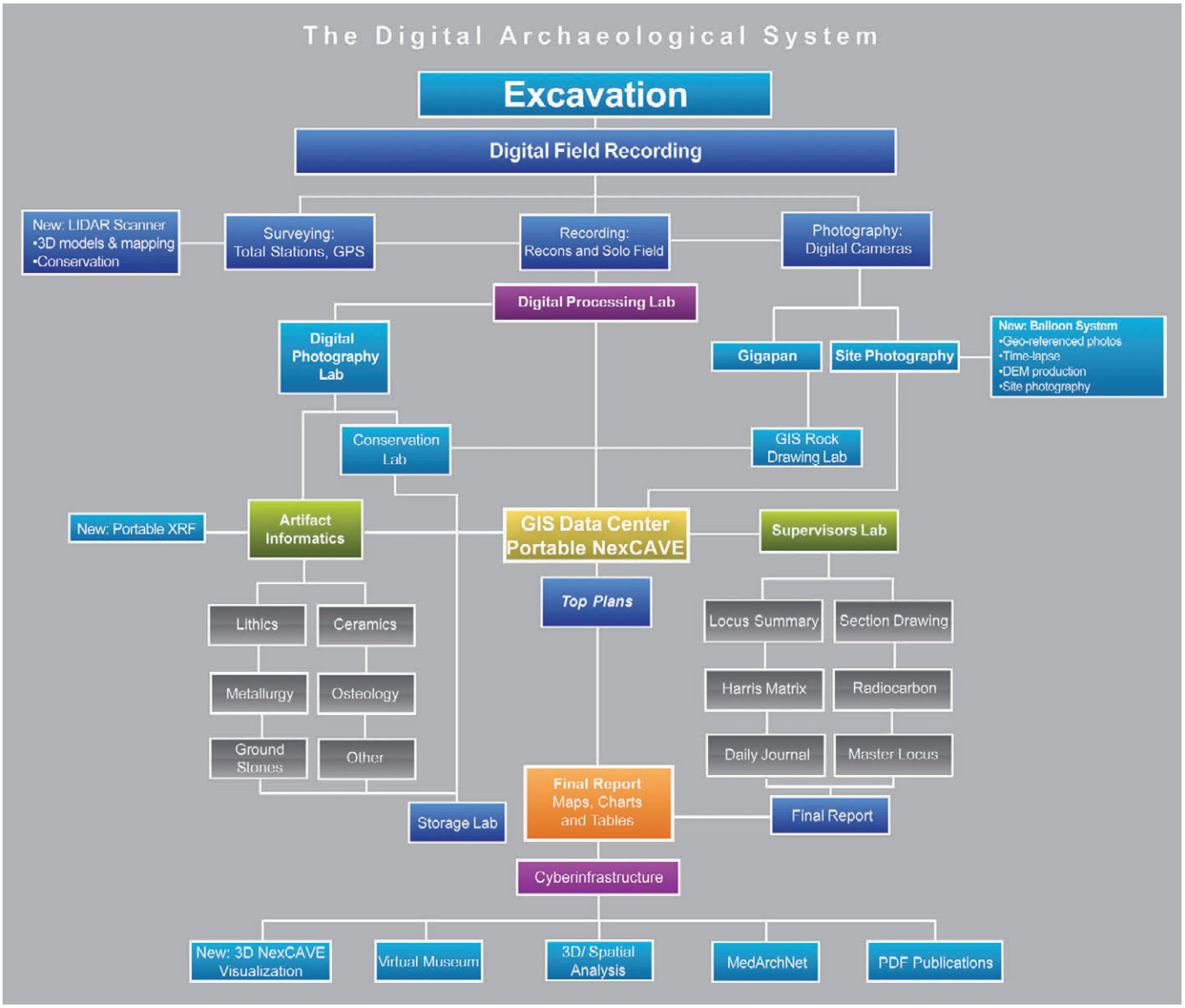

Figure 1.20 Flowchart illustrating the On-Site Digital Archaeology (OSDA) 3.0 system with new elements highlighted: laser scan mapping, helium balloon airborne photography, StarCAVE, NexCAVE, Artifact Informatics, and cyber-archaeology represented by the Mediterranean Archaeology Network (MedArchNet). OSDA 1.0 may be found in Levy, Anderson, et al. (2001) and OSDA 2.0 in Levy and Smith (2007).

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world today. As a field science where the context of phenomena is key for understanding both natural and cultural processes, archaeology depends on precisely documenting the *x*, *y*, and *z* coordinates of excavation and cultural heritage data. By acquiring this kind of metadata for material culture, it is possible to thread together an array of different kinds of spatial and analytical data recorded in the field that ultimately relate to the larger theoretical and historical questions that drive our quest to tackle the anthropological and historical models outlined at the end of this introduction and in most chapters in this volume.

OSDA begins with the mapping of all realms of material culture or any spatial information of relevance to the archaeological research. For archaeological field survey work, we depend on differential GPS, whereas excavation work depends on Total Stations (see Chapters 6, 7, and 12, this volume). Both methods have a high degree of accuracy, typically around 1 to 2 cm margin of error. All locations of artifacts, features, and topographic points are stored in a GIS database that can be quickly and easily accessed for analysis or transferred to a variety of three-dimensional computer modeling programs. Many of the other technologies we use rely on the data taken with the total station. For example, most imaging techniques we use are georeferenced using control points taken with the total station. Balloon photographs, a relatively new system for ELRAP and described below, are imported into ArcGIS and georeferenced. This allows us to create detailed site plans of architecture and other features. For a more detailed description of how Total Stations and GPS are used in the field, readers are referred to Levy and Smith (2007). Figure 1.22 shows how georeferenced aerial photographs taken with the "new" (as of 2009) helium balloon system are used for creating publishable maps at Khirbat en-Nahas (KEN). These data are subsequently used in the three-dimensional visualization environments discussed below.

Fundamentals of OSDA

Like traditional excavation recording (Hawkes 1954; Renfrew and Bahn 2008), digital data collection for excavation work breaks down into three primary components: surveying, artifact and context recording, and photography. The advantage of on-site digital archaeology is that it embraces the notion that the control of time and the control of archaeological context are the archaeologist's most precious commodities for modeling and explaining the past at the highest degree of accuracy. It also enables the processing and publication of archaeological data in a much more efficient and timely manner. Spatial data are recorded in two formats to facilitate using the data in GIS: points and polygons. A point is a single *x*, *y*, and *z* coordinate that is recorded for a specific special artifact find or elevation recording. A polygon is a closed plane figure with at least three vertices (e.g., triangle, rectangle, octagon). Polygons are used to draw, digitally, archaeological contexts (or loci) in the field. A polygon is recorded using a total station or EDM (Electronic Distance Measurer) by collecting multiple coordinates of the different vertices of the desired locus. Using the handheld Recon data collector and SoloField TDS Software, the vertices collected from the total station are automatically connected to create the desired polygon dimensions.

Surveying

Surveying is the means by which all spatial information concerning archaeological data, from artifacts to architecture to site plans, are recorded. The primary digital surveying tool used by ELRAP is a Leica Total Station. Total Stations were originally chosen for the Jabal Hamrat Fidan (JHF) project in the late 1990s over GPS surveying instruments, because of their relatively low cost (as low as $1,700 on eBay for used models; all the ELRAP Total Stations have been used models); reliability; precision; speed in acquiring sub-centimeter accurate *x*, *y*, and *z* (elevation) coordinates; and the fear that GPS instruments might lose satellite lock in heavily mountainous desert terrain. For the 2006 ELRAP season, we decided to link our earlier work (1998–2002) based on a local survey system in the JHF area with the international UTM (Universal Transversal Mercator) system by resurveying known ground control points (GCPs) using a sub-centimeter Leica 500 GPS. We accomplished this by working closely with Fawwaz Ishakat of the Hashemite University. Accordingly, before the 2006 season, we paid the RJGC (Royal Jordanian Geographic Center) 100 JD to process and obtain the UTM WGS84 coordinates for its cemented GCP located in the JHF Mountains. Using this point as the beginning GPS reference station, a second rover Leica GPS using RTK (real-time kinematics) was used to collect GCPs from our camp out over 12 km to our desired excavation site in 2006—Khirbat en-Nahas—to tie in our old local system to the main grid. The degree of accuracy using

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the GPS system was ± 2 cm and completed in one day. ELRAP continues to rely on total station technology for field recording; however, to improve the collection of data, an effort was made to purchase more powerful and rugged data collectors (i.e., the TDS Recon). Starting in 2011, the project employed a Reflectorless Leica TS-02 Total Station.[13] Once the total station is set up at the excavation site, data can be collected easily. Students are trained to record points within a matter of hours and, with practice, master the total station and TDS Recon technology. Currently, the most advanced and expensive GPS units can reach centimeter accuracy but still can require an extended period to record each point when satellite visibility is low.

The primary drawback to the use of Total Stations over GPS in the field is the requirement of a trained surveyor to establish control points and set up the instrument over these surveyed points for spatial recording. Establishing new control points is a complicated process that cannot be performed by a novice. The procedure, involving triangulation of multiple points, requires time and preplanning that must occur prior to excavation. Leading surveying companies such as Trimble and Leica have recognized this problem and have recently released "Smartstations" that use GPS to establish centimeter-accurate control points at any location desired and auto-configure the EDM for immediate surveying. As outlined above, these two systems were combined for the ELRAP in 2006 to tie our old local grid to the international UTM grid system.

Recording Archaeological Finds and Contexts

Recording is the means by which all data (excavation area, date, square, locus, basket, special find descriptions, etc.) are stored in GIS-formatted file systems and linked to the spatial information collected with the total station. The primary recording tool used in the research presented in this volume is a TDS Recon, using SoloField TDS software. The TDS Recon is a ruggedized, waterproof, dustproof, glare-resistant, droppable personal digital assistant (PDA). It runs SoloField TDS software, which collects user-entered data on a specific point (special find) or set of points (a polygon shape representing a locus) and triggers the total station to record the coordinates for the point or polygon data. At the end of the excavation day, these data are exported as an ArcGIS shapefile on a GIS-designated high-end PC laptop in the project "clean lab." The shapefile contains both the spatial information for every point and polygon as well as a spreadsheet database with the data entered for each recorded artifact or locus.

In 1999, a new number field called the "EDM number" was assigned to every special find and polygon in addition to its locus and basket information (Levy, Anderson, et al. 2001). The EDM number is a unique sequential number assigned to every special find or locus recorded with the total station. It provides the key number field in GIS for all data to be linked with their spatial information. The added benefit of the EDM number is that it allows new data to be joined to the GIS by this primary field key. For example, the metallurgical specialist can join all the measurement and classification data of a specific special find to their data in GIS by the EDM number. The EDM number is also used to link digital field photographs and lab photographs to the GIS system. Finally, the EDM number also provides a check on basket numbers to make sure that there are no mistakes or overlap.

Digital Photography in the Field

Digital photography is used in the field to record archaeological sites (on the ground and from the air), architecture, loci, and in situ artifacts. There, digital cameras serve two basic functions. First, they are used for capturing high-resolution photographs of architecture, in situ features, and artifacts during excavation. Many excavations rely on a professional photographer to take all site photos—a long tradition of American excavations in the Levant (Dever and Darrell Lance 1978). The advantage of using film was the assurance that the excavation photographer would capture the appropriate material with a professional eye and have the correct focus, lighting, and exposure. Advances in digital cameras through automation have made the need for an on-site professional photographer obsolete. In 2004, ELRAP recognized the advantage of immediate viewing of photographs on digital cameras—especially for images used in the production of maps (see below). If a mistake was made, the photo could be immediately discarded and reshot. We also found that having a supervisor trained with a few simple photography skills gave greater precision to what he or she desired to photograph. Thus, by 2006, each area supervisor's dig kit included a small Nikon digital camera (ca. 4 megapixels [MP]), a professional menu board and letters, and photographic scales (north arrow and meter stick). By also training

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students in on-site digital photography, we effectively have a photographer at each excavation area, making it unnecessary to have a professional photographer on site during the day. However, for final excavation photographs and the most significant discoveries in the field, publication-quality photos are professionally taken by the project directors (Levy and Najjar both have strong backgrounds in photography).

The second use of digital cameras in the field is for digitizing site architecture using a boom system, which eliminates the need for a professional on-site architect to produce site plans. A compact high-definition (Nikon Coolpix P4, 8 MP) digital camera is suspended securely on a boom pole approximately 7 m above the ground (Figure 1.21). The boom pole is attached to the camera rig, protected in a plastic enclosure using a ball joint, and leveled to the gravity vector to get a perfectly vertical "aerial" photograph of the desired architecture. In the past, to georeference the photographs for digitization in AutoCAD, a range pole was placed in the photograph, and two surveyed coordinates using the EDM were recorded in the photograph (cf. Levy, Adams, and Najjar 2001). In subsequent years, we used spray paint to mark the reference coordinates. During the 2006 season, we discovered an alternative noninvasive method of marking features with masking tape: drawing a cross on the tape, labeling it, and recording the center of the cross's x, y, and z coordinates using the total station. By using the high-resolution 8-MP Nikon camera, these relatively small "Xs" could be clearly seen in the image—even though the photos were shot from a height of approximately 7 m (Figure 1.21). The problem with the "boom" system was that only small excavation areas could be captured in one photograph. This made it imperative to develop a low-altitude system that would enable us to photograph the entire excavation area with one "shot" (see the helium balloon platform discussion below).



Figure 1.21 The original "boom" system used on the ELRAP expedition. By attaching a small digital camera to the pole, it was possible to photograph roughly one 5 x 5–m excavation square. Numerous setups were required so that the individual georeferenced photographs could be used for rock drawing (see Figure 1.3). This system was cumbersome and time-consuming, factors that stimulated innovation and the development of the balloon system.

"Dirty" Digital Processing Lab

After excavations are completed for the day, all artifacts are brought from the field to the "dirty" digital processing lab (DDPL) for initial sorting. This lab's primary function is to make sure every artifact recorded in the field has been labeled correctly and corresponds to its digital record, now stored in the Recon data collector. Each day, data from each excavation area Recon are downloaded from the GIS server and imported into the daily basket list database. The daily basket list is used to check all the field tags, make sure there are no misplaced artifacts, and conduct a preliminary check to ensure data were entered correctly in the Recon; all mistakes are noted. The excavation area supervisor or assistant is then called into the DDPL to correct and explain all mistakes. In the field, the assistant supervisor is responsible for keeping a paper copy of all data entered into the Recon as an extra check. Thus, there are three checks (supervisor hard copy, tags, and digital entry) to ensure no data are lost or left uncorrected due to human error. Once the mistakes are identified and solved, all three checks are updated. Thus, the mistakes common to human error are eliminated prior to the creation of GIS daily

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top plans and labels for digital photography of all artifacts. The final task of the DDPL is to send artifacts for publication-quality photography, preliminary artifact analysis, conservation, and storage in crates that are inventoried for final storage at the Department of Antiquities of Jordan or at UCSD.

Rock and Architecture Drawing Lab

As noted above, with the invention of the boom system and, later, the low-altitude helium balloon photography platform, we eliminated the need for a trained site architect (see Figure 1.22; Chapter 2, this volume—area excavation maps). The advantage of the boom system is that the actual rocks, installations, and wall lines can be traced with centimeter accuracy. Once the day's excavations are completed, the boom camera photographs are downloaded onto the server and imported into the GIS program. Previously, this was done in the cumbersome AutoCAD program—which has a steep learning curve and required training with a separate group of students. With the development of ArcGIS 9.1, it was possible to carry out all the digitizing tasks in ArcMap that were previously done with AutoCAD. Briefly, the recorded reference points for the boom shots are either called up from the day before or imported if new. The pictures are georeferenced to the reference points and the ArcMap 9.2 rectification tool is used to orient and scale the picture in relation to the excavation area map stored in the GIS. By 2009, we used ArcGIS version 9.3, which has some updates but the same basic functionality as version 9.2. Once georeferenced, the rocks and all other pertinent features are traced with the ArcMap editing tools. Since ArcMap can maintain scale, the photograph can be zoomed in to ensure accurate drawing of every rock and line feature. The result is architectural plans that include the

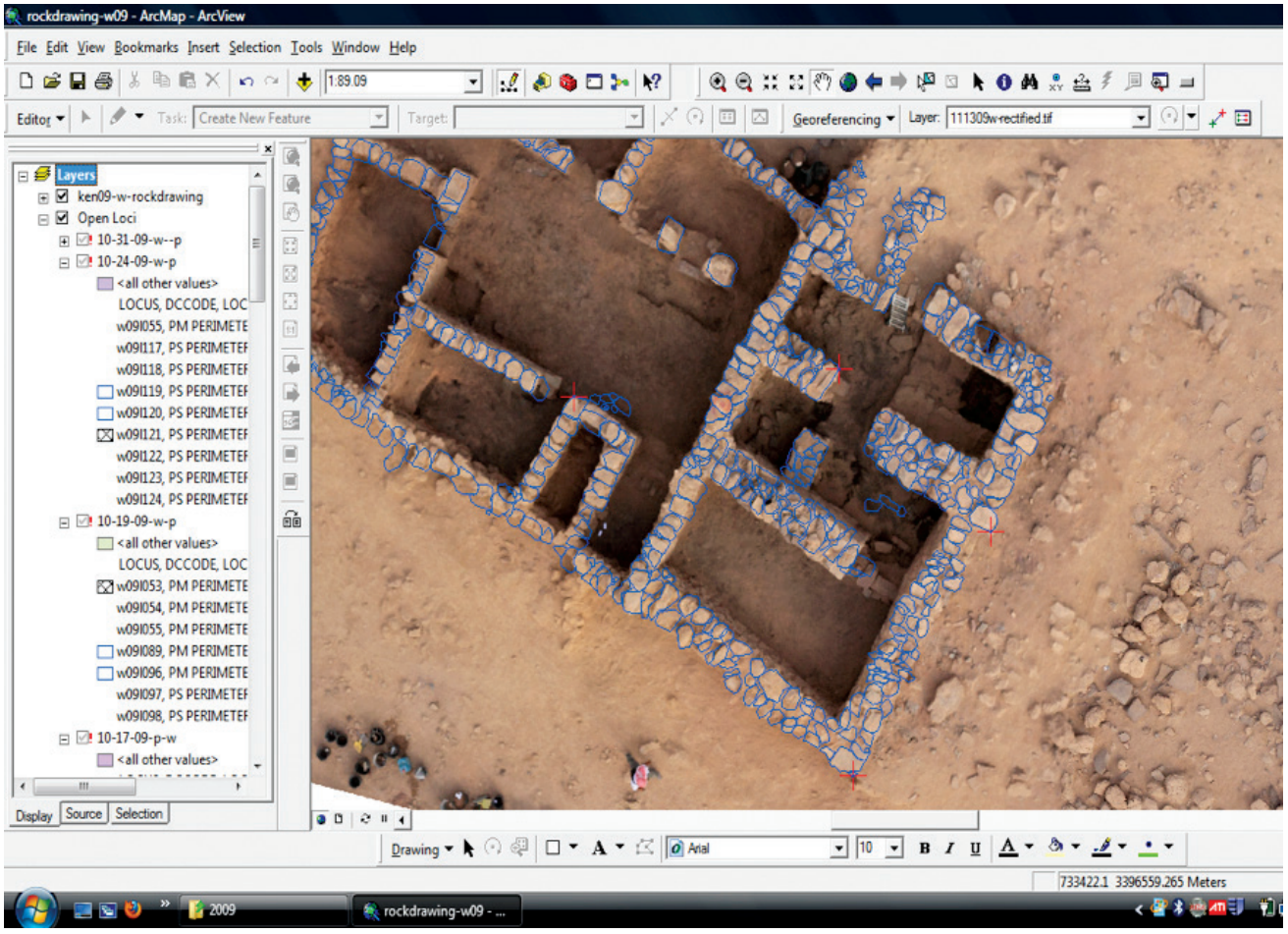

Figure 1.22 Image of ArcMap screen captured by the University of California, San Diego balloon system in 2009 that is georeferenced. The rocks are "traced" to create a detailed architectural plan. Shown here is part of a building complex from Area W.

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smallest rocks that fill in the gaps in walls. Given that everything is now drawn in ArcMap GIS, the data can be simply manipulated in any of the three-dimensional modeling programs available in ArcMap for daily top plans, three-dimensional excavation area or site modeling, and other uses.

Final Digital Photography Lab

Every significant artifact is digitally photographed in the digital photography "clean lab" for future analysis, preservation, recording, and reference in GIS. An average ELRAP season will shoot around 6,000 artifacts in the "clean lab." Two artifact photo booths are used for achieving the diffused lighting and background environments needed for producing publishing quality photographs (see especially Chapters 2, 9, 11, and 13 and the DVD, this volume). Generally, between two and six photographs are taken of each artifact to capture its different angles. Having a digital photography lab in the expedition base camp allows for artifacts to be captured in a professional way before being stored or transferred to another location. Digital photography enables more artifacts to be photographically recorded and more image files to be stored systematically than film. The artifact's photo files are labeled with the same easy identification and spatial reference in GIS and scientific visualization using the StarCAVE, NexCAVE, and other platforms described below. Thus, the photo EDM number is listed first, which provides the *x*, *y*, and *z* coordinates of the image. This is followed by an abbreviated description of the angle shot (e.g., 50001_t.jpg would designate EDM number, locus number, and a photograph taken of the top or dorsal side of the artifact). In 2006, all photo files for a specific artifact were combined into a "retriever" file under its EDM number (e.g., 50001.ret). A retriever file is a file created using a program called Retriever, which can call up all linked photos for immediate viewing as thumbnails or select for individual large-scale viewing. The advantage of using a retriever file is that it can be hyperlinked to an Excel or Access database file as well as ArcGIS. Since the retriever file is named according to the EDM number and all our databases use the EDM for joining and accessing artifact data, the retriever information can be queried and called up just as easily as any other information joined in ArcGIS. This allowed for rapid access of the entire artifact excavation photographs within the current programs used by the ELRAP for analysis, including Excel, Access, ArcGIS, or any other program that has hyperlinking capabilities. By 2009, we found Adobe Photoshop Lightroom 2 to be very useful for organizing the photographic files.

Conservation Lab

This wet lab serves the function of "first response," restoring and conserving artifacts found during excavations. Generally, artifacts requiring conservation go first to the digital processing and photography labs. The conservation lab coordinates with the photography lab for taking "before" and "after" digital photographs of the artifacts being treated.

Preliminary Artifact Analyses Labs

The ELRAP project has specialist artifact labs for preliminary analyses of archaeometallurgy, ceramics, ground stone, lithics, and zooarchaeology that are run primarily by doctoral students working with the principal investigator. Some of the preliminary tasks include washing, sorting, labeling, weighing, counting, and measuring artifacts and ecofacts. Data are recorded on hard-copy forms and entered in digital datasheets that can later be linked, by locus number, back into GIS for preliminary distribution studies, more in-depth analyses back at the university, and, ultimately, final publication.

Storage Lab

The final destination for most artifacts after processing, photography, and preliminary analyses is storage. Once artifacts have been subjected to preliminary analyses, the DDPL organizes the storing of artifacts in rectangular plastic red crates (ca. 50 × 30 × 30 cm) readily available in Amman and ideal for permanent storage. The field storage lab arranges artifacts in the crates according to excavation area and material culture in a logically organized system that allows easy future access. A master Excel database is produced using the complete loci and basket information available on the Recons for all artifacts recovered during the excavation. The master database is then updated with the storage crate/box number in which the artifact is stored. This crate/box inventory database is rejoined to the master database in GIS so that future researchers can query the database to find in which boxes the artifacts they desire are located. As will be seen in the various chapters in this volume, the

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ELRAP collections represent a unique material culture record of one of humanity's most important technological achievements in pyrotechnology. In terms of the future, we worry about the lack of interest and foresight from nongovernmental organization and academic administrators who do not make the curation of these archaeological materials—which are such a rich research and teaching resource—a priority.

Field Supervisors Lab

The 2006 ELRAP excavations focused on four areas: Area A Fortress, Area F Fortress Interior, Area R Monumental Building, and Area M Metallurgical Building complex. To ensure that everything recorded in the field is digitally stored, a lab was specifically designed for field supervisors to allow them to enter all their data from journals, locus summaries, the Harris matrix, section drawings, photography, daily graphic diaries, and so on into a digital format, to be stored in a series of folders structured the same for each excavation area. All of these data are stored on the project server that can be accessed by anyone on the local ELRAP network. Student volunteers assist the supervisor in daily data entry on dedicated networked laptops. During the excavation and postexcavation field writing, each supervisor has a dedicated laptop for writing up his or her final report. The laptops are wirelessly networked with the main ELRAP server so that they can access their site photos, digital artifact photographs, all the databases, and any maps, charts, or tables generated for them in ArcGIS. As described earlier, by 2009, we expanded the excavations in Area R and opened a new Area W. The same system was followed, resulting in the data preparation for the Chapter 2 study presented here.

The ELRAP GIS Data Center

The goal of making all the excavation data digital is to be able to store them in a GIS for scientific visualization and analyses. Once the data are stored in a GIS, they can be used to create daily top plans, end-of-season final reports (maps, statistics, and charts), artifact-specific analyses (pottery, archaeometallurgy, zooarchaeology, etc.), and professional publications such as the present volume. ArcGIS, at its core, is a relational database, which means data from different databases can be linked by a common number field—the EDM number. This allows all databases and later analytical studies to be joined to the current GIS by this common field. Having multiple databases joined together with spatial data enables the user to conduct complex multivariable studies. For archaeology, it allows all the realms of material culture to be linked together, associated with precision spatial data, and analyzed as complete data sets. Furthermore, storage and retrieval are organized by the GIS, which allow a higher degree of centralization and control of the data than could be achieved with paper/analog-based studies. A GIS significantly shortens the time between excavation and publication, which still remains a considerable problem in archaeology today. Beginning in 2010, we have worked to produce an integrated database system that will facilitate all these aims as well as three-dimensional spatial studies (see database discussion below).[14] The remaining discussion describes the equipment required to run a GIS lab in the field, the individuals involved, the creation of daily top plans, and production of final reports suitable for publication.

Organization of the GIS Lab

The centrality of the GIS lab for all digital data processing and storage generally necessitates state-of-the-art portable computers as well as high-speed local networks and data storage systems. Over the past excavation seasons (2002–2009), the ELRAP digital archaeology system has used two dedicated computers per excavation area as the minimum for efficient data processing. The high-end laptop is used by the GIS area specialist for all GIS activities, including architecture and rock drawing. A fast laptop is also used for running Adobe Photoshop and Pagemaker for use by the digital photographer. Medium-range laptops are dedicated for all forms of data entry by the supervisor, assistants, and computer-savvy students and report writing. One of the latter computers is also dedicated to the DDPL for downloading Recon data, managing the daily digital basket list and other processing databases, and uploading data to the server. Finally, the specialists running the different preliminary artifact analyses often use their own laptops that can be networked to the ELRAP server.

Beginning in 2006, the server ran on one of the high-end laptops configured as a server networked to a gigabit hub gateway and linked with a wireless router for the medium-range computers. For backup, a 400-GB external hard drive was used for copying all data on a daily basis. ArcGIS is designed to run proficiently over networked systems and enables a high degree of control

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of the data and prevention of dispersed copies of old projects and data. The other advantage of running off the server is that any computer can access the shared data so that areas are not tied to one computer.

The transition to gigabit Ethernet has increased data transfer by approximately 10 times, which saves time loading and transferring data on the networked laptops. During power outages, which do occur on occasion in our Bedouin village, the laptops switch automatically to battery power, allowing around three more hours of work without electricity. Two to three printers are also connected to the network for printing spreadsheets, photos, labels, top plans, or any other digital data presentation. By 2011, with the implementation of a portable NexCAVE and associated computing power, speed has increased exponentially.

The GIS Team

Prior to departing for Jordan, the specialist who oversees all ELRAP GIS projects and server maintenance trains two students for each excavation area in preparation for the expedition. The student *GIS area specialists* are trained in producing daily excavation area top plans for the supervisors and the final excavation reports. With two students per area, they can be rotated daily to prevent fatigue and allow them to participate in other post–field lab activities. Having dedicated students producing top plans frees up the supervisors and assistants to focus on their journals and field reports. The supervisors are expected to oversee the GIS top plans to ensure the integrity of the data. After the first week of field excavations, new students are brought in to learn how to use GIS in the ELRAP digital archaeology program.

Daily Top Plans and Publication-Quality Maps

Top plans, once known as daily graphic diaries, are daily printed maps that display the current loci being excavated, exposed architecture, and the location of all special finds. Prior to going digital, top plans were traced daily by hand on a light box by the area supervisor. Special finds were roughly measured in the field using measuring tape and a simple "dumpy level" to measure elevation to illustrate the data mentioned above. The drawbacks of this system are that it is time-consuming, lacks precision and accuracy, and is only in hard-copy form. If any type of spatial study were to be conducted, it would require an entire year or more to digitize the top plans into ArcGIS, and the data would still be dependent on the accuracy at which the supervisor or site architect drew the original top plans.

Producing top plans with GIS is a fast process and allows for specially crafted top plans for each area according to what the supervisor desires to see for the next day's excavation. The point and polygon data for every area already have been downloaded as shapefiles in the DDPL and are directly uploaded to the server to be accessed by the GIS area specialists. From their networked computer, they can directly import the shapefiles into their current ArcGIS project. First, the point data (special finds and elevations) are automatically assigned symbols so that each type of special find can be distinguished visually on the map. Supervisors have a printed key of the descriptor codes that they carry in the field. Second, detailed labels for these special finds (e.g., "50001 HA Hammer stone") are generated on the map. Depending on the preference of the supervisor, any type of label information can be generated for the point data. Third, the polygons (loci) are imported into the GIS.

The polygons are assigned different colors according to whether they represent the opening, modification, or closing of a locus. This procedure allows the supervisor to immediately recognize what new loci were opened the previous day, as well as those that were closed. Labels are also generated that can depict dates of the loci or elevation or any other needed information. Fourth, the supervisors are then called in to look over their top plan and give any input or corrections. The supervisors' checking of the top plan serves as a fourth check on the entire digital system. Once the drawing of the boom photography of site architecture is finished using the editor tool in ArcMap, it is ready for GIS analysis. Since the architecture is already georeferenced, it immediately drops into place on the top plan. The final step of producing the top plan is to update the printing template so that it represents the data collected that same day. The top plans are printed on tabloid-size paper over the networked printers. Multiple copies of different sizes can be produced for the area's supervisor. From start to finish, daily top plan production averages between 30 minutes and one hour depending on the amount of finds and loci excavated that day. With careful editing, the data collected from boom photography, rock drawing, and site surveying can be coupled together in the GIS and used to produce publication-quality maps (see "Excavation Area Maps" in Chapter 2, this volume).

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Making More Out of x, y, and z: New Imaging Techniques Used in OSDA 3.0

The 2009 OSDA 3.0 system, used in the preparation of this volume, integrates a number of imaging techniques, including a specially designed helium balloon platform for taking vertical and oblique photographs of archaeological/cultural heritage sites; GigaPan photography, which enables multi-gigapixel panoramas to be taken of sites with digital single-lens reflex (DSLR) cameras; and terrestrial light detection and ranging. By the end of the 2009 field season, we were busy developing an integrated relational database that could bring together the different file format data files produced by this array of different data capture devices (Gidding et al. 2011) that has aided in the analyses of data at the time of this publication.

a) Airborne Balloon-Based Imaging

Terrestrial-bound photography provides a record of excavations, but to place the site in its more general context for larger scale analyses, aerial photography is needed. Here we describe improvements on the "boom" system used in OSDA 1.0 and 2.0. As noted above, the boom system was time-consuming, was awkward, and involved long hours of "stitching" georeferenced photos together to cover one excavation area. These problems were a catalyst to design our airborne helium balloon system in the summer of 2009, which was developed by undergraduate students at the UCSD Center of Interdisciplinary Science for Art, Architecture and Archaeology (CISA3)/California Institute for Telecommunications and Information Technology (Calit2) and deployed in Jordan in September of that year. It consists of a helium-filled balloon with a sail appendage mounted on a stable aluminum platform equipped with two 15-MP DSLR cameras monitored with a live feed (Figure 1.23). The balloon (Kingfisher Aerostat from Southern Balloon Works) is tethered to an operator on the ground that can position it over a specified excavation and cover areas up to 700 m^2. The system can capture images up to a height of approximately 200 m at high resolution and excellent stability that ensures image quality. The system is versatile enough that it can be brought down to a lower height for even higher-resolution image capturing.

The vertical high-resolution images of site architectural features are georeferenced and aid in the creation of publication-quality maps using ArcMap in the ArcGIS 9 suite. All photographs are shot as stereopairs that can be used to create digital elevation models (DEMs). For oblique views, the cameras can be manually rigged to supplement more interpretive analyses. For the 2011 expedition, we developed an automated self-stabilizing aerial camera platform based on experiences learned during the 2009 ELRAP expedition.[15]

Another requirement for this system was quick deployment on a daily basis. Thus, complicated rig systems were avoided in the design of the aluminum platform. The balloon was kept inflated throughout the two-month-long expedition season with little helium loss. It was sheltered each night in an on-site tent-like "hanger." In the 1930s, the Megiddo project similarly had to construct an on-site hanger for its photography balloon—one of the earliest such applications (Guy 1932). OSDA 3.0 cameras were positioned on the balloon chasse system at the beginning of each day, allowing it to be ready for shooting within 10 minutes.

Rapid recoverability of the balloon is possible by being tethered to the operator with a high-strength, lightweight, Spectra line. This allows the operator to position the balloon over a specified area for shooting and recover it using the tether. Operation is simple—the balloon is "walked" until positioned over the area of interest. A live-feed from the air-borne cameras to a laptop on the ground allows a visual check to determine if the system is over the target.

Desert conditions required that the balloon system be rugged; thus, there are few electronic components. The balloon itself was rugged and able to withstand UV radiation during its long deployment. More than 13,000 images were successfully captured, amounting to over 200 GB of data during the eight-week season (Table 1.3). We are currently designing a more rugged aluminum platform, a remote control to facilitate automated camera movement for both vertical and oblique photography, and stereo-video photography to enable three-dimensional fly-through and fly-over of archaeological and cultural heritage sites.

b) GigaPan

GigaPan enabled us to use our DSLR cameras to produce multi-gigapixel images at KEN not only to capture high-resolution panoramic views of the site (Figures 1.24 and 1.25) but also as a supplemental research tool. To enhance data acquisition and analysis, GigaPan photographs can be overlaid on the point clouds of archaeological features acquired digitally

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Figure 1.23 Top left: Helium balloon and photography platform in flight. Top right: View of monumental Iron Age building at Khirbat en-Nahas (excavation area shown, ca. 15 x 25 m). Bottom: Image composite of Khirbat en-Nahas (ca. 10 ha; square fortress = ca. 73 x 73 m). Shot from altitude of approximately 200 m.

by laser scanning. Individual excavation areas were imaged using the GigaPan (Areas M, R, T, and W) and will then be georeferenced with the billion-point laser scans made with the laser scanner.

The GigaPan imagery supplements the laser data by providing more accurate, higher-resolution color information than delivered by laser scanning. The process enhances the positional accuracy for the high-density three-dimensional laser point clouds with color and texture information of comparable fidelity. The combined record is both photographically representative and three-dimensionally precise down to the millimeter and works well in the scientific visualization devices described below.

c) Terrestrial Laser Scanning for Archaeological Fieldwork versus Cultural Heritage Conservation

Recent developments in on-site scanning technologies add an important new field tool to the OSDA 3.0. This adds an important component to controlling the spatial context of the increasingly large data sets that ELRAP has collected since 2002 and reports on in this volume. Terrestrial laser scanning was introduced in 2009 at KEN to augment recording, analysis, and conservation efforts. The scanning was carried out with a Leica ScanStation 2 that uses laser light to capture a collection of three-dimensional points sampling the geometry and color of objects within its field of view. We acquired over 1.75 billion points in

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Figure 1.24 GigaPan 360° view of Khirbat en-Nahas, Jordan. This imagery will be used in various three-dimensional visualization environments.



Figure 1.25 GigaPan view (180°) of the interior of a room in the Area W Iron Age building complex; Khirbat en-Nahas will be used to supplement areas not covered by terrestrial laser scans in the field.

space comprising a high-resolution spatial record of the ancient fortress walls, gatehouse, residences, and some 100 ancient unexcavated buildings visible on the site surface. The application of laser scanning for documenting ongoing excavations is relatively new: To date, most archaeology terrestrial laser applications have focused on recording sites as a means of ancient monument conservation (Barton 2009) and as a reconnaissance tool (McCoy and Ladefoged 2009). In the United Kingdom, relatively high-resolution laser scanning (ca. 1–2 m) was used for site prospecting that produced results as good as or better than aerial photography (Bewley et al. 2005). Our goal is to use laser scanning as a heuristic device to investigate archaeological data collected during the course of excavation as well as provide an accurate conservation record of a site.

i) Terrestrial laser scanning on-site—Recording a 10-ha archaeology site with sub-centimeter accuracy

The application of OSDA 3.0 in Jordan exploited the full potential of sub-centimeter accuracy provided by laser scanning for site recording and analyses. First, points were sampled every centimeter (compared to the 5-cm resolution of previous scans our team carried out in the Anza-Borrego desert, California, in preparation for the Jordan project [see Fox 2008]). Laser scanning at KEN produced even more detailed scans, determining points approximately 1 mm apart. The laser scans also yielded color and intensity information for each point, providing some insights about the properties of the material. Successfully scanning a large archaeological site using terrestrial laser technology poses a set of unique challenges, including proper scanner and target setup in and around sensitive archaeological artifacts dispersed over a site that in this case extends over 10 ha. At KEN, line-of-sight distance from the scanner was limited, with many surfaces requiring scans from oblique angles adversely affecting the achievable range, speed, and scan resolution. These challenges were further aggravated by electrical power requirements imposed by extended acquisition runs as well

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as environmental conditions such as dust and heat that affected both the scanner and the control laptop. Finally, solid boundary conditions for high-precision georeferencing of the acquired data had to be provided.

At least half a dozen laser-based surveying devices using either time-of-flight or phase-based techniques (to determine the distance between the scanner and a target within line of sight of the scanner) are now commercially available. Most of these devices support a spherical scan envelope that is swept out one point at a time during the acquisition process. Most commonly, the laser is directed via a rotating or pivoting mirror, covering approximately 270° vertically (the remainder is commonly occluded by the system's tripod) and a rotating head allowing for 360° horizontal sweeps. Common sampling rates range between 15,000 and 150,000 points per second with a sample spacing that may be as small as 1 mm for systems with an average laser spot size of approximately 4 mm.

System Specification

The Leica ScanStation 2 used at KEN is theoretically capable of sampling rates close to 50,000 points per second and acquisition densities of less than 1 mm^2 over distances up to 300 m for objects with a 90 percent albedo. Under Jordan field conditions, sample distances of 100 m tend to be more realistic. The scanner weighs approximately 19 kg, the battery pack 12 kg, and its surveyor's tripod 9 kg, for a total of 40 kg for the base system, excluding the acquisition laptop. When combined with a ruggedized transport case, the overall weight more than doubles, requiring an experienced operator and one assistant. The ScanStation 2 has a maximal scan range of –45° to +45° vertically, requiring a two-pass sweep and 360° horizontally. User-specific scan windows can be flexibly defined within this. In specifying a solid angle of interest, a physical resolution is derived using an average distance to target. With these two parameters in place, the physical resolution is computed in terms of samples per degree—in effect creating a variable spatial resolution based on the varying distance from scan surface to scanner. In the course of each scan, stationary surveyors' markers are scanned and enumerated as a spatial reference that can be used to align data collected from multiple scan positions. To drive the scanner, power is required as well as a standard Ethernet connection to a control terminal (limited by specification to ca. 100 m). Electrically, the world-compatible power supply draws up to 400 W for the scanner, although in practice the scanner averages 100 W power, plus 60 W average for the control laptop.

Field Deployment

A scanning sampling strategy is needed when tackling a large site as not all areas are of equal interest. The foremost concern when deploying the scanner is its placement relative to the object or panorama of interest. Uniformity of coverage is of utmost importance, as locations not visible from the scanner's head will show up as voids in the final scan. Careful planning to cover a particular feature or surface from multiple angles is required to capture surface characteristics that would otherwise be represented as shadows with insufficient coverage. This involves a "walk-through" with the excavation director to identify significant areas for detailed scanning.

The main excavated areas on the site were scanned at very high resolutions (1 or 2 mm). These high-resolution scans have provided an impetus for developing new processing and visualization techniques capable of handling these large data sets. For key excavation areas, such as the fortress gatehouse, the following scanning goals were met:

1) Provide a clear and unobstructed view of features of interest.
2) Select locations where the scanner is equidistant to the features of most interest.
3) Provide multiangle coverage of nonplanar surfaces—commonly, several scans were needed to avoid occlusions. In practice, this required changes of scanner elevation as well as position.
4) Have solid georeferencing support with limited interference from surveying targets (markers).
5) Limit required scan distance to control errors introduced by variations in temperature and humidity.
6) Minimize the number of scan positions needed to achieve target objectives with respect to coverage and resolution.

In practice, handling ancient rooms with interesting features is relatively straightforward: the laser technician can "walk" the scan lines, observe occlusions, and make concessions of coverage between prospective scan positions. A digital camera and diligent analysis of occluded spatial regions also help in planning. Constraints such as the suggested minimum distance

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from corners and surfaces help to converge prospective scanner placement between multiple candidate sites.

To achieve greatest wide-area coverage of the site, a number of specialized scans directed exclusively at low-resolution panoramic coverage from an elevated position are best. Covering wide areas uniformly is best achieved by choosing a set of physically elevated candidate sites with the greatest visual coverage of the site. These wide-area scan sites can be co-located with areas of interest for background scans, with resolutions of 1 cm at 50 m considered acceptable.

Empirically, the time flow for a scanner placement is estimated as follows:

- Five minutes for tripod deployment
- Five to 10 minutes for cabling and scanner setup
- Eight minutes to boot up the scanner
- Ten minutes to acquire background photography
- Five minutes to acquire the surveyor's markers
- Sixty minutes for each 30 million points to be scanned (in practice)

Based on these parameters, it was important to minimize the number of scanner placements. For example, interior scans inside a building can be around 30 million points. Thus, the deployment cost noted here governs the time spent acquiring the scan. The only limitation for prospective scanner placement is direct line-of-site visibility to at least two separate surveyors' markers, and those markers should be clearly visible and within 100 m.

Georeferencing

Included in the scanning field deployment are four surveyors' markers. These markers are placed strategically to be seen from the majority of the scan locations, so that scan location can see at least two markers. The purpose of registering placement relative to the markers is so that several scans from different physical positions can be stitched together as one uniform scan. These stationary markers serve as the ideal reference points for chaining together a collection of scans.

With careful placement, four markers are sufficient for all but the most complicated and obscured areas of interest. Complications arise when multiple sites of interest are to be scanned and co-registered when one of two conditions is encountered:

7) Four target sites are insufficient to cover both areas of interest.
8) The areas of interest are separated by more than 100 m.

In the course of the scanning campaign at KEN, both of these conditions occurred. To avoid the propagation of error likely to occur if targets were moved, they were never moved until all scanning was complete. Likewise, revisiting a site using a distant marker as a common registration link was ill-advised as error could easily be propagated in false or noisy measurements to the distant marker. To solve both problems, a strategy was established of systematically moving the scanner along the scan path in one direction through the site—thus containing error propagation by avoiding revisitation of scanned areas.

Trying to manage the trade-off and process of marker placement, scanner placement, context of scans, and ordering of on-site scan work flow proved to be formidable. In practice, the scan site and all regions of interest were thoroughly surveyed visually for an entire day before any equipment was deployed.

ii) Postexcavation Laser Processing

The product of a scanning campaign is a collection of raw point clouds, one per scanner setup. These individual point clouds subsequently have to be merged, cleaned, and georeferenced (assigned latitude, longitude, and elevation), turning the data collection into an accurate representation of the field site and excavation, suitable for visualization, analysis, and co-registration with other digital data assets.

The scanning campaign at KEN yielded some 1.75 billion scanned points that were acquired following the scanning procedure outlined above. The process ensured that several GPS-referenced markers were visible in each cloud, establishing a common reference coordinate system for the entire collection, and that scans could be accurately merged. Once merged, the overall data collection was cleaned to remove redundant, undesirable, or extraneous points, for example, those of inadvertently scanned persons or equipment. Of particular importance was the treatment of points covering objects visible in multiple clouds, since not all objects were scanned equally well in every cloud: some were near the scanner, with high point density and precision, and some were far away, or at an awkward angle with low density and precision. Consider a part of a wall that is visible in multiple clouds, with a differing scan quality in each. If the wall is covered well enough by points from

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a single "best" cloud, the overall quality of the data set can be improved by removing the lesser-quality wall points from the other clouds. The size of the resulting data sets has historically presented a major obstacle: just bringing the points to the screen quickly is a technical challenge. To address this, we have developed a novel system that allows billions of points to be interactively visualized on commodity hardware—however, the algorithms involved are not presented here.

Once the overall point cloud is available, a baseline record for the site is established that captures its spatial characteristics at a specific moment in time. With this record in place, it is then possible to virtually explore the site, flexibly and freely, overcoming on-site limitations with respect to how easily particular locations may be accessible. When paired with intuitive interaction and display devices, visualization of these point data allows for the exploration of spatial relationships, correlations, and measurement of the site and its artifacts (Figures 1.26 and 1.27). The use of room-sized display walls, such as HIPerSpace, and virtual reality environments, such as the NexCAVE and StarCAVE (e.g., Figures 1.42 and 1.43), provides a means to collaboratively study a vast amount of georeferenced data of various types within an appropriate topographic context. At the same time, laptop-centric visualization provides a means to analyze data in the field, at a level of interactivity previously only seen in videogames. This may include analysis of the locations of artifacts, correlation of radiocarbon samples, and augmentation of close-up photographic records or references in the georeferenced context provided by the point cloud. We have also experimented with more structured analytical paradigms. One example is a grid system that partitions the site into fixed-size cells. The grid provides an organizational structure for annotations and measurements and enables a constrained cell-by-cell navigation mode that complements the freeform three-dimensional inspection interfaces. In addition to letting us view the site as a camera would—in perspective—the visualization system can also be used to cut out and draw arbitrary slabs and slices of the site orthographically, overlaid with a measurement grid and the real-world scale. This mode allows us to perform both qualitative and quantitative analyses. For example, we can quickly measure length visually by positioning and scaling the



Figure 1.26 Viewed from above, a visualization of the laser scan record resembles an aerial photograph. Note the differing levels of scan coverage corresponding to areas of greater and lesser interest: areas with minimal coverage appear as gaps or shadows between the more important regions scanned with a high point density. Shown here is the Iron Age fortress (ca. 73 x 73 m) in Jordan. Compare with Figure 1.4. *Image: CISA3/Calit2.*

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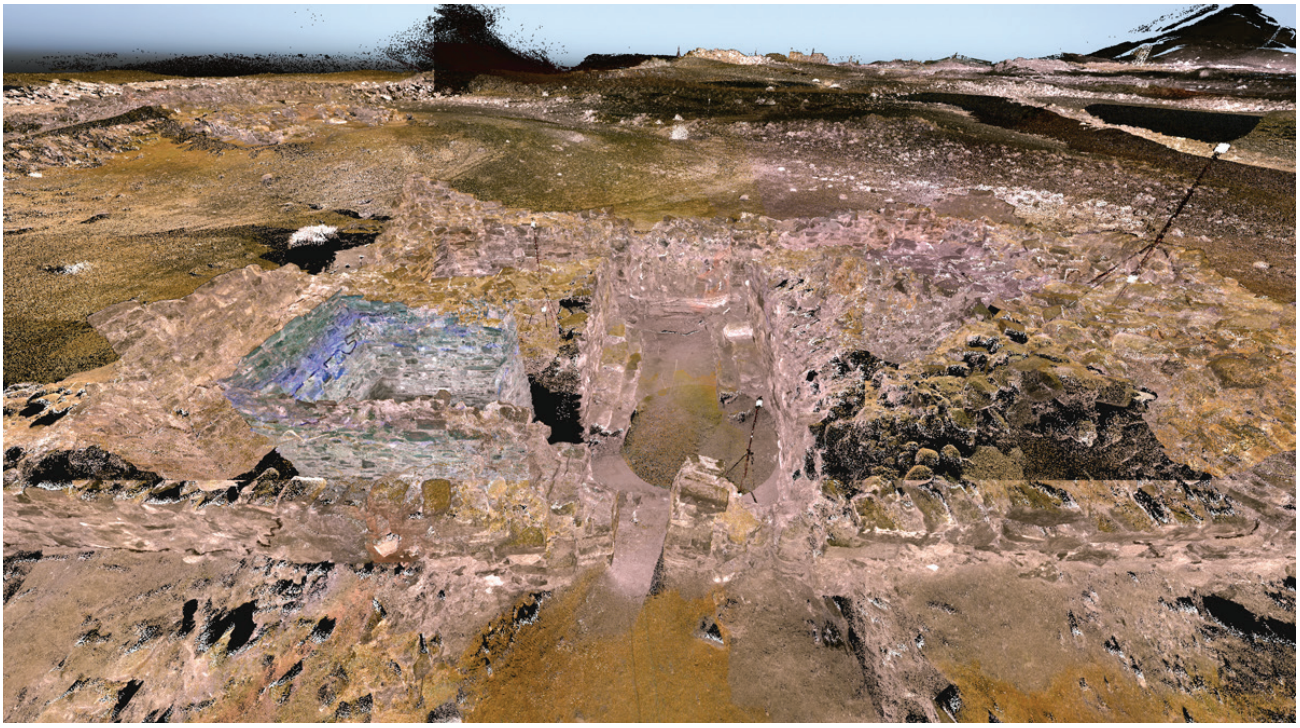

Figure 1.27 Viewing an area of interest up close reveals the detail acquired by the laser scan scanning technique. A structure with interior rooms can be seen in full detail in the foreground, with sparser coverage of other areas and the background. Shown here is the gatehouse of the fortress at Khirbat en-Nahas. *Image: CISA3/Calit2.*

viewing slab appropriately. We can also easily obtain ground plans (Figure 1.28) or vertical sections (Figure 1.29) by positioning the viewing slab parallel or perpendicular to the ground and selecting the appropriate slab thickness. Note that these types of analyses are made possible by the performance and interactivity of the underlying visualization system—the subject of interest is interactively manipulated into the desired position on the measurement grid, with continuous visual feedback, simply by moving through the virtual environment.

For a number of the critical radiocarbon dating studies presented in this volume (see Chapter 2, Area A Gatehouse discussion), we were able to use an additional tool for augmented point-cloud visualization developed by Vid Petrovic as part of the ELRAP research team (Petrovic et al. 2011). This involves augmenting the bare laser scan record with visual annotations generated dynamically from a GIS database that enables the rapid exploratory visualization of many kinds of data with their appropriate spatial context (locus) (Figure 1.30). To obtain a better understanding of the contextual relationships between the radiocarbon-dated sample and the stratigraphy of the excavation area, we visualize the exact sample location and corresponding loci together with the spatial scaffold provided by the laser scan point-cloud data (Figure 1.31). This tool enables ELRAP researchers to "revisit" the excavation on the day the data were recorded and reexamine these spatial contexts that are of key importance for locking down chronological issues.

Portable Analytical Tools—XRF in the Field

Portable high-precision analytical tools are rapidly allowing researchers to bring the geoarchaeology laboratory to the field (e.g., Katz et al. 2010). In recent years, the field of X-ray fluorescence (XRF) has been revolutionized with the development of portable devices. Instead of bringing samples to the laboratory, the researcher can now measure the bulk chemical composition of materials in the field and get results on the spot. Pioneering applications of this type of research have been carried out on early metallurgy sites in Israel (Vardi et al. 2008; Yekutieli et al. 2005). The portable XRF has various applications, and more and more publications demonstrate the important role of integrated chemical analysis in field research. For example, archaeologists can measure and map soil composition (metalliferous pollution or other chemical variables of

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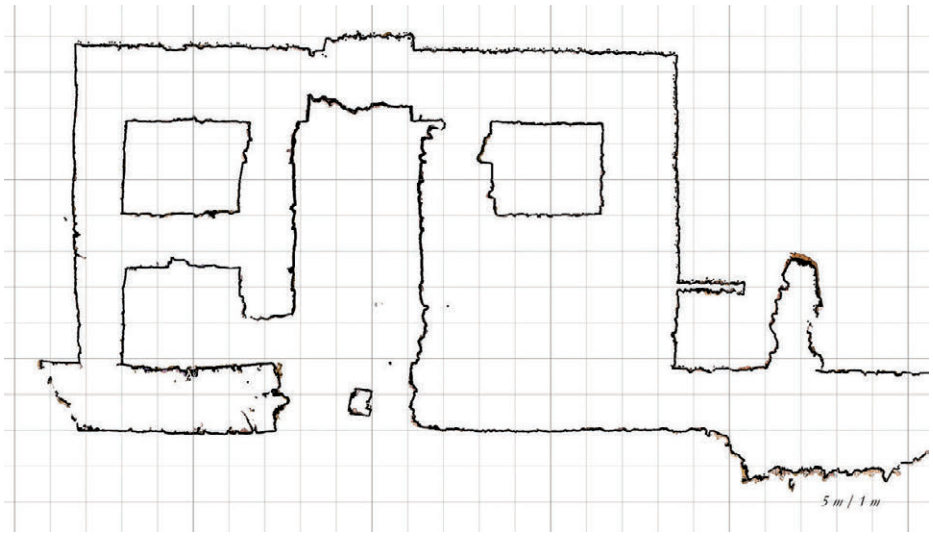

Figure 1.28 The point visualization tool can be used to present spatial relationships faithfully and to scale. The point cloud data are a precise record of the scanned area or objects and can be used to perform measurements and other analyses. For example, we can obtain a floor plan of the Iron Age gatehouse with minimal effort by selecting a horizontal slice of points to view. Image: CISA3/Calit2.

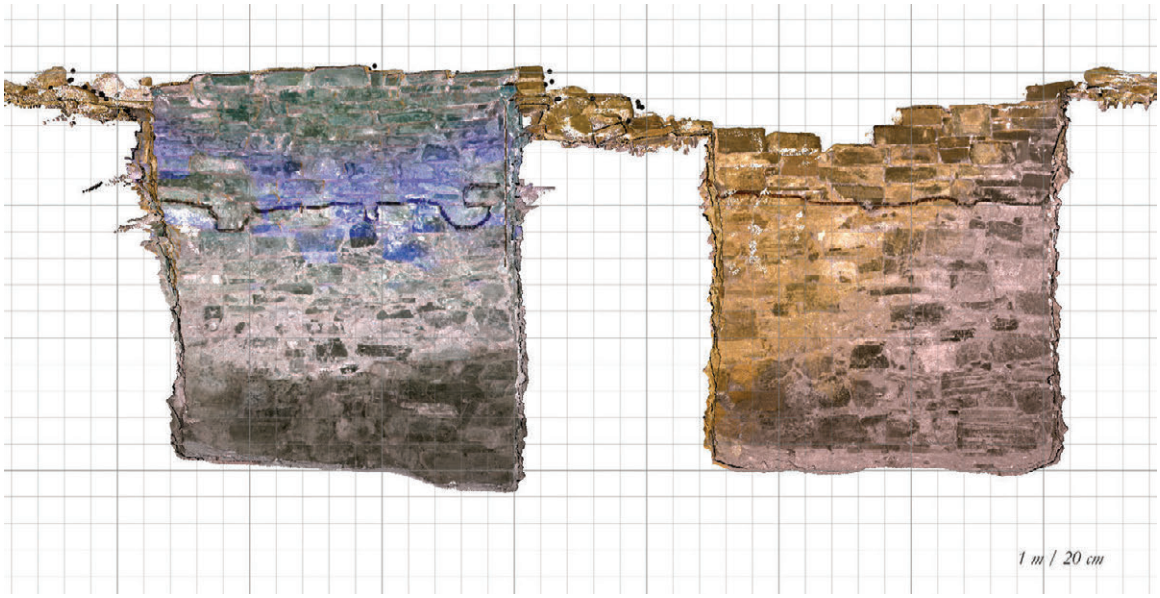

Figure 1.29 Alternatively, structures can be isolated and compared, such as the above common wall with obstructions removed. Note the automatic grid-line and scale overlay; the grid spacing and scale legend updates dynamically as the view is changed by the researcher. Here a north-face section has been made through the laser scanning data to illustrate a section illustrating two walls that delineate the doorways to two guard rooms. Image: CISA3/Calit2.

interest) spatially on site or along profiles in excavated sections, correctly identify objects already in the preliminary stage of research (bronze vs. copper vs. iron artifacts, gemstones, beads, etc.), obtain typological "chemical signatures" of artifacts as part of the sorting and cataloguing process in the field, and so forth. One of the fundamental advantages of portable devices is the ability to measure materials that cannot be carried to the laboratory due to governmental rules or the large size of some cultural material.

The output information of the portable XRF is a complete list of chemical elements found in the sample, with their relative or absolute quantities (depending on instrument calibration and type of material). The measurement itself is nondestructive, rather quick (usually up to 300 seconds), and in most cases without the need of special sample preparation. The fast measurement process results in an exponential growth of digital data that should be organized and correctly linked to the sample information and excavation contexts. A major caveat

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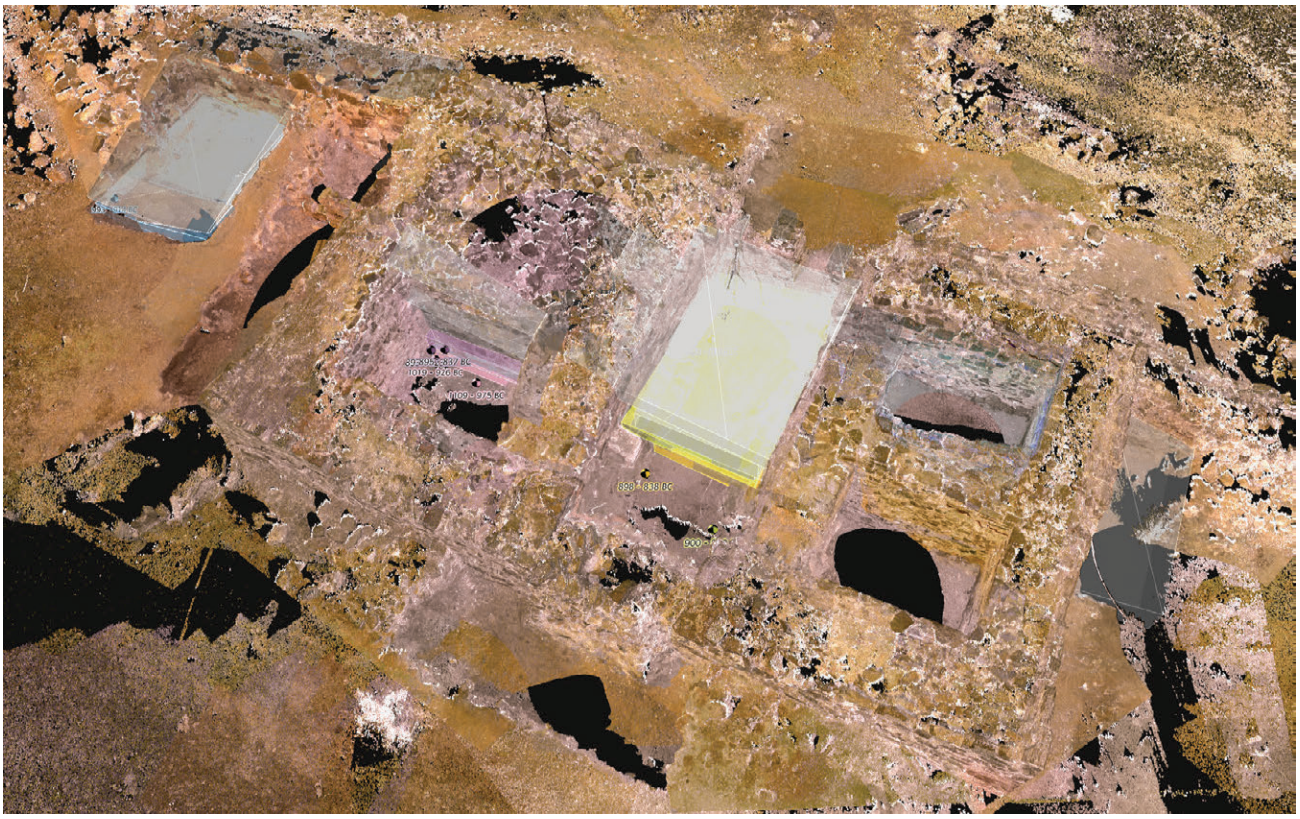

Figure 1.30 Khirbat en-Nahas gatehouse laser scan data visualization augmented with dynamic locus annotation.

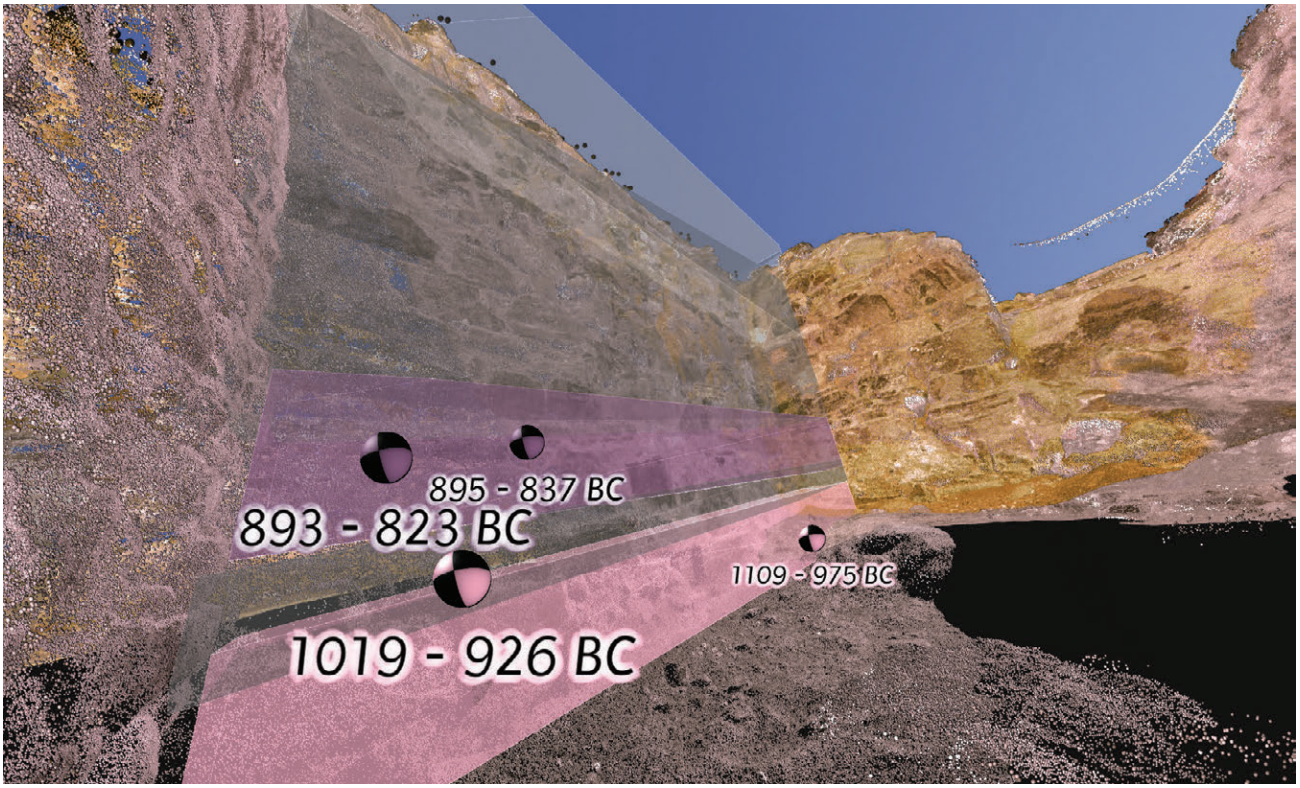

Figure 1.31 Close-up of walls from southeast guardroom of the Iron Age gatehouse with the location of radiocarbon samples dating from the tenth and ninth centuries BCE.

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of XRF application is that each measurement represents only a limited portion of the sample on the scale of a few millimeters (in diameter and in depth, depending on the specific structure of the device, its settings, and the type of material). This should be taken into account in the case of heterogeneous, corroded, or patinated samples, and such metadata regarding sample characteristics must complement the XRF data.

At KEN, we integrated data from routine XRF measurements with the master GIS-based database of the excavation. More than 600 artifacts were measured with a portable Bruker XRF device, including soil samples, scarabs, copper ore, ceramics, slag, and metal artifacts. The field measurements helped, for example, to identify high impurities of iron in the raw product of primary smelting and the lack of tin in most of the copper objects from the site; we also obtained elemental composition of hundreds of artifacts that had to stay back in Jordan. One such artifact was an arrowhead (Figure 1.32) made of pure iron (now corroded). The XRF reading (Figure 1.33) of this artifact (.PDZ file format in our system) is linked to its EDM number and by it to its spatial coordinates, context (locus, basket), digital photography, and other information included in the relevant Access database. The XRF database is currently being integrated into the visual analytics methodology described in this chapter. The fact that we could definitively identify an important iron artifact at the KEN copper production site was extremely important in the field for helping us interpret the social meaning of Area W (see Chapter 2, this volume).



Figure 1.32 Arrowhead from Area W, a weapon made from iron, 2009 UCSD Jordan expedition (EDM w09f2918).

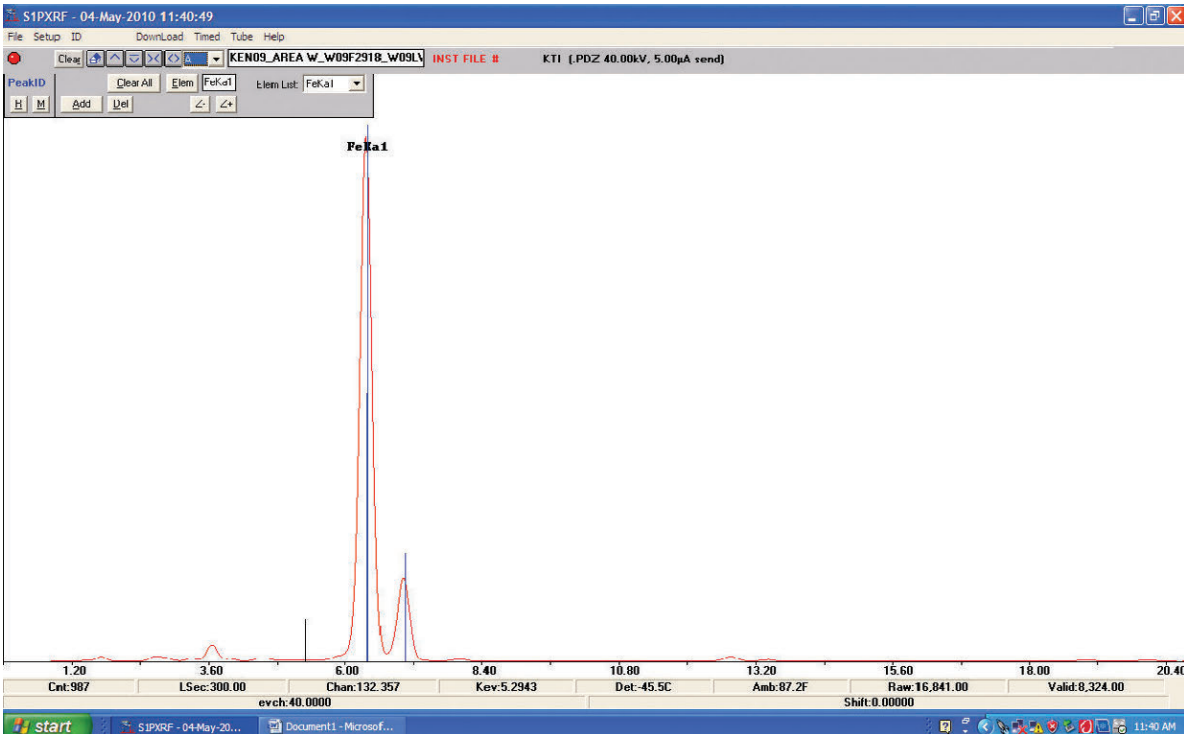

Figure 1.33 X-ray fluorescence reading of the arrowhead (Figure 1.11) in initial examination mode showing that the artifact contains almost exclusively iron (Fe).

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Portal Science, Cyber-Infrastructure, and Cyber-Archaeology

MedArchNet—DAAHL

To share ancient settlement patterns and other archaeological data with as large an audience as possible, a cyber-infrastructure is needed that can promote the sharing and analyses of data in a communal manner. The National Science Foundation (NSF) GEON "Cyberinfrastructure for the Geosciences" project (http://www.geongrid.org), which has an information technology component led by Chaitan Baru, serves as model for how the Earth science community uses a cyberinfrastructure with "data portals" to facilitate delivery, discovery, access, and integration of distributed heterogeneous data sets (Baru in press). Our group has built a similar cyberinfrastructure to unify the many digital data sets and methods described in this volume. This "portal science" application, called the Mediterranean Archaeology Network (MedArchNet; Figure 1.34), is envisioned as a series of linked archaeological information or atlas nodes, each of which contains a regional database of archaeological sites that share a common database structure to facilitate rapid query and information retrieval and display within and across nodes in the network. To date, one digital archaeology atlas node is fully functional and used by hundreds of researchers. MedArchNet is a signature project of UCSD's CISA3/Calit2 and the Geo-Archaeological Information Applications (GAIA) Lab, Archaeological Research Institute at Arizona State University directed by Stephen Savage and Thomas Levy. The ultimate vision of MedArchNet is to develop a network of archaeological sites (from remote prehistory to the early twentieth century—see http://medarchnet.org). MedArchNet currently contains one active archaeological information node—the Digital Archaeology Atlas of the Holy Land (DAAHL) at http://daahl.ucsd.edu.

The MedArchNet cyberinfrastructure provides secure and reliable storage of data from the field to the central data storage facility. It will provide authenticated, portal-based access to data, derived products, analysis, visualization, GIS tools, collaboration spaces, and so on, including provision of "publish/subscribe" interfaces for data, to enable a large user community to gain access to data and derived products. The cyberinfrastructure will manage heterogeneous archaeological data from a variety of sources and support a community of contributors as well as users of the information, using a comprehensive authentication and authorization system to control access privileges of different classes of users.

The MedArchNet approach to archaeological site data envisions our data nodes as "switchboards" that contain top-level site and project metadata, plus bibliographic references and extensive use of linked resources outside the

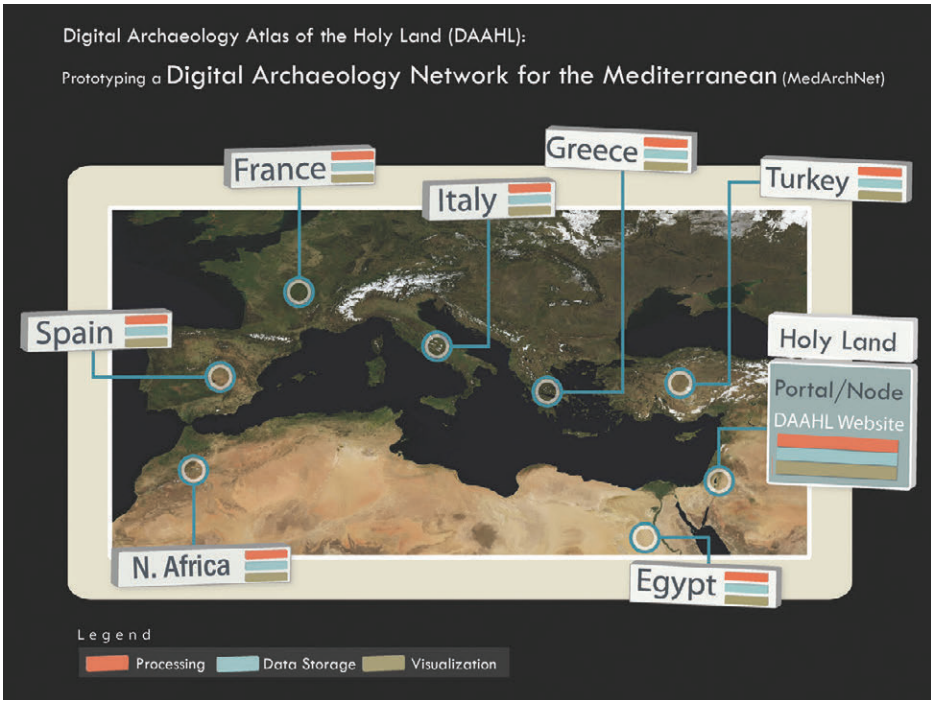

Figure 1.34 The MedArchNet website, which highlights the most active node—Digital Archaeology Atlas of the Holy Land (http://medarchnet.calit2.net).

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MedArchNet data structure. It is not our goal to corral every bit of data about every site in the Mediterranean—an enterprise that would clearly be impossible even if it were desirable. Rather, the MedArchNet approach is designed to let researchers and the public easily find archaeological sites based on location and other attributes such as site type, features, and time periods; provide a mechanism for creating substantive maps linked to the various MedArchNet nodes; and then point the user to the locations of substantive research on the site, whether it be online or offline. The MedArchNet project serves to highlight the research of the archaeological community, rather than subsume it under the MedArchNet umbrella. Each data node maintains a table of data donors, including contact information and primary websites, and each site contributed by a donor will be "branded" with the donor's information. Whenever a contributed site is displayed, the donor information is also shown, so the links to the donor's website are clearly shown, along with specific external resources for individual sites.

The MedArchNet project actively cooperates with research organizations and government agencies to develop new data nodes and applications. Each of our current nodes has received significant sponsorship. The DAAHL (Figure 1.35) is a sponsored project of the American Schools of Oriental Research, the flagship organization that coordinates North American archaeological research in the Levant (http://www.asor.org). As MedArchNet develops additional data nodes, we look forward to expanding our cooperative efforts with additional data donors, research organizations, and government agencies. The MedArchNet databases are UTF-8 encoded, so they support multinational character sets; moreover, the Google Translation tool is included at the bottom of every MedArchNet web page, so the output can be translated into any available language at the touch of a button. To take advantage of the cyber-infrastructure established with DAAHL, more than 40,000 georeferenced site and artifact photographs from the ELRAP expeditions will be hosted on this website and included on the DVD that accompanies this volume.

The DAAHL website illustrates some of the content-rich methods it uses to disseminate data drawn from its database. Efforts to harvest archaeological site data from Israel and Palestine are currently under way. Another highly innovative feature is the DAAHL's virtual museum (Figure 1.35), which displays interactive, three-dimensional objects at their original find locations through a Google Earth API—the user can manipulate the object in all three dimensions as well as the map itself. For researchers and the public, much of the ELRAP artifact imagery contained on the DVD that accompanies this volume will be accessed via the online virtual museum.



Figure 1.35 DAAHL's online virtual museum georeferences artifacts collected and recorded during excavations and displays them over a Google Maps platform. Shown here is a ninth-century BCE pottery sherd found at Khirbat en-Nahas hovering over a Google Earth image.

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MedArchNet is already having a significant research and education impact by providing easy online access to archaeological data and information. The MedArchNet hub and its data nodes are deployed to provide access to information contributed by each member of the MedArchNet "virtual organization." Via the hub, users are able to navigate back to the original member sites and databases to access the full information and related data from the respective site. Each data donor receives full recognition and credit for their contribution. Individual portals have been developed initially for American Schools of Oriental Research (DAAHL) and other partnering groups. The network of linked portals supports collaborations among users and provides a platform for initiating and sustaining discussions related to cross-site thematic areas of study.

In an era of rapidly expanding population and urban development, a system such as MedArchNet can provide mechanisms to monitor archaeological site conditions over time and lessen the impact on cultural heritage resources by carefully planning and significantly enhancing site preservation and development potential in the Mediterranean basin. Furthermore, by uniting archaeological site metadata from many disparate data sets and organizations, the MedArchNet cyberinfrastructure will dramatically improve the ability of researchers to ask large-scale, cross-border questions of the archaeological data, providing fresh new insights into some of the most culturally meaningful regions on Earth.

Three-Dimensional Artifact Scanning

For much of its history, postexcavation archaeological research has relied on manual drawings of artifacts that are often time-consuming and expensive to produce, subjective in detail, and limited in their two-dimensional scope. Often, those drawings depict mere fragments of artifacts, making it difficult for archaeologists to re-create complete objects. To create the necessary three-dimensional algorithms that reflect the chronological and cultural "address" of ancient potters in Jordan, our team uses NextEngine laser scanners to obtain triangulated meshes of the potsherds that can later be converted into any three-dimensional vector format (two-dimensional images generate raster or dot-based images, but vector or shape-based images are more amenable to mathematical manipulation). Since all the three-dimensional scans done by our team can also be imported into MATLAB (a numerical computing environment and programming language), we can compare and analyze, in the same format, both the three-dimensional scans and two-dimensional vectors of images taken from archaeological publications (see Fox 2008).

The portable and relatively inexpensive NextEngine three-dimensional scanners are "field-operable" units. They consist of two components—a turntable and a data capture device. The turntable allows for the object scanned to rotate 360° in front of the data capture device at specific intervals, allowing for the scans to stitch together more accurately. The data capture device consists of two primary components, a laser array and a digital 3-MP camera to capture texture data. This combination allows us to create photorealistic models of the artifacts as portable as the computers that we used to scan the artifacts (Figures 1.36 and 1.37).

In 2009, we took the three-dimensional scanners to the field for the first time. This was an experiment to test how they would cope with the harsh desert conditions experienced within our field lab. In the CISA3 lab, there is total climate, environment, and light control, allowing us to ensure that the artifacts are in the optimal conditions for high levels of scan accuracy (Guidi et al. 2008). The problem in Jordan was how to adjust to far more challenging conditions while in the field. The ambient temperature was a particular problem, restricting us to scan mostly in the early morning when the day was coolest. There was also the issue of the effect of ambient light influencing the accuracy of the scans. To solve this problem, we simple built an inexpensive enclosure out of cardboard to create the most controlled environment possible in our field lab. With these minor adjustments, we were able to achieve quality resultant scans in the field.

An area we are currently investigating is how to further streamline the three-dimensional scanning process. One method to circumvent the unavoidable time expense required for three-dimensional scanning was to purchase several scanners, thus reducing scan time by one-third. We are also trying to automate a number of the processes so that less student time is required to scan and process these data. In general, now that we have begun three-dimensional scanning of artifacts, the NextEngine scanner has become a standard tool in our archaeological "digital tool box."

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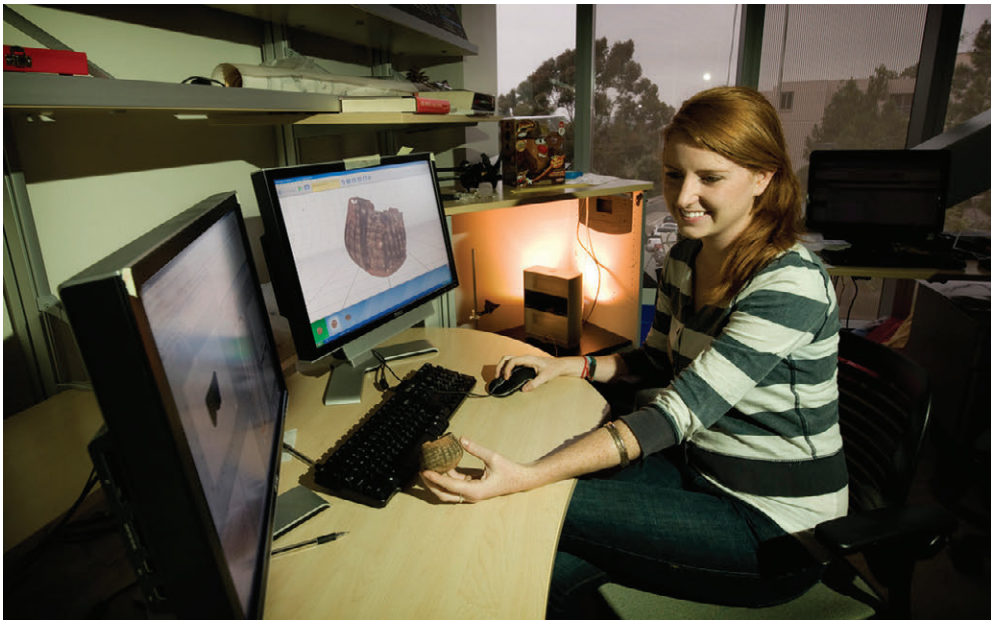

Figure 1.36 Former UCSD undergraduate Caity Connolly uses the NextEngine three-dimensional scanner to image a small Iron Age ceramic vessel in the CISA3/Calit2 cyber-archaeology lab. This instrument was taken into the field to Jordan in the fall of 2009. *Photo: Eric Jepsen, UCSD/Calit2.*

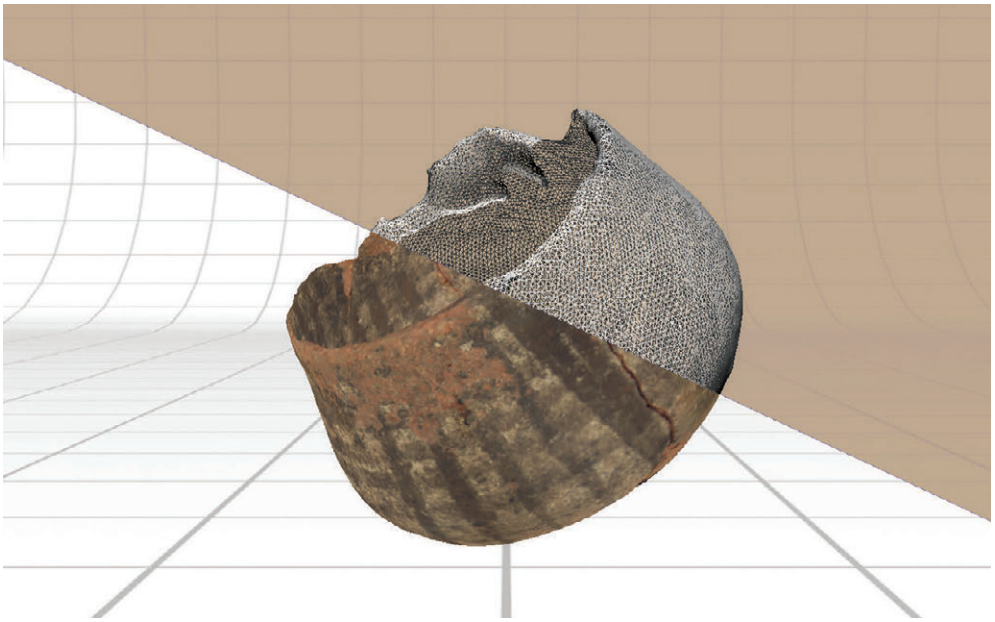

Figure 1.37 Three-dimensional scan of an Iron Age ceramic cup from Area R, Khirbat en-Nahas. The three-dimensional image file is used in the Pottery Informatics program described here. *Image: CISA3/Calit2.*

Artifact Informatics: Pottery Informatics Queryable Database—PIQD

Beginning in 2008, we began to develop an informatics database for the processing of diagnostic Iron Age (ca. 1200–500 BCE) pottery sherds. The goal of this project was to develop a method of digitizing artifacts collected in the field within an analytical framework similar to that used in bioinformatics for the analysis of protein and DNA sequences (Altschul et al. 1990). The increased precision achieved through these analyses exposed a number of drawbacks to the use of only digitized two-dimensional illustrations of ceramics. One of the most prevalent problems was the relative subjectivity of the professional illustrators' attempts to draw a two-dimensional profile representative of the whole sherd, its stance, and measured diameter. To achieve the most accurate representation of the diagnostic pottery sherds recovered from excavation, in 2009 we began to scan pottery using the NextEngine three-dimensional scanner (see Figures 1.36 and 1.37),

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allowing us to confidently attain accuracy within 0.12 mm for each sherd scanned. Once the sherd is scanned, it is imported in MATLAB, where its proper stance, rim diameter, and profile are extracted at this same level of precision (Figure 1.38). In addition, we used the three-dimensional scanner to scan other artifacts even more geometrically complex.

Although there has been increasing interest among archaeological projects aimed at digitizing various aspects of their archaeological data sets, there has been no satisfactory solution for integrating these different projects' data for cross-regional comparison and analyses. Most researchers still must rely on printed publication reports to conduct any form of regional study. In general, this medium is very limited in its ability to inform the reader of the nuances of the material culture collected at the site, such as architecture, stratigraphy, ceramic, and other artifact assemblages.

To circumvent a number of these drawbacks, a comprehensive online queryable digital database called the Pottery Informatics Query Database (PIQD) was started for the Iron Age ceramic assemblages of the southern Levant (http://daahl.ucsd.edu/PIQD/PotteryInformatics.php). This project was begun in 2008 between Smith and Levy at UCSD CISA3/Calit2 and Avshalom Karasik and Uzy Smilansky at the Weizmann Institute of Science–Hebrew University in Israel. It is a new online tool designed to enable researchers to test their own interpretations and models against the ever-expanding digital medium of ceramic data sets in ways that conventional print data cannot provide. Where the PIQD differs from other online archaeological databases that may archive published two-dimensional vectorized images or three-dimensional models of ceramics is in query-ability—in particular, with objective mathematically based algorithms of artifact (ceramic) profiles. This project uses recent technological advances developed by Karasik and Smilansky (Karasik 2008) to mathematically encode and store the ceramic profile data as complex algorithms (Figure 1.38). Three mathematical representation functions (radius, tangent, and curvature) measure various scales of differences in vessel form, stance, and rim diameter, which can be used to determine in an objective manner the statistical difference between ceramic shapes. This technique, combined with several methods of cluster and discriminant analysis, has been used to construct objective mathematically based typologies and ceramic prototypes. Specifically for the PIQD, the three functions enable the rapid search of a whole database of digitally stored vessels in an objective, mathematically grounded approach. In this sense, these queries are similar to online BLAST (Basic Local Alignment Search Tool) searches (Altschul

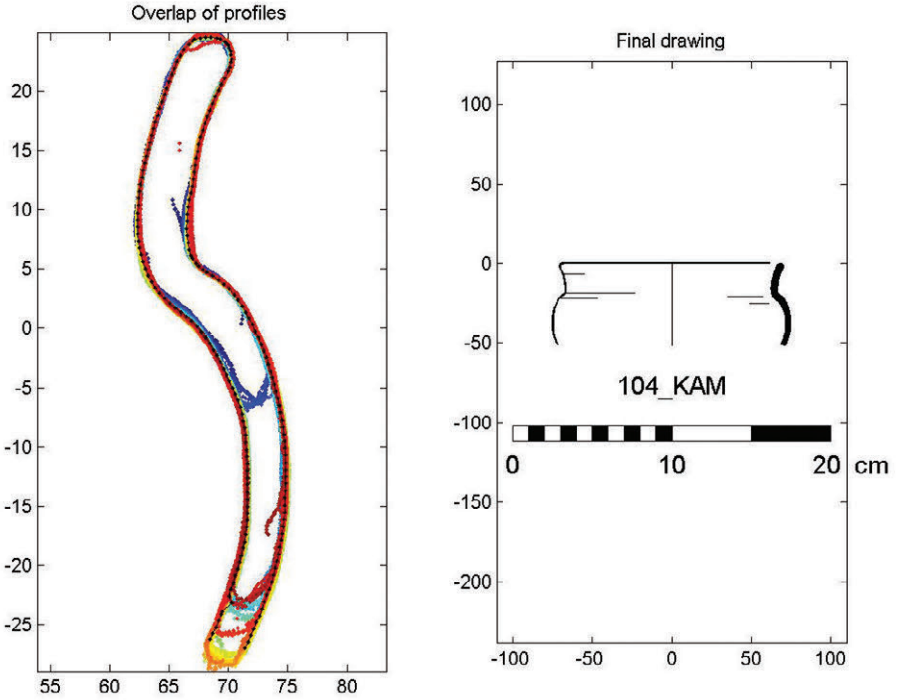

Figure 1.38 Mathematically extracted two-dimensional profile of a three-dimensional scanned bowl from the Iron Age site of Khirbat am-Malayqtah, Jordan and creation of a pottery drawing suitable for publication.

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et al. 1990) developed in the field of genetics in being able to rapidly associate large quantities of digital vessel profiles to each other based on similar morphological traits.

The PIQD has been designed using MySQL, PHP, Ajax, and Javascript with an embedded Google Maps API to provide a fully queryable spatial environment for the user. In essence, the PIQD is an open-source GIS. Google Earth and Google Maps function as a real-time spatial display for all the ceramics' coordinate information. MySQL functions as the server database to organize all the stored ceramics profiles, curvature functions, three-dimensional scans, and metadata, while PHP and Javascript are used to query the database.

Currently, the PIQD is being designed to run autonomously in its incorporation of new vessel profiles and the computation of its mathematically-based typology query system. Users are able to directly upload their raw data and have the PIQD properly store them, insert the metadata into tables, and run the needed cluster analyses. A set of automatic error-checking mechanisms was developed to ensure that only error-free data are accepted into the PIQD for study. By this means, the PIQD is able to expand exponentially as multiple researchers can contribute their ceramic assemblage data to the overall PIQD without the need for a technician to oversee every new entry. At present, more than 10,000 ceramic figures and their associated metadata from Iron Age Edom have been incorporated into the database (Figure 1.39). The immediate goal is to achieve complete coverage of the Iron Age for all of the southern Levant, which will reach into the 100,000s.

Finally, two daughter programs were also developed to further facilitate the original contributions of archaeologists and their publication. These programs plug directly into the PIQD. First, the PlateMaker program enables publication-quality plates of queried ceramics to be auto-generated and manipulated on the fly (Figure 1.40). Tables are dynamically linked to the displayed figures on the plate so that either the reordering of the table or the plate always remains synced. Second, the MasterTable is a dynamic spreadsheet that can expand or contract hundreds of fields and rows of data stored within the PIQD based on a simple user interface. It can immediately update changes made to the data through direct user input or barcode scanners. Finally, a series of archaeological functions were developed to further facilitate common but complex manipulations of archaeological data sets. These functions can be accessed for any future daughter programs related to archaeology.

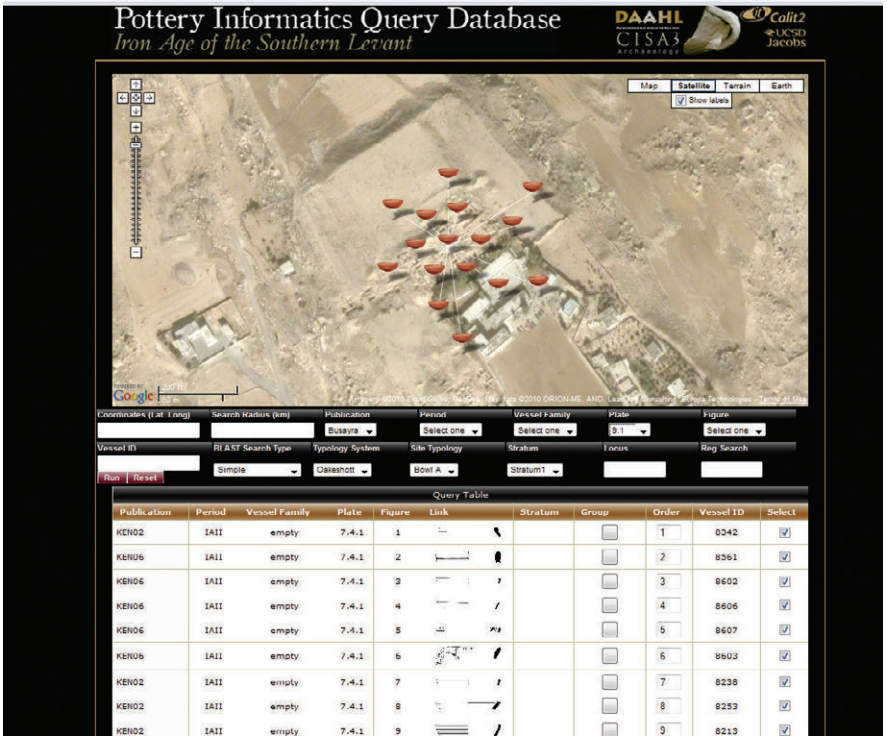

Figure 1.39 The Pottery Informatics Query Database GUI Page.

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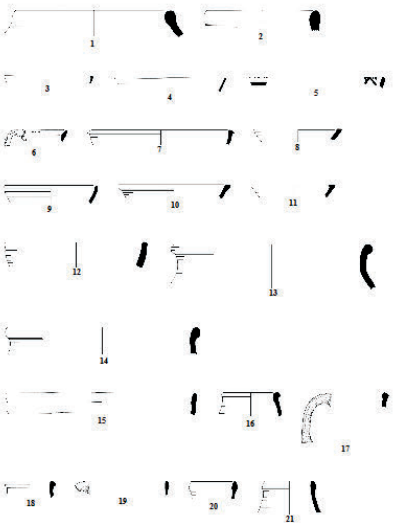

Plate 7.4.1: KEN Area A Str. Virgin, V, IV, III-IV

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	773	93	1933	A4b	Virgin	Pithos	PT10	A2	White Slip (int./ext.)
2	136	166	4128	A4	V.	Pithos	PT8	A2b	White Slip
3	364	190	4354	A3a	IV	Bowl	BL1f		
4	382	180	4230	A3a	IV	Bowl	BL17b	A1b	High fired dark gray fabric
5	391	180	4297	A3a	IV	Bowl	BL21a2		Painted Design Slip
6	366	180	4329	A3a	IV.	Juglet	JT3		
7	267	41	1242	A3	III-IV	Bowl	BL3a3		
8	341	36	1204	A3	III-IV	Bowl	BL10	A1	
9	180	41	1263	A3	III-IV	Bowl	BL16	I1	Red Slip and Horizontal Burnish (int./ext.)
10	345	40	1234	A3	III-IV	Bowl	BL24	A1	Red Slip (ext.)
11	178	40	1289	A3	III-IV	Bowl	BL		
12	181	41	1263	A3	III-IV	Bowl	BL		

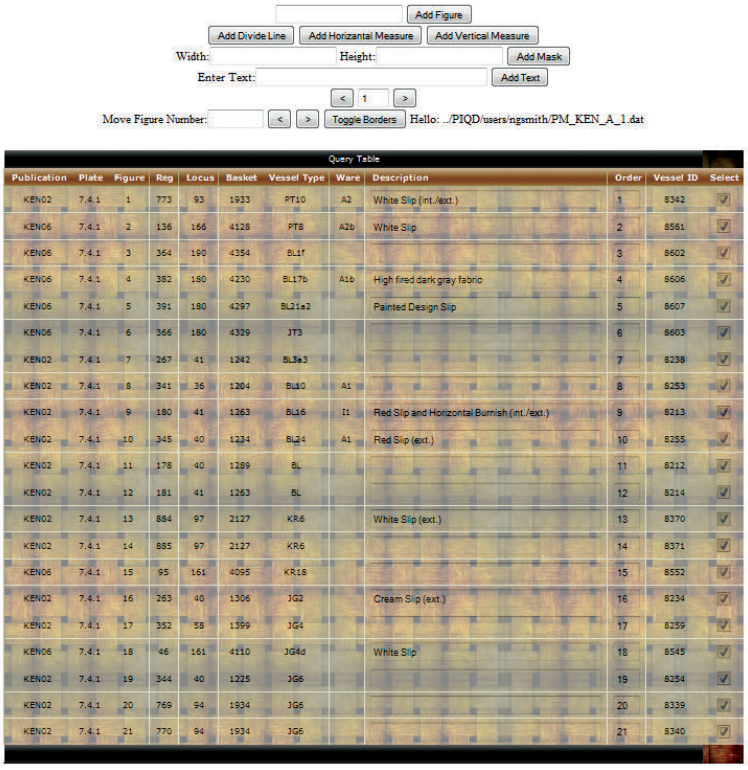

Figure 1.40 The PlateMaker: a daughter program of the Pottery Informatics Query Database designed for the rapid deployment of publication-quality ceramic plates used here (see Chapter 4, this volume).

The PIQD is not limited to only the Iron Age but can be adapted for any ceramic period. For example, we are also developing a mirror of the Iron Age pottery informatics database for the Early Bronze Age in the southern Levant. In a period such as the Early Bronze Age, where variation in the pottery is not especially significant through time (Dever 1973), this digital technology can provide an important new way to make inferences about the material within the site itself. The PIQD has the potential for revolutionizing how ceramic assemblages are analyzed, typologies are constructed, and regional analyses are conducted. As the PIQD grows, the dependence on the printed medium will subside as equivalent data can be found on the PIQD but by a much more rapid and accessible manner. The PIQD, itself being an online tool part of the MedArchNet, means that it can be used for data analyses not only in the southern Levant but wherever a portal has been established. Moreover, the PIQD is not limited to the Iron Age period or ceramics but has been designed to eventually be adapted for various forms of material culture and archaeological periods (see Chapter 4, this volume).

Toward a Cyber-Archaeology: Data Acquisition Techniques and Visualization

Multispectral imaging holds great promise for the transformation of traditional dirt archaeology into its digitally enabled form. Visual records in the form of static images and videos in the visual range provide a baseline, capturing the spatial and temporal characteristics of a site. These can be further augmented with thermal images capturing subsurface characteristics, photogrammetry techniques associating physical dimensions with image data, three-dimensional topological scans yielding high-resolution point cloud collections via laser scanning, or stereo photography techniques, all of which are backed up by "traditional" on-site surveying techniques. While it is still possible to use old-fashioned dumpy levels and measuring tapes, the trend is for research-oriented projects to employ

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some form of on-site digital archaeology recording of the excavation process (Bunimovitz and Lederman 2009; Daly and Evans 2005; Levy 2010b; Levy and Smith 2007). The compelling reasons for the transition to digital-enabled archaeology are accompanied by a set of daunting challenges associated with the exponential growth of data that have to be properly recorded, processed, fused, analyzed, archived, and preserved. Some of the required workflows, visualization, and analysis techniques as well as underlying infrastructure are extensive and illustrated here.

Visual Analytics and Instruments

a) HIPerSpace—A Visual Analytics Cyber-Collaboratory

The complexity and amount of data that we are confronted with as a result of the digitally enabled archaeology paradigm creates unique challenges for the accurate and efficient analysis of data in formats appropriate for the tasks at hand. Data records acquired with the acquisition tools described here are massive in size and multidimensional in nature. Moreover, comprehensive data analysis usually requires simultaneous access to multiple data sources represented in domain-specific and synthesized formats, requiring an environment that co-locates domain specialists and data assets while enabling interactive, visual data analysis and reasoning.

To address this challenge, our team has developed the concept of visualization portals, scalable, high-resolution tiled display environments, operating at tens to hundreds of megapixels resolution, while enabling intuitive, information-rich, and rapid visual analytics, capitalizing on multiple human senses to convey higher-dimensional content. The "gold-standard" for these environments has been HIPerSpace, a 1/3 gigapixel resolution visualization environment, with the ability to collocate vast data collections in real time, for a broad set of two- and three-dimensional formats (http://hiperspace.calit2.net). HIPerSpace is powered by a scalable and hardware agnostic visualization middleware called CGLX (Doerr and Kuester 2011), which was designed to provide a common visualization platform, supporting networked, scalable, multitile two- and three-dimensional visualization environments. With this infrastructure in place, it has been possible to also transform the traditional data analysis workspace into its digital equivalent, where data in the form of images, videos, three-dimensional models, publications, web references, simulations, and so on can be co-located in one room-sized collaborative digital workspace. Figure 1.41 shows the co-location of multiple different artifacts from UCSD excavations in Jordan that can be manually or automatically sorted, clustered, segmented, and filtered,



Figure 1.41 Interactive visualization and co-location of different artifacts from Jordan on HIPerSpace. The HIPerSpace is made with 72 "off-the-shelf" Dell 3007WFP-HC, 30-inch displays or tiles. *Photo: Falko Kuester, Calit2.*

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effectively providing immediate control over how data are being represented and explored. Figures 1.41 and 1.42 show an interactive visualization of sites and artifacts based on large-scale high-definition images. Together with a point cloud data set obtained via laser scanning, it provides an accurate three-dimensional view of a field site and the means to explore the site, topological artifacts, and spatial relationships. HIPerSpace and other environments similar to it, described below, are a portal into vast archaeological data collections and allow research team to harness both data and, even more important, the human assets, the researchers on the forefront of new discoveries.

The HIPerSpace has proven to be a critical element for rapid visual comparison of theory with massive experimental data collections, enabling transdisciplinary teams of scientists to swiftly validate and comprehend theory and practice (Figures 1.41 and 1.42). With visualization as a unifying language anchored in mathematics and physics, OptIPortals (http://wiki.optiputer.net/optiportal/index.php/Main_Page; DeFanti et al. 2008) provide a unique mechanism to communicate information in a universal format that allows hard domain problems to be approached by co-located or spatially separated interdisciplinary research teams.

b) The StarCAVE

Archaeological data are especially suited for building scientific visualization paradigms and creating virtual environments for cyber-archeology. At Calit2, our group has focused on four main approaches to help create cyber-infrastructures for archaeology (Knabb et al. in press). The areas of archaeological visualization research center on the use of the three-dimensional immersive visualization environment called the "StarCAVE" (DeFanti et al. 2008; Levy et al. 2008; Figure 1.43):

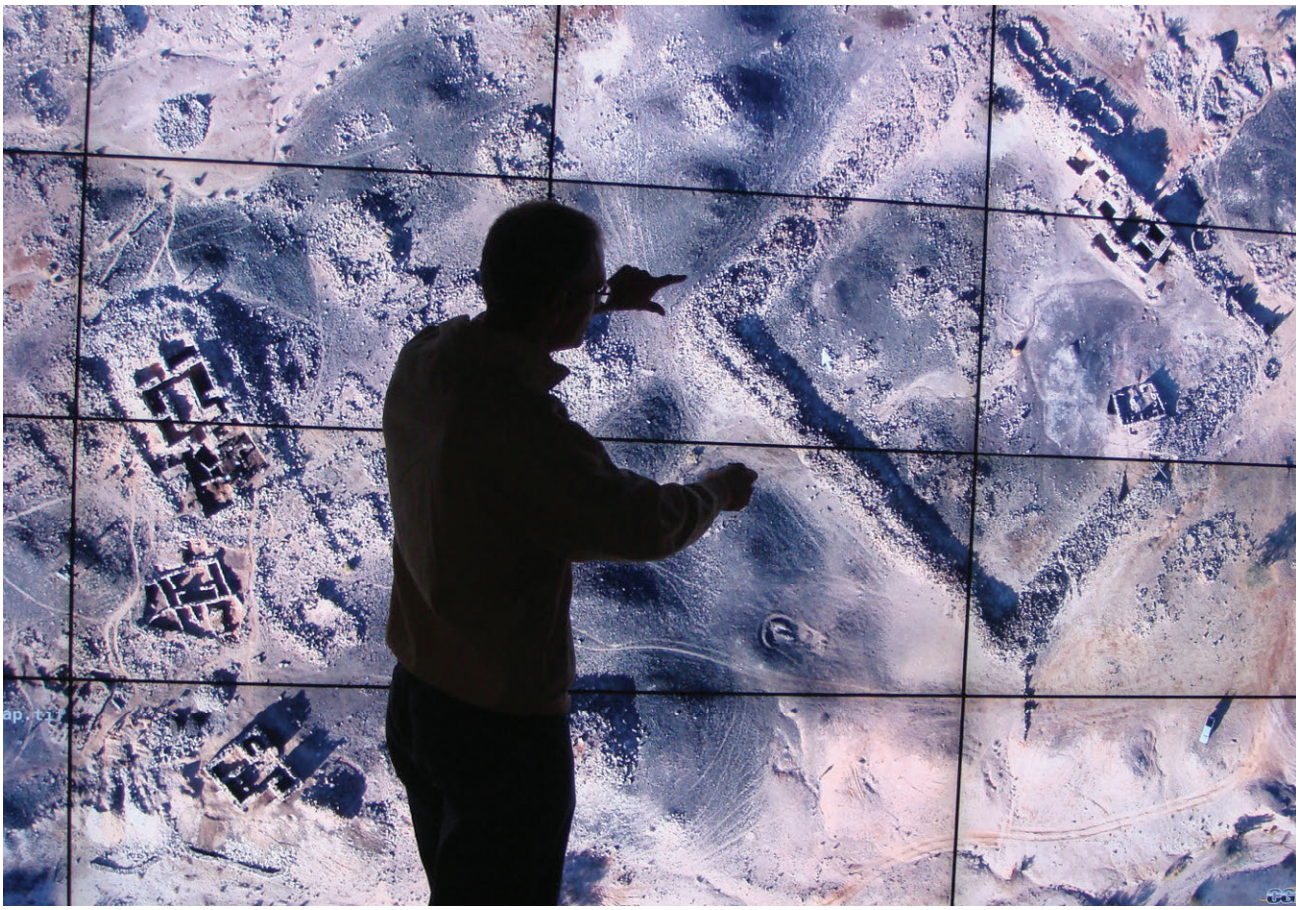

Figure 1.42 Interactive visualization of a large-scale high-definition composite aerial photograph, providing a georeferenced view of Khirbat en-Nahas and a means to explore the site, topological artifacts, and spatial relationships. *Photo: Falko Kuester, Calit2.*

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1) The StarCAVE is used to display compelling visual imagery using data collected in the field, including spatial data, digital images, and site reports. This is an important and efficient way to disseminate complex information in a manner that is straightforward and comprehensible (Forte and Siliotti 1997). Furthermore, researchers are able to investigate each excavation area or unit and the data collected from these units in three dimensions.
2) After visualizing an archaeological site in the StarCAVE, it is used as a heuristic tool. One is able to revisit the site and data again and again without ever going back to the field. In this manner, we can investigate the topological and spatial relationship between artifacts, features, and other areas of the site and how these changed through time.
3) The StarCAVE is also used as a virtual reality GIS. GIS programs, such as ESRI's ArcView, allow the user to browse, query, and manipulate the database, but these cannot handle three-dimensional data. Virtual reality technology such as the StarCAVE does, however, operate in a three-dimensional virtual world and is sophisticated enough to simulate a "real" environment. The precise location of each recorded artifact, feature, and locus is, in a manner of speaking, put back together again. In addition, the incorporation of GIS databases into the virtual reality model imparts the archaeologist with the ability to perform spatial and statistical analyses similar to the tools available in standard GIS programs.
4) The StarCAVE contributes to cultural heritage preservation. The unfortunate consequence of archaeological research is we destroy that which we study. Now, incorporating the many sources of data we collect into a virtual reconstruction of the site preserves a record of what was destroyed during the course of excavation in a manner that is more compelling to a large audience than a two-dimensional representation.



Figure 1.43 Jürgen Schultz and Kyle Knabb demonstrate an Iron Age building and excavation section through an associated slag mound from Khirbat en-Nahas in the StarCAVE. The StarCAVE is a 360° total immersive three-dimensional virtual reality environment with additional imagery on the floor. *Photo: Eric Jepsen, UCSD-Cali2.*

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Our three-dimensional virtual reality visualization application is designed to run within COVISE. COVISE allows us to design software applications at the desktop and then run them in a large variety of virtual environments, including Power Walls, CAVEs, and tiled display walls, including the StarCAVE at Calit2. The StarCAVE is a five-walled, rear-projected, 360° virtual reality device. It uses 34 high-definition (1080p) projectors to generate passive stereo images on 15 screens and the floor. We use head tracking and a three-dimensional input device to navigate and interact with virtual environments. Our application uses COVISE's VRML loader, as well as the previously described artifacts plugin. We converted the Google Sketchup model to a VRML file to load it directly into COVISE. Once that happened, we were able to navigate around the terrain and to all the excavation sites modeled, as well as get a bird's-eye view of the entire area. In addition to the navigation around the scene, the users can scale the size of the excavation area so that they can display life-size three-dimensional structures, which makes them appear as if the users were on site. Alternatively, the size can be scaled down so that the area looks like a small model where everything is within arm's reach. The ability to change the scale helps point to specific locations and will help in the artifact display mode to select larger volumes of artifacts than the person can comfortably reach when displayed life size. However, the ability of the display to convey size like in the real world allows users to not only perceive objects at their original level of scale but also measure distances and sizes with their hands or a virtual measuring tape.

The current implementation allows users to optionally display or hide the artifacts or the Sketchup model, so they can focus on either without cluttering the screen with the other. This functionality is selected directly from within the virtual environment using a three-dimensional menu. The three-dimensional menu API we use is part of the COVISE framework and allows the programmer to add buttons, check boxes, sliders, dials, submenus, and custom dialog windows. Although the menus are mostly two-dimensional and resemble menu systems in desktop systems, they can be moved around freely in the three-dimensional environment so that they are not in the way when exploring the virtual world (Levy et al. 2008).

c) NexCAVE

Calit2 virtual reality researchers offer archaeologists a 3-to-21 panel, three-dimensional visualization display made from newly available synchronized three-dimensional high-definition televisions (HDTVs). The technology, dubbed *NexCAVE*, was designed and developed by Calit2 research scientists. The NexCAVE technology was developed at the behest of Saudi Arabia's King Abdullah University of Science and Technology (KAUST), which established a special partnership with UCSD last year to collaborate on world-class visualization and virtual reality research and training activities (Figure 1.44).

When paired with polarized stereoscopic glasses, the NexCAVE's modular, micropolarized panels and related software will make it possible for archaeologists to visualize massive data sets in three dimensions, at unprecedented speeds and at a level of detail impossible to obtain on a typical computer display. The NexCAVE's technology delivers a faithful, deep three-dimensional experience with great color saturation, contrast, and very good stereo separation. The JVC panels' xpol technology circularly polarizes successive lines of the screen clockwise and anticlockwise, and the glasses you wear make you see, in each eye, either the clockwise or the anticlockwise images. This way, the data appear in three dimensions. Since these HDTVs are very bright and high contrast, three-dimensional data in motion can be viewed in a normally lit environment, even with the lights fully on in the room.

The NexCAVE's data resolution is superb, close to human visual acuity (or 20/20 vision). The 10-panel, three-column NexCAVE has an approximately 6,000 x 1,500–pixel resolution, while the 21-panel, seven-column version built for KAUST has an approximately 1,500 x 1,500–pixel resolution. The NexCAVE's LCD screens are scalloped "like turtle shells," which allows the screens' bezels (frames) to be minimized because the screens are tucked behind one another. This works well in three dimensions because the virtual reality illusion is so strong that you do not even see the screens and bezels as "windows," just the three-dimensional images in motion and stereo.

NexCAVE's specially designed COVISE software (developed at the University of Stuttgart, Germany) and CGLX software (developed at UCSD) combine the latest developments from the world of real-time graphics and PC hardware with high-end Nvidia game engines. The Calit2 and KAUST NexCAVEs are connected via 10-GB/

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Figure 1.44 The 21-panel Xpol LCD stereo NexCAVE with UCSD—Department of Antiquities of Jordan excavation data from Khirbat en-Nahas on display at the opening of the King Abdullah University of Science and Technology (KAUST), September 2009. Shown here are Tom Levy, UCSD (left), and Sami Almagouth, KAUST, with the NexCAVE demo in Saudi Arabia. *Photo: T. DeFanti, Calit2.*

second networks, which allows researchers at KAUST to collaborate remotely with UCSD colleagues. NexCAVEs are being designed and built for several new partners around the world. For the opening of the KAUST celebration in September 2009, archaeological data from the UC San Diego Levantine Archaeology Laboratory excavations in Jordan that had been originally modeled for the StarCAVE were featured in the NexCAVE. We are now building a portable NexCAVE prototype that will help answer the problem of "data avalanche" now facing field archaeologists.

The ELRAP Integrated Database System

While the creation of a fully integrated database for ELRAP is nearing completion, some aspects are functional and have been relied on in this volume. Thus, it is important to outline where ELRAP is at and where we are headed as our project data sets published in this volume will also be available online through DAAHL. Other data database systems have been built within the archaeological community over the years to attempt to deal with some of the data avalanche. Our current system is summarized in Gidding et al. (2011). All of these deal with three different levels of analysis: macro-scale, micro-scale, or something in between. On the macro-scale, the most common databases store information regarding individual site locations and some basic details as opposed to comprehensive data regarding the excavated materials (see DAAHL, Pleiades [http://pleiades.stoa.org]). Other systems have been designed to help organize single-site level organization of data focusing primarily on the basic spatial recording of artifacts and their contexts (see ARK, http://www.lparchaeology.com/cms/services/ark-archaeological-recording-kit; Online Cultural Heritage Research Environment [OCHRE], http://ochre.lib.uchicago.edu; and Reconstruction and Exploratory Visualization: Engineering meets Archaeology [REVEAL] [Gay et al. 2010]). More recently, there has also been a push to create digital repositories that can accept any kind of data, with coding sheets provided, to provide a central place for broad access to research (see the Digital Archaeological Record [tDAR], http://www.tdar.org; Archaeological Data Service [ADS], http://archaeologydataservice.ac.uk). However, none of the systems mentioned above deal with the combination of intra- and intersite analysis that includes a number of diagnostic tools for material analysis.

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Other archaeological data, including site information, survey feature information, and artifact information, can be manually input with data entry web forms that our new system provides (Figure 1.45).

Within the server, several workflows are in place to put field data into the database system according to different typological categories. Regarding geospatial data, measuring devices such as Total Stations produce shapefiles, which are a standard geospatial vector data format for GIS, and others, such as dGPS devices, produce raw data in their original format. Our data system can import shapefiles into a post-GIS database by converting their formats. For the data collected with the dGPS, we preprocess the raw data into shapefiles for import.

More immediately, this project operates as the back end that allows for more complex scientific visualizations that take advantage of the three-dimensional recording of data collected in the field using the GPS and total station methods described above. As we begin to integrate other sources of diagnostic data into the visualization system in development by our colleagues, we anticipate using our framework to generate dynamic visualizations of the archaeology as it is excavated. These more complex visualizations can be used analytically and to better communicate our research as it is in motion last (Petrovic et al. 2011). The ability to easily disseminate results in a systemic fashion is a step forward for archaeological research away from simply publishing long-form monographs that provide only a select picture of excavation results and methodologies.

Summary—Confronting the "Data Avalanche"

This introduction has presented the evolution of the ELRAP integrated system of on-site digital archaeology coupled with an active cyberinfrastructure for Levantine archaeology with data that are capable of being viewed with a variety of three-dimensional visual instruments. New applications of three-dimensional data processing and visualization offer important tools for integrating data and viewing them in new ways that may lead to both important discoveries and

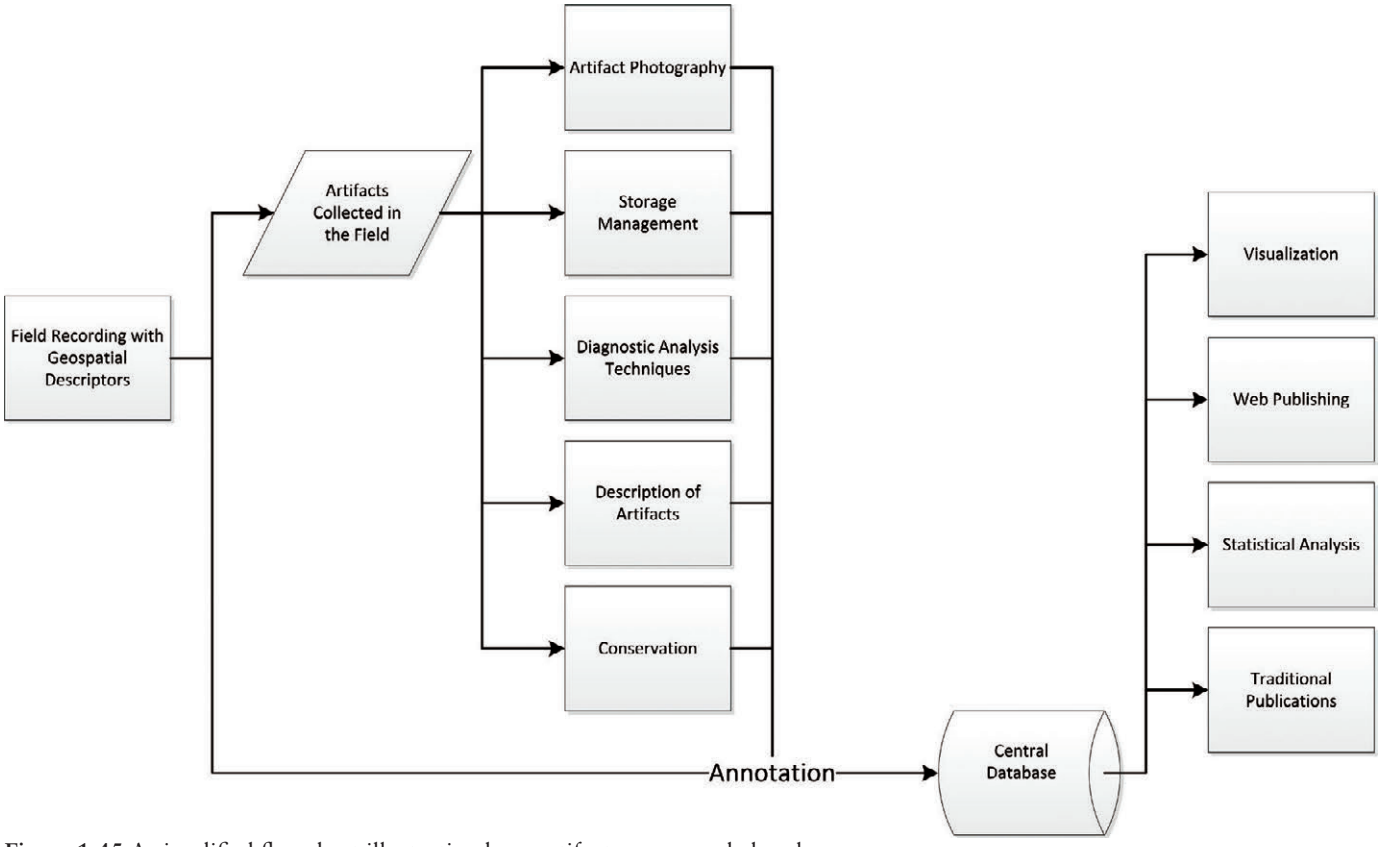

Figure 1.45 A simplified flowchart illustrating how artifacts are recorded and stored in the ELRAP database for later retrieval (Gidding et al. 2011).

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Table 1.3 The data avalanche facing ELRAP can be seen by comparing the data acquired in the 2007 and 2009, UCSD CISA3/Calit2 expeditions in Jordan.

Data Collection Instrument	2007 Excavation Season, GB	2009 Excavation Season, GB
3D NextEngine Scanner (artifacts)	0	168
High-resolution digital artifact photography	70	253
High-resolution digital site photography	10	52
Balloon-based stereo digital photography	0	253
GigaPan panorama photography	0	15
Terrestrial laser scanning	0	500
GIS data	20	30
HD video	72	120
Total	172	1,391

interpretations. The discussion of data acquisition techniques revolves around the problem of how to acquire digital data in the first place. We refer to this as creating a "digitally enabled archaeology." Here the type of data and how they can be obtained is outlined in relation to a number of imaging techniques used by the UCSD CISA3/Calit2 team. These include total station, GPS, laser scanning, balloon-based airborne imaging, and three-dimensional artifact scanning. How these data are synthesized is also discussed. To achieve a true "cyber-archaeology," the global networks that portal science cyberinfrastructures such as MedArchNet and its Pottery Informatics Queryable Database are discussed. Finally, a number of visualization paradigms and environments for cyber-archaeology that take advantage of these data sets are also described. The ones used by the CISA3/Calit2 team include the HiPerSpace, StarCAVE, and NexCAVE.

Based on the ELRAP study presented here, our team has experienced a "data avalanche." This is highlighted in Table 1.3, which outlines the range of digital data collection instruments used in the field in 2007 versus those used in 2009. The exponential increase in digital data (from 172 GB in 2007 to 1,373 GB in 2009) is astounding. How will archaeologists deal with this data avalanche in their field projects in the future? Our team is working on a portable NexCAVE that will have software, computing power, and portability needed to thread together all these rich sources of data in a manageable manner. One of our goals is to equip our helium balloon platform with stereo digital video cameras to allow our *x*, *y*, and *z* archaeology data to be fully integrated into the three-dimensional visualization instruments currently evolving. In summary, the integrated cyber-archaeology methodology discussed above plays a critical role in the processing, analyses, presentation, and interpretations presented in this volume.

Controlling Time—Radiocarbon Dating and Age Modeling

Radiocarbon dating of carbonaceous samples has been one of the most significant developments in archaeological science and yet has not been widely and systematically applied in Levantine archaeology until comparatively recently. We have applied careful radiocarbon dating widely in the study of the sites examined here and present the results by area within this monograph.

Single dates require calibration owing to the nonlinear production rate of ^{14}C. This is now well established through the Holocene period in both hemispheres, although at very high levels of measurement precision, small regional offsets are apparent in some locations (Bronk Ramsey 2010; McCormac et al. 1995). One major problem with precision in radiocarbon dating is caused by the complex nature of the calibration curve, which often results in multimodal distributions for single dates (Figure 1.25). Single calibrated dates can be useful, but the past few years of research in the Iron Age of the Levant has shown that the level of precision available is not sufficient to answer the archaeological questions being posed. To resolve questions requiring subcentury precision, many more dates are needed, and increasingly, robust statistical methods are needed to

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produce chronometric data that are reliable. The most common method applied is based on Bayesian statistics. There are now many examples of this in the literature, as well as many publications describing the technique (Anderson et al. 2001; Bayliss 2009; Bayliss and Bronk Ramsey 2009; Bronk Ramsey 1994, 1995, 1998, 2000, 2001; Buck et al. 1996; Buck, Christen, et al. 1994; Buck et al. 1999; Buck et al. 1991; Buck, Litton, et al. 1994; Buck et al. 1992; Christen 1994; Higham and Higham 2009; Higham et al. 2005; Nicholls and Jones 2001), and therefore the methodological basis will be outlined only briefly here. Statistical models are necessary for several reasons, one of which is that analyzing complex multivariate data by eye is extremely difficult to do and often produces results that are "importantly wrong" (Bayliss 2009). Another is that statistical methods allow us to quantify our uncertainty in a way that is not possible using other nonscientific techniques (Figure 1.46).

Bayes's theorem is given by the following formula (after Bronk Ramsey 2009):

$$p(\mathbf{t}\,|\,\mathbf{y}) \propto p(\mathbf{y}|\mathbf{t})p(\mathbf{t})$$

In this equation, *t* denotes the set of parameters and *y* denotes the measurements that have been made, in this case radiocarbon measurements. $p(\mathbf{t})$ represents our prior beliefs regarding the values for parameters *before* one collects the data. We usually call this simply "the *prior*." In Latin, *a priori* means information that is held to be true prior to observation. In archaeological chronology building using Bayesian methods, this represents the archaeological information available concerning the sample and its unknown calendar date.

Prior information is key in Bayesian modeling. Let's term a carbon sample q_1. While we have no concrete information about the actual age of q_1, we do have information about its position relative to two other samples within the excavated sequence. We know that it is earlier than the deposition of samples to be dated from strata 2 and 3 (i.e., for the series of samples, we know that $q_1 < q_2 < q_3$). This is important *prior* relative archaeological information that can be used in the mathematical process. It is important to note that the prior here is completely independent of our measurements or radiocarbon dates; it is based solely on an archaeological analysis of the relative sequence information. $p(\mathbf{y}|\mathbf{t})$ in our equation is the *likelihood*. In Bayesian modeling, this represents the radiocarbon data, but rather importantly here, it is in the form of a probability distribution function corresponding to its calibration age range. Finally, $p(\mathbf{t}|\mathbf{y})$ denotes the *posterior*. This gives the information obtained about q_1 as a probability estimate, based on the prior and likelihood distributions. A larger posterior probability occurs when the grouped calibrated dates agree with the data and are plausible in light of the prior input into the model.

A hypothetical example of the modeling approach can be given by way of illustration and is shown in Figure 1.46. In this example, our prior information consists of three archaeological phases—3, 2, and 1, from bottom to top. There is no hiatus visible between them.

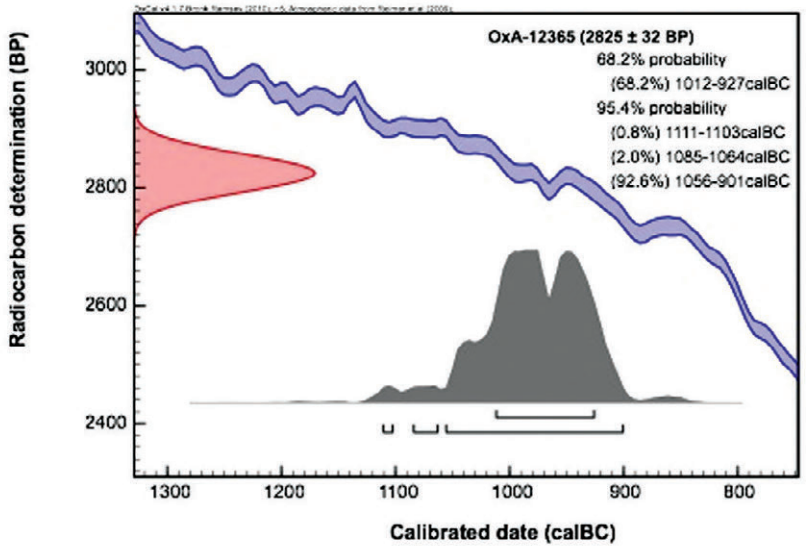

Figure 1.46 A simple radiocarbon age (*y*-axis) with Normal distribution and its calibrated range equivalent on the *x*-axis. The line running from top left to bottom right is the INTCAL09 (Reimer et al. 2009) calibration curve.

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Table 1.4 Hypothetical results of the accelerator mass spectrometry (AMS) radiocarbon dating as used in Bayesian modeling in Figure 1.47.

Phase 1
OxA-abc 2859 ± 26 BP
OxA-def 2840 ± 26 BP
OxA-hij 2844 ± 26 BP
Phase 2
OxA-klm 2782 ± 25 BP
OxA-nop 2758 ± 28 BP
OxA-qrs 2531 ± 26 BP
Phase 3
OxA-tuv 2710 ± 26 BP
OxA-wx 2765 ± 26 BP
OxA-yz 2831 ± 26 BP

Our prior information, therefore, says that 3 must be the earliest phase, and it is superseded with no temporal gap by 2, and then the same happens from 2 to 1. We have funded for three samples from each level (Table 1.4). They are short-lived samples of charred seed.

The results are shown in Figure 1.46. In the example, we can see the range in the single calibrated ages shown in the upper diagram. There appears one determination that is younger than two others from the same phase. The lower diagram shows the results of the Bayesian modeling. The posterior distributions, or the results of the Bayesian analysis, are shown in darker outlines, and the likelihoods are shown in a gray outline. The modeling suggests that OxA-qrs is indeed an outlier and too young. Importantly, using outlier detection analysis (Bronk Ramsey 2010), we can obtain a statistical estimate of how much of an outlier the result is. In this case, the outlier probability is 100 percent, and because of this, the result is not included in the posterior calculations.

The modeling also gives us an estimate of the agreement between the likelihoods and the posteriors in the form of either an agreement index (for the overall model and the individual posterior distributions) or an outlier probability. In this model, a prior outlier probability of 5 percent was given to each determination. You can see in Figure 1.47 that these are given in brackets next to the OxA- number. In all cases except two, the outlier probability is either the same or lower than 5 percent, suggesting they are not outliers. One is 14 percent, which is not significant, and the other of course is very significant at 100 percent. As the posterior outlier probabilities increase, their influence on the posterior modeled results decreases. A probability of 50 percent means that in one of every two runs of the model, that result is not included.

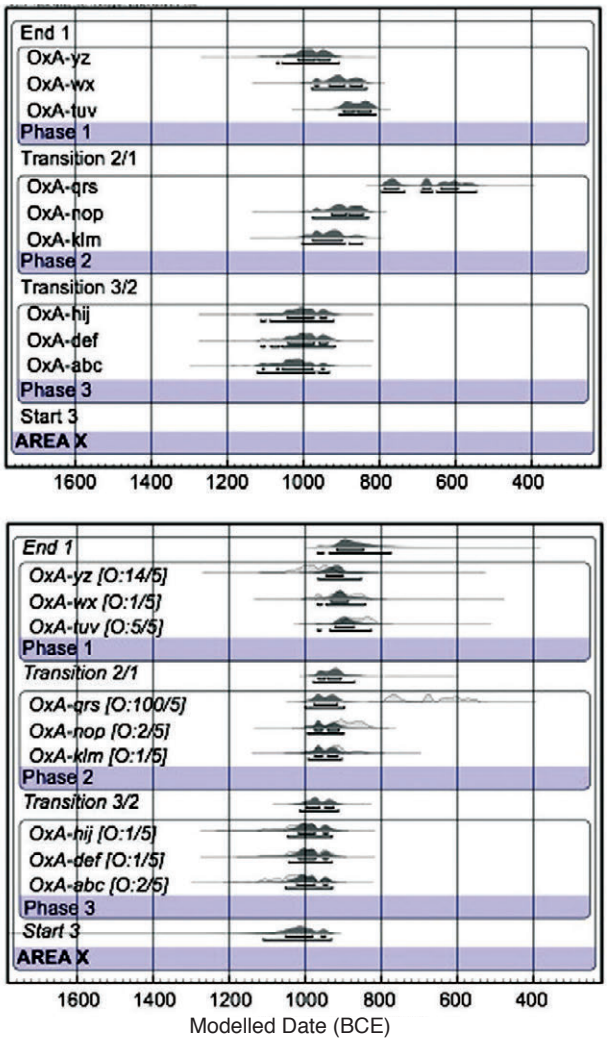

Figure 1.47 Top diagram: The single calibrated ages or likelihoods, derived from the data in Table 1.4. Bottom diagram: Posterior results are shown in black, with the likelihoods in light gray outline. In brackets are the results of the outlier analysis, which shows that OxA-qrs has a 100 percent probability of being an outlier in the model. Note that the model also provides probability distribution functions (PDFs) for the start of the phase 3 occupation, for the dates between the transition of one phase to another, and finally for the end of phase 1. These boundary distributions are not radiometrically dated; they are determined from the model analysis.

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The model gives us the opportunity to assess the age of key boundaries that mark the transition from one phase in the model to another. These boundaries are not directly dated but are produced as a function of the modeling itself. For example, the boundary transition 3/2 gives the probability distribution for the start of phase 2 and the end of phase 3 in our example. These boundaries are important, because in archaeology, the age of the beginnings and endings of different cultural phases is usually of key importance, since this allows us to explore the rate of cultural change. In addition, we can obtain probabilistic estimates for the length or span of successive phases of activity on the site. We will return to these estimates when we examine the dating of different excavated areas at KEN in the monograph (Chapter 2, this volume).

It is critical that careful attention is paid to sample taphonomy and context in the selection of samples for dating if a Bayesian model is to be built. Since the prior information can be extremely informative in the modeling and the posteriors, a failure to be rigorous in this area can prove to be problematic, since the results may be biased. This is why we have paid so much careful attention to the provenance, context, and location of our dated samples. In addition, it is important to remember that when we date samples from the archaeological record, there may be a significant temporal difference between the age at which the material we date ceased taking up ^{14}C and the date at which it became incorporated into the archaeological record. It is therefore important to select short-lived items, such as single seeds or grains, or the exterior rings of tree wood, for the accelerator mass spectrometry (AMS) dating. Of course, in many instances, models are not entirely reflective of the archaeological reality and therefore invite error, too. Accurately structured analysis models are required, because if the model assumptions are inappropriate, then the analysis can give misleading results. This is what we have attempted to do in this volume with respect to the chronometric modeling work.

Conclusion—Social Collapse at the End of the Late Bronze Age: Environmental and Social Context to the Rise of Complex Levantine Iron Age Societies

This chapter has outlined the basic methods, environmental setting, and research design that underlie the Iron Age research of the UCSD's Edom Lowland Regional Archaeology Project that has been carried out in Jordan's Faynan district since 2002. In terms of method, ELRAP has made the application and development of cyber-archaeology a key component of the field and laboratory as a means of controlling the spatial context of material culture with the highest degree of accuracy. Even at the time of writing this volume, our team had developed new three-dimensional tools to interrogate the spatial location of questionable radiocarbon samples to make it possible to more accurately construct Bayesian analyses of suites of radiocarbon dates to test contentious chronological models concerning the tenth century BCE. The introduction also presents a detailed overview of the environmental context of the Faynan copper ore district. In antiquity, from the fifth millennium to Islamic times, copper was the *raison d'être* for human settlement in the Saharo-Arabian desert zone. This environmental description provides the needed contextual data that lay the groundwork for understanding the oscillations in mining and metallurgy during the approximately 700-year Iron Age period. Finally, two generic models of social interaction that are deeply linked to social interaction on the local and pan-regional scale have been presented along with a series of test implications. These socioeconomic models underlie the fieldwork and data analyses brought together in most chapters in this volume. As will be demonstrated in this volume, the new insights into the Iron Age archaeology of Edom point to the centrality of technology—mining and metallurgy—for understanding the emergence, maintenance, and ultimate collapse of the polity known in ancient Near Eastern texts as Edom.

Most scholars working on the problem of the archaeology and history of Iron Age Edom, with its heartland being in present-day southern Jordan, are in agreement that a kind of "nomadic imperative" has operated in the evolution of complex societies in this region since the second millennium BCE until the early twentieth century CE (Bienkowski 1992c; Bienkowski and van der Steen 2001; Kitchen 1992; Knauf (Belleri) 1995; LaBianca 1999; LaBianca and Younker 1995; Levy 2002, 2004; MacDonald 2000; Porter 2004). This means that there is general recognition that during the course of the past three millennia, the socioeconomic structure of nomadism has provided an important, if not special, adaptive advantage to life in this semi-arid and arid region of the southern Levant. However, there is a tendency among these researchers to disagree about the social evolutionary trajectory that the Iron Age

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nomadic communities of this region, generally referred to as "Edomites," took to achieve increasingly complex levels of social organization to the tipping point of being recognized in historical sources as a "kingdom" or in anthropological circles as an archaic state (cf. Feinman and Marcus 1998). In this volume, we will explore three interrelated anthropological processes in conjunction with the most recent Iron Age archaeological fieldwork in southern Jordan to help bring the scholarly community into closer agreement on the role of nomadism in the formation of complex societies in the arid zone of Edom. These models include (1) *ethnogenesis* rooted in the works of Emberling (1997; Emberling and Yoffee 1999), Faust (2006), Levy (Levy and Holl 2002), and others, and (2) *political ecology*, where access to natural resources plays an important role in structuring the political and economic life of societies. The political ecology model was developed by anthropologists such as Cole and Wolf (1999) based on the earlier cultural ecology model of Steward (1968), Rappaport (1969), and others where the material conditions of society, especially how food and other basic resources are procured, help structure society. The political ecology model has evolved further through application in other fields, including political science and geography, and (3) what we will refer to here as an *oscillating tribal segmentary social system* model. The latter model builds on the work of Tapper (1990), Earle (1987, 1991a, 1991b), Sahlins (1968), and others. This multivariate model, used to explain the rise of social complexity in Iron Age Edom, is illustrated in Figure 1.48.

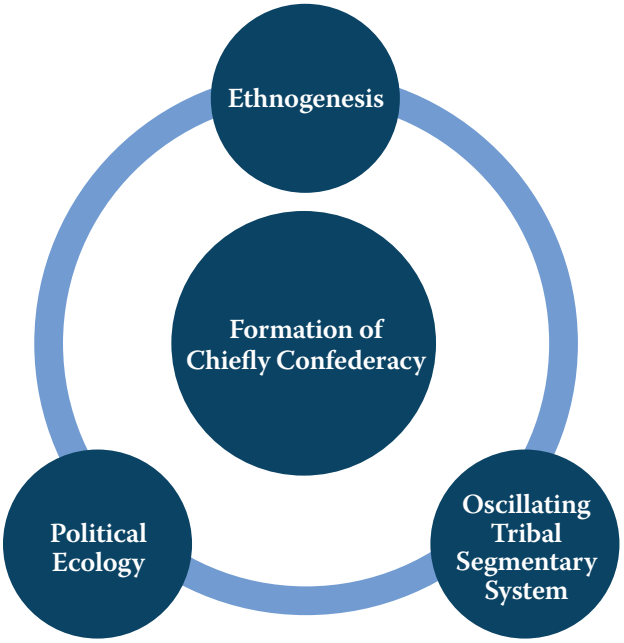

Figure 1.48 Model for the formation of a chiefly confederacy.

At the end of the second millennium BCE (Late Bronze IIb period), the core civilizations of the eastern Mediterranean underwent a social and environmental crisis that led to their collapse (Chew 2001). The major civilization collapse included the Mycenaeans on mainland Greece (Tainter 2006; van Andel et al. 1990; Wright 1968), the Hittites in Anatolia (Drews 1993), and a short crisis in Egypt that occurred at the end of the thirteenth century that brought the Nineteenth Dynasty to an end (Mazar 1992) and ultimately brought an end to the Egyptian New Kingdom. One of the results of the collapse of these empires was the disruption of trade around the eastern Mediterranean, with the island of Cyprus and its highly successful Late Bronze metal industry being decimated. As will be shown below, the interruption of the Cypriot copper trade along with poorer climatic conditions helped set in place a number of opportunities for sociopolitical development for the local peoples of the southern Levant.

The core area of Edom today extends in the north from the Wadi al-Hasa, along the Wadi Arabah on the west, the desert plateau on the east, and the Wadi Hisma in the south, which borders the Hijaz desert of the Arabian peninsula. During some phases of occupation during the Iron Age, the area of Edom may have extended westward across the Wadi Arabah into the region that makes up part of the southern Negev desert (Centre 2001; Rainey and Notley 2006). The core area of Edom includes approximately 12,000 km^2 with four major phytogeographic zones, including (1) a narrow band (ca. 20 x 110 km or 2,200 km^2) of Mediterranean vegetation that receives over 450 mm of average annual rainfall (AAR) and 800 plant species; (2) a sinuous semi-arid band (ca. 45 x 170 km or 5,450 km^2) of Irano-Turano vegetation that engulfs the limited ridge of the Mediterranean environment with around 250 to 450 mm of AAR and approximately 300 plant species; (3) the Saharo-Arabian desert zone that includes approximately 4,350 km^2 of territory characterized by 150 to 24 mm of AAR and some 300 plant species; and (4) restricted areas of Sudanian vegetation composed mostly of acacia trees and other thorn species, dwarf shrubs, and African grasses (Danin 1983); the Sudanian environment is found in pseudo-savanna

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in wadi beds, cliffs and rock formations, oases, and the Dead Sea Rift as well as a variety of secondary habitats outside the rift (Shmida and Aronson 1986). In general, these phytogeographic zones in Edom constitute two main geomorphologic units: the highlands, dominated by the semi-arid and Mediterranean zones, and the lowlands, which consist primarily of Saharo-Arabian and Sudanian vegetation. In examining the impact of the environment on human occupation, it is important to review the paleoenvironmental evidence in the Late Bronze–Iron Age for any confirmation of climatic change and its influence on culture change at this time.

In a recent synthesis of south Levantine paleoenvironmental data, Arlene Rosen (2007:42–43) suggests that it is significant that the social and political events surrounding the development of the first secondary states in the southern Levant during the Iron Age occurred when rainfall conditions seem to have been drier than those at present. In addition to the sociopolitical opportunities due to Late Bronze Age civilization collapse in the eastern Mediterranean, poor climatic conditions also set in at the end of the Late Bronze Age (LB IIb, ca. 1300–1200 BCE) that may have contributed, with social and economic factors, to the collapse of the major eastern Mediterranean civilizations at this time. Thus, Iron Age complex societies emerged and crystallized in Israel, Philistia, Ammon, Moab, Edom, and other regions under a rainfall regime that was even less beneficial for dry farming than that of today, as seen in speleotherm data (Bar-Matthews and Ayalon 2004), paleo-limnology studies (Enzel et al. 2003), geomorphology (Rosen 1986), and other paleoenvironmental data sets. The net impression is that climatic conditions were drier than today. As Rosen (1986:143) points out, during the Iron Age, the southern Levantine societies had to contend with feeding increasingly large populations. If the Chalcolithic period (ca. 4500–3600 BCE) represents the first "population explosion" in the southern Levant, then the Iron Age is the second major growth spurt in human population in the region. To cope with the poorer climatic conditions, a wide range of new agro-technologies were employed, from the adoption of widespread agricultural terracing and water well construction in the highlands of Canaan (Hopkins 1985, 1993) to the adoption of innovative systems of production and trade in Edom, as will be shown here. As suggested in this volume, we need to search for a multivariate model that takes into account social, political, and environmental variables to explain the rise of Early Iron Age complex societies in the southern Levant in general and for Edom in particular. In summary, the collapse of Late Bronze Age civilizations in the eastern Mediterranean may represent a unique situation in the history of the region. Not just one major power declined, whose place was quickly filled by another ancient "superpower"; rather, at the end of the thirteenth century BCE, there was a complete disruption of all core civilization authority in the eastern Mediterranean that led to a complete power vacuum that the region had not witnessed since the formative prehistoric periods when the first chiefdoms emerged during the late fifth millennium BCE (Levy 2006b, 2007). This chapter does not attempt to investigate the reasons Late Bronze Age civilizations in the eastern Mediterranean collapsed since the notion of societal collapse is a study in its own right (Burton 2004; Diamond 2005; Tainter 1988; Yoffee and Cowgill 1988). As shown by the paleoenvironmental data discussed here, the socioeconomic collapse of Late Bronze Age civilizations was also accompanied by a general decrease in rainfall and deterioration of the climatic conditions that required new agro-technology strategies and, as will be suggested here, new social organizations to cope with these social opportunities and environmental constraints. The power vacuum enabled new ethnic groups to converge on the southern Levant (modern Israel, Palestine, Jordan, southern Lebanon and Syria, and the Sinai peninsula) such as the Sea Peoples (Stager 1985, 2003) and nomadic tribes from the Arabian peninsula and perhaps other neighboring regions.

ELRAP in Context

In concluding this introduction, a few words should be said about the development of the Edom Lowlands Regional Archaeology Project. It evolved as an outgrowth of Tom Levy's long-term research on the role of copper production in the formation of complex societies during the late fifth to fourth millennium in Israel's northern Negev desert (Levy 1987, 2006; van den Brink and Levy 2002). In 1996, during the last season of UCSD's excavation at an Early Bronze Age site near Kibbutz Lahav, Pierre Bikai, director of the American School of Oriental Research (ACOR) in Amman, visited the kibbutz where he met Levy at lunch in the dining room. Following a tour of the site, Bikai suggested to Levy that he work in Jordan. At the end of the excavation season, Levy traveled to Jordan, where Bikai introduced him to the country and the Faynan region during a high-speed off-road tour. By the end of the visit, Levy had the privilege of meeting Ghazi Bisheh, then director general of the Department of Antiquities of Jordan. Dr. Bisheh generously invited Levy

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to work in Jordan and asked where he would like to conduct research. As chemical analyses had shown that the copper used in a variety of ancient tools from Levy's excavations in the Negev had its origin in Jordan's Faynan region (Levy and Shalev 1989; Shalev et al. 1992; Shalev and Northover 1987), Faynan was selected as the new study area for a deep-time study of mining and metallurgy on south Levantine cultural change. Early on, Levy felt it was important to partner with Mohammad Najjar, then with the Department of Antiquities of Jordan, who had carried out archaeological work in Faynan for many years, and Andreas Hauptmann, who had recently completed the first multiyear archaeometallurgical investigation in Faynan (Hauptmann 2000).

To get to know each other, in the spring of 1997, Levy organized an international research team to carry out an "action archaeology" study concerning the very beginnings of ancient mining and metallurgy in the southern Levant that would link Jordan's Faynan copper ore region with Chalcolithic sites that smelted these ores in Israel's northern Negev desert. This was a 10-day National Geographic Society expedition that involved using stone tools to mine copper in Faynan, transporting it by donkeys (the fifth-millennium beast of burden) across the deserts of southern Jordan and Israel, and then smelting it at the Chalcolithic site of Shiqmim, where Levy had excavated many years with David Alon (Levy 2001, 2007; Ozment 1999). This was the first major archaeological collaboration between Jordanian, Israeli, American, and German researchers following the 1994 peace treaty between Israel and Jordan, and it received considerable media interest. Following Director Bisheh's suggestion to also work with an archaeologist with organizational experience in Jordan, Levy invited Russell Adams to join what became known as the Jabal Hamrat Fidan project (Levy, Adams, and Najjar 2001; Levy et al. 1999; Levy, Adams, Witten, et al. 2001; Witten et al. 2000)—the beginnings of the deep-time study of ancient mining and metallurgy. By 2003–2004, the Jordan Valley Authority proposed to construct a dam across the Wadi Fidan, and Levy and Najjar were asked to direct emergency excavations at the Wadi Fidan 4 and 40 sites (Levy, Adams, and Muniz 2004; Levy, Najjar, Muniz, et al. 2005; see also Chapter 9, this volume). ELRAP emerged as a direct result of these rescue excavations. Table 1.2 presents a list of the different ELRAP survey and excavations projects and supervisors who worked with Levy and Najjar as field directors of this enterprise.

From an institutional perspective, what has remained consistent with ELRAP is the sponsorship by UCSD, with Levy serving as principal investigator and co-director of fieldwork with Najjar. By 2004, the doctoral program at the UCSD Department of Anthropology, in association with the Judaic Studies Program, was able to accept a growing number of graduate students. It is especially gratifying that through the successful Iron Age UCSD doctoral research of Erez Ben-Yosef (2010), Neil Smith (2009), and Marc Beherec (2011), the scholarly depth and integrity of much of the research in this volume was made possible. The laboratory research took place at the UC San Diego Levantine Archaeology Laboratory, where extensive collections of material culture excavated and collected by the ELRAP expeditions are graciously on permanent loan by the Department of Antiquities of Jordan and at Calit2's CISA3, where the cyber-archaeology methods described above took place. As ELRAP began to focus on the Iron Age, it became necessary to employ the most objective dating methods possible. Following the 2002 excavations at KEN, Levy spent part of his sabbatical in Oxford, where he met Thomas Higham, deputy director, of the Oxford Radiocarbon Accelerator Laboratory. This collaboration developed into one of the central pillars of the ELRAP research endeavor that has helped place our study of Iron Age Edom at the center of scholarly discourse (see discussions in Chapter 2, this volume, and Levy and Higham 2005; Levy et al. 2010). Thus, this volume represents an interdisciplinary study concerning the archaeology of Iron Age copper production and society in Faynan. Whereas Hauptmann (2007) and the Deutsches Bergbau-Museum team carried out the first deep-time regional archaeometallurgical study in Faynan, and Graeme Barker's (Barker, Hunt, et al. 2007) Council for British Research in the Levant conducted the deep-time regional desertification study of Faynan, ELRAP represents the first anthropological archaeology study of ancient metallurgy in Faynan based on large-scale excavation and systematic site survey. To date, as reflected in this study, ELRAP has focused primarily on the Iron Age.

Acknowledgments

Much of the new cyber-archaeology research used in the ELRAP project has been funded by two UCSD Chancellor Collaboratory grants awarded for the 2008–2009 and 2009–2010 academic years and the CISA3/Calit2 Cyber-Archaeology Laboratory at UCSD. Thanks especially to Ramesh Rao, director, and the staff at Calit2, San Diego division, for support

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of the balloon project. Throughout this field project, we have benefited from the generous support of the following director generals of the Department of Antiquities of Jordan: Dr. Ghazi Bisheh, Dr. Fawwaz Al-Khraysheh, and Professor Ziad Al-Saad. None of this research would have been possible without the enthusiastic participation of hundreds of undergraduate students who took part in the UCSD archaeology field school programs that took place in conjunction with ELRAP. In the future, we hope to produce similar integrated studies of ancient mining and metallurgy for other periods in Jordan's Faynan copper ore district.

Notes

1 This chapter relies on some previous publications: Levy and Smith (2007), Levy et al. (2010), and Levy (2004). The environmental discussion relies on Ben-Yosef (2010) and Levy (2009).

2 The Greek (φινω,φαινων) and Latin (*Phunon*) names of the area also followed the Hebrew *Punon* and helped preserve this origin in the Arabic name (Freeman-Grenville et al. 2003).

3 Papyrus Anastasi VI dates to the end of the thirteenth century BCE and states, "We have just finished letting the Shasu people of Edom pass the fortress of Merneptah-hotphima-'e (life, prosperity, health), which is in Tjeku, to the pools of Pi-tum" (*ANET*, 259 [Pritchard 1969]).

4 Seir is mentioned in Amarna letter no. 88 and in descriptions from the days of Rameses II and III, without mentioning Edom, while in Papyrus Anastasi VI (note 2 above), the Shasu of Edom are mentioned without S'eir. There is no connection between the two terms in any other Egyptian text except that both regions are peopled by Shasu. S'eir is more frequently mentioned perhaps because it is closer to Egypt (Kitchen 1992).

5 Some of the arguments are based on the date of 'P' (the Priestly segments in the Old Testament); when accepting its early date (Zevit 1982). The passages of Num. 34.3–4 and Josh. 15.1–3 depict Edom's western borders from 722 to 587 BCE, situated along the road from Arad to Kedesh Barnea.

6 An important exception is the major ore deposits in sub-Saharan Africa (Bisson 2000).

7 Possible mining evidence in local copper mineralizations in the magmatic complex was reported from several locations. For example, in Wadi Khubat, approximately 40 km north of Aqaba, a cave with chisel marks and green deposits is described in a popular hiking book (Haviv 2000) and was visited by the present authors in December 2000. In addition, Rothenberg (1973) mentions some mines south of Eilat, such as the one in Wadi Tueiba.

8 In the visit (March 9, 2009), the following participated: E. Ben-Yosef, M. Najjar, T. E. Levy, A. Levy, and 'Aweid Sayadin.

9 Interestingly, archaeological evidence of gold production in the tenth century CE was reported from the geologically parallel region on the western side of Wadi Arabah (Amar 1997).

10 The Iron Age technologies studied here are not different in their basic principles from the ones practiced in the later Roman and Late Islamic periods. We believe that the field evidence in el-Furn relates to the problem of iron as a by-product in the smelting of copper and not to the practice of iron smelting per se.

11 As part of the new research project "Reconstructing Ancient (Biblical) Israel: The Exact and Life Sciences Perspective" of Tel Aviv University and the Weizmann Institute of Science, there is a new effort to reconstruct the climate of the Iron Age by pollen studies from cores drilled in the Dead Sea and the Sea of Galilee. Preliminary results of this study agree with the trends observed by previous research for the Late Bronze and Iron Ages (Langgut and Neumann 2010, Langgut et al. 2013).

12 Frumkin and Elitzur (2002) also raise the intriguing possibility the "Valley of Salt" (*gai ha-melach*, the battleground between King David and, later, King Amaziah and the Edomites; e.g., 2 Kings 14:7) is in fact the dried southern basin of the Dead Sea.

13 The ELRAP project in Jordan serves as one of the test sites for the 2010–2015 National Science Foundation IGERT (Integrative Graduate Education and Research): Training, Research and Education in Engineering for Cultural Heritage Diagnostics (NSF 0966375): principal investigator (PI), Falko Kuester; co-PI, Maurizio Saracini; and co-PI, T. E. Levy. New digital tools have been purchased for our new fieldwork that will soon move ELRAP into OSDA 4.0. Other new equipment includes Nicolet iS5 FTIR, Tracer III-SD XRF, Thermal, and Imager.

14 The integrated database project is being carried out by Aaron Gidding, Yuma Matsui, Tom DeFanti, Falko Kuester, and Thomas Levy, funded by a 2010-Calit2 Strategic Research Opportunities (CSRO) grant to Levy entitled "Cyberinfrastructure, Portable NexCAVE and Archaeological Research."

15 The self-stabilizing aerial camera platform has been developed by former UCSD undergraduate Alan Turchik as part of the UCSD National Geographic Engineers for Exploration program.

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2 Excavations at Khirbat en-Nahas, 2002–2009
An Iron Age Copper Production Center in the Lowlands of Edom

Thomas E. Levy, Mohammad Najjar, Thomas Higham, Yoav Arbel, Adolfo Muniz, Erez Ben-Yosef, Neil G. Smith, Marc Beherec, Aaron Gidding, Ian W. Jones, Daniel Frese, Craig Smitheram, and Mark Robinson

The recent excavations at Khirbat en-Nahas (KEN) provide an empirical anchor for understanding the history, social context, tempo, and role of copper production during the Early Iron Age in southern Jordan (ca. twelfth to ninth centuries BCE). The site is more than 10 ha in area and contains over 100 buildings that protrude on the site surface. Enveloped in large "slag mounds"—the debris of ancient smelting activities—Khirbat en-Nahas is the largest Iron Age copper smelting site in the southern Levant. The excavations at KEN form the centerpiece of the University of California, San Diego–Department of Antiquities of Jordan Edom Lowlands Regional Archaeology Project (ELRAP). This chapter reports and discusses the significance of the three major excavation campaigns at the site (2002, 2006, and 2009) when seven different excavations were carried out to sample this intriguing ancient metal production center. The excavations were carried out in the four-chamber gatehouse linked to the fortress compound (Area A), a building located inside the fortress devoted to re-melting and casting of copper metal (Area F), two large-scale buildings that may reflect elite residences at the site (Areas R and T), a building devoted to the storage of ground stone processing equipment (Area S), deep sounding through one of the site's many industrial slag mounds (Area M), and a residential/storage complex (Area W). Here we discuss the architecture, small finds, archaeometallurgical remains, and the full suite of 108 accelerator mass spectrometry radiocarbon dates processed from KEN. These are illustrated and contextualized by previously unpublished architectural plans, sections, artifact drawings, photographs, and tables. With the exception of metal production layers located at the base of the deep sounding in Area M above virgin soil that dates to the thirteen to eleventh centuries BCE, most of the excavation areas at KEN date to the tenth and ninth centuries BCE. The excavations at KEN described here have important ramifications for understanding the social evolution of Iron Age Edom and provide the foundation on which all other chapters in this volume rest.

Opposite: Aerial view of Khirbat en-Nahas with most of the excavation areas. The square fortress is seen in the upper left of the image, view northwest. *Photo: UC San Diego Levantine Archaeology Laboratory.*

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The work reported here represents the large-scale interdisciplinary excavations at the Iron Age (IA) copper production site of Khirbat en-Nahas (KEN) (Levy et al. 2004; Levy, Higham, et al. 2008). The work is a part of a deep-time study of the impact of mining and metallurgy over the past eight millennia in Jordan's Faynan district (Ben-Yosef et al. 2010; Levy and Najjar 2007; Levy et al. 2012). Faynan is part of the IA polity known from the Hebrew Bible as Edom, located in the Saharo-Arabian desert zone in southern Transjordan. At least by the seventh to sixth centuries BCE, Edom extended westward across the Wadi Arabah, from Transjordan into the Negev Desert (Beit-Arieh 1995; Edelman 1995; Finkelstein 1992; Thareani 2010; Thareani-Sussely 2008; Zucconi 2007). Edom is characterized by two major geomorphologic units, the highland plateau and the lowlands that border Wadi Arabah. As will be discussed in this chapter, before our project, most IA excavations were carried out on the highland plateau, largely ignoring the copper ore–rich Edom lowlands. Nelson Glueck's (1939a, 1940a) surveys in Edom were the first systematic investigation of the network of Iron Age metal production sites in the lowlands of Edom and recognized the centrality of the site of KEN in that system. While the Czech Orientalist Alois Musil (1907) was the first to sketch the site in 1898, and the site was subsequently visited by Kirkbride, Horsfield, Head, and Fritz Frank (Frank 1934) before Glueck, it was Glueck who first dated correctly these sites to the Iron Age. Glueck assumed that the most important periods of metal production at KEN were during and after the reign of King Solomon (Glueck 1940a) (ADD 60–61). The site was later cursorily surveyed by Burton MacDonald (1992). In the early 1990s, the Deutsches Bergbau-Museum, under Andreas Hauptmann (2000, 2007), carried out technological studies at KEN (Engel 1993) and preliminary soundings at one of the buildings visible on the site surface (Fritz 1996). In addition to Building 200 (n = 1 radiocarbon sample), three slag mounds were sampled around the perimeter of the site, providing a total of eight Iron Age dates: East—near Fritz's Building 200 (n = 4 samples), North—HD 10991 (n = 1 sample), and West—near the fortress gate (n = 3 samples) (see Hauptmann 2007:88–89 for all Deutsches Bergbau-Museum [DBM] radiocarbon dates). Beginning in 2002, we carried out large-scale IA surveys and excavations in the lowlands (Levy et al. 2004). The largest site is KEN (10 ha) with approximately 100 buildings visible on the site surface, including one of the largest IA Levantine desert fortresses (Figures 2.1, 2.2). In 2002, we began excavations in the fortress gatehouse (Area A), a building devoted to the storage of ground stone tools, possibly for slag processing (Area S), and around 1.2 m of the upper portion of a slag mound (Area M). A suite of 37 radiocarbon samples from our 2002 excavations was processed by accelerator laboratories in Oxford and Groningen and yielded Early IA dates for the occupation of the site, between the end of the twelfth century and the end of the ninth century BCE (Higham et al. 2005; Levy, Najjar, van der Plicht, et al. 2005). These dates confirmed and complement the radiocarbon dates published earlier by the DBM (Hauptmann 2007) with greater stratigraphic control and better defined archaeological context. In 2006 and 2009, we returned to KEN for two additional long (ca. two months) excavation seasons, which enabled us to obtain a complete stratigraphic profile of the site extending for over 6.5 m in depth (Area M), sample inside the fortress enclosure (Area F), excavate two monumental buildings (Areas T and R), and sample architectural complexes in the southernmost portion of the site (Area W). Here we summarize the 2002, 2006, and 2009 expedition seasons.

In this volume, we are able to present, for the first time, a detailed report on all the excavations at Khirbat en-Nahas (2002–2009). The stratified excavations in the lowlands of Edom provide an objective dating technique that pushed the absolute chronology of Edom back into the twelfth through ninth centuries BCE and linked this metal production center with the period of the early Israelite kings and their neighbors mentioned in the Hebrew Bible. The tenth-century BCE portion of this Levantine chronology, known as the IA IIa, is a highly contentious period. The KEN excavations bring the early history of IA Edom into the realm of social interaction between tenth-century BCE (and earlier) ancient Israel and this region. Although the DBM published 9 radiocarbon dates from the Heidelberg lab (Hauptmann 2007) and we published 10 dates from Oxford and 27 dates from the Groningen labs (Higham et al. 2005; Levy, Najjar, van der Plicht, et al. 2005), this sample was not substantial enough for some scholars (total of 46 dates) to accept the implications of this new dating framework for Edom. The 2002 results were criticized by researchers (Finkelstein 2005; van der Steen and

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Bienkowski 2005a, 2005b, 2006) who misunderstood the application of Bayesian statistics to help achieve subcentury dating accuracy and had preconceived dating frameworks that would not allow for the construction of monumental fortresses and complex polities in Edom during the tenth and ninth centuries BCE that might resonate with the biblical narratives for these centuries. To help resolve these controversies, deeply stratified excavations to virgin soil were needed to date the full occupation span of KEN and measure the tempo and scale of metal production during the IA. Thus, during the 2006 excavation season, a complete stratigraphic sequence at KEN was achieved with a suite of 22 high-precision radiocarbon measurements and artifact data (Levy, Higham, et al. 2008). An additional two dates from the lowest layer in Area M were processed after the study by Levy et al. was published, and those data are included in the most up-to-date radiocarbon dating model for KEN discussed here. The following presents the final report on the excavations at KEN through the 2009 season. Table 2.1 summarizes the stratigraphy for each excavation area at KEN along with a new general stratigraphy represented in Roman numerals that links all areas together. For the general stratigraphy of KEN, we use the term *stratum*, while for the stratigraphy of each area, the term *layer* is used throughout the report. As will be demonstrated in this chapter, the interdisciplinary excavations at KEN, with its emphasis on the application of cyber-archaeology methods, serve as both the chronological and material cultural anchor for understanding the nature of culture change in northern Edom during the earlier phases of the Iron Age. The stratigraphic excavations carried out in seven different areas at KEN provide a robust data set that reflects cycles of Iron Age copper production, building activities, radiocarbon chronology, material culture change, and social interaction when local Iron Age societies took advantage of the power vacuum following the collapse of the major eastern Mediterranean civilizations at the end of the Late Bronze Age. In addition, the field methodologies developed at KEN provide an accurate analytical framework for making comparative studies with other Iron Age sites in the research area.

Table 2.1 Correlation of strata from all excavation areas (A, M, F, S, T, R, and W) at Khirbat en-Nahas. The Roman numerals in the first column represent the general strata that are used to compare these different areas at the site. The main tool for correlating cross-cutting contexts was the high-resolution radiocarbon dating. Color key: white = unoccupied/postabandonment features; orange = mainly smelting and other pyrotechnological activities; green = mainly architectural remains (buildings); blue = unexcavated contexts; pink = virgin soil.

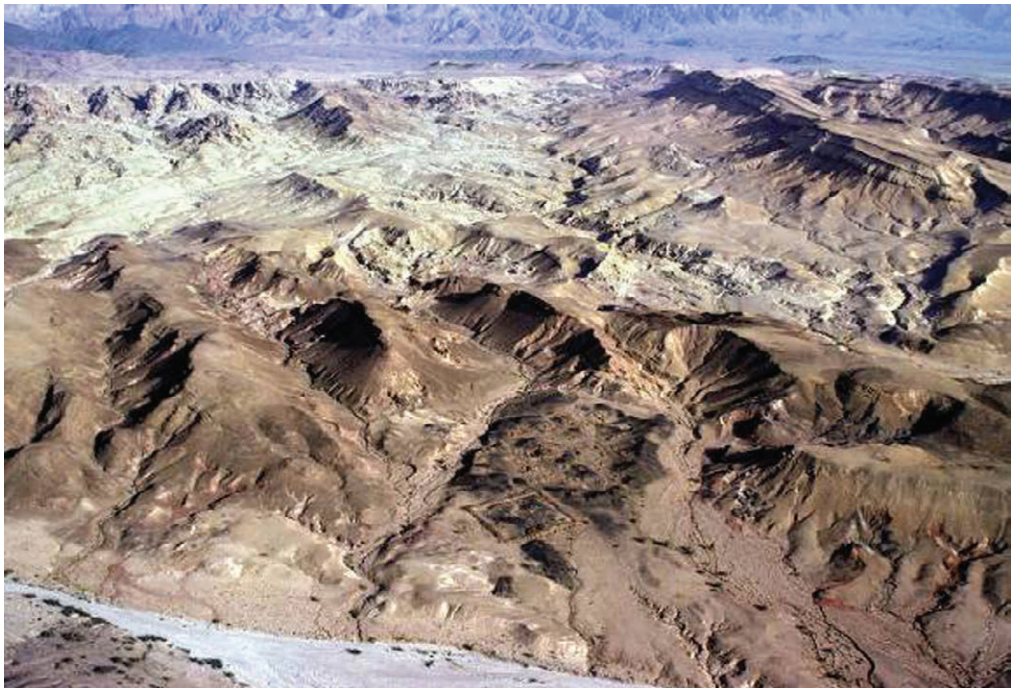

Figure 2.1 Aerial view looking southeast at Khirbat en-Nahas situated on the south bank of the Wadi al-Ghuwayba. The large Iron Age fortress (ca. 73 x 73 m) and extensive slag mounds can be seen from the air. *Photo: Courtesy ROHR Productions Ltd., Nicosia.*

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Table 2.1 Correlation of Strata from all Excavation Areas (A, M, F, S, T, R and W) at Khirbat en-Nahas. The Roman numerals in the first column (St. = Stratum) represent the general strata that are used to compare these different areas at the site. The main tool for correlating cross-cutting contexts was the high resolution radiocarbon dating. Color key: white = unoccupied / post-abandonment context; orange = mainly smelting and other pyrotechnological activities; green = mainly architectural remains (buildings); blue = unexcavated contexts; pink = virgin soil

St.	^{14}C	KEN-A	KEN-A description (2002, 2006)	KEN-M	KEN-M description (2002, 2006)	KEN-F	KEN-F description (2006)	KEN-S	KEN-S description (2002)	KEN-T	KEN-T description (2006)	KEN-R	KEN-R description (2006, 2009)	KEN-W	KEN-W Description (2009)
I		A1a A1b	Post-abandonment	-	Post-abandonment			S1a S1b	Post-abandonment					W1A	Collapse
II	9th	A2a	Ephemeral metal production outside gate	M1 ; 1a	Smelting; (1a after building abandonment?)	F1a F1b	Post-abandonment (Unoccupied)	S1	Abandoned possible corral	T1a	Post-abandonment (Unoccupied)	R1a R1b Post-abandonment	Post-abandonment	W1B	Post-abandonment (Unoccupied)
													R3 courtyard copper production complex		
	9th	A2b	Intensive metal production	M2a	Intensive smelting; late phases in building	F2a	Addition of small architectural units	S2a	Minor extensions of main building					W2	Structure complex; storage areas; cultic? Undated
III	Late 10th - early 9th	A3a	Decommissioning Residential?	M2b	First phase of building; intensive smelting	F2b	Main building w/ basins, recycling	S2b	Main building – casting/ slag processing	T1bT 2a	2nd occupation phase floor	R2a	Some additions to structure		
IV	10th	A3b	Building of gatehouse	M3	Industrial horizon; intense copper production	F2c	Crushed slag below building	-	Unoccupied	T2b	Main building phase, residential	R2b	Main building phase, residential		
V	Early 10th	A4a	Crushed slag/ below gate	[IV-V]				S3	Sparse crushed slag	T3	Pre-building smelting	R3a R3b	Crushed slag below building	W3	Metallurgical debris
VI	Late 12-11th	-	Unoccupied	M4	Copper production	-	Unoccupied	S4	Small scale metal production and domestic activities	-	Not excavated	-	Not excavated		
VII	13-12th			M5a M5b	Installations; small scale production			S5	Unoccupied						Not excavated
-	-	A4b	Virgin sediment	-	Virgin sediment	F3	Virgin sediment	S5	Virgin sediment						

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Figure 2.2 Detailed aerial view of the northern half of Khirbat en-Nahas (view south) before the UCSD excavations took place. The photograph was taken in 1999 and shows the unexcavated gate house (Area A) associated with the fortress and the rubble rock pile indicating the monumental building (Area R) at the site directly south of the fortress. A small secondary drainage (left) bordering the eastern side of KEN. Down-cutting of this drainage eroded parts of the site, including slag mounds and other features. *Photo: UC San Diego Levantine Archaeology Laboratory; Helicopter courtesy of HRM Queen Noor Al-Hussein and the Royal Jordanian Air Force.*



Figure 2.3 Overview of Khirbat en-Nahas taken with the ELRAP helium balloon platform showing the seven excavation areas, 2009 season. *Photo: UC San Diego Levantine Archaeology Laboratory.*

Fortress Gatehouse—Overview of Area A

The fortress was excavated during two major excavation seasons—first in 2002 and then in 2006 (Table 2.2). During these excavations, the gatehouse, labeled Area A, was the primary focus of exploration. As will be described below, only the interior of the fortress was sampled in 2006 in Area F. In Nelson Glueck's (1935) original survey report, he suggested that the huge mound of rock rubble visible on the western side of the large square fortress was the gatehouse. During our first excavation season at KEN, we decided to excavate the perimeter of this rubble mound to delineate the dimensions of the possible gatehouse and sample its two northernmost chambers (Figure 2.3). The 2002 excavations revealed that this structure was in fact a chambered gatehouse. After the second

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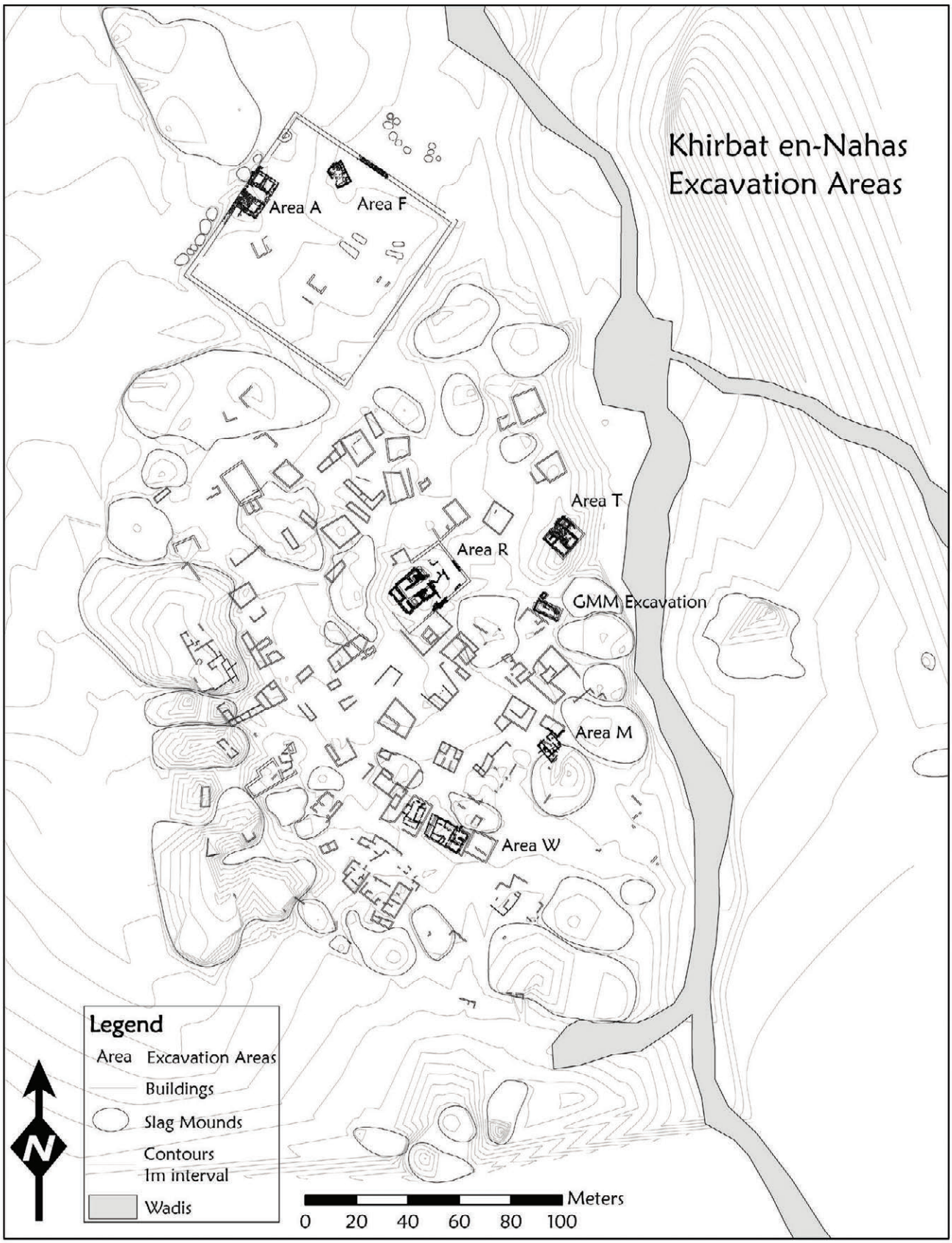

Figure 2.4 (*a*) Topographic map of Khirbat en-Nahas with excavation areas and architectural units visible on the site surface.

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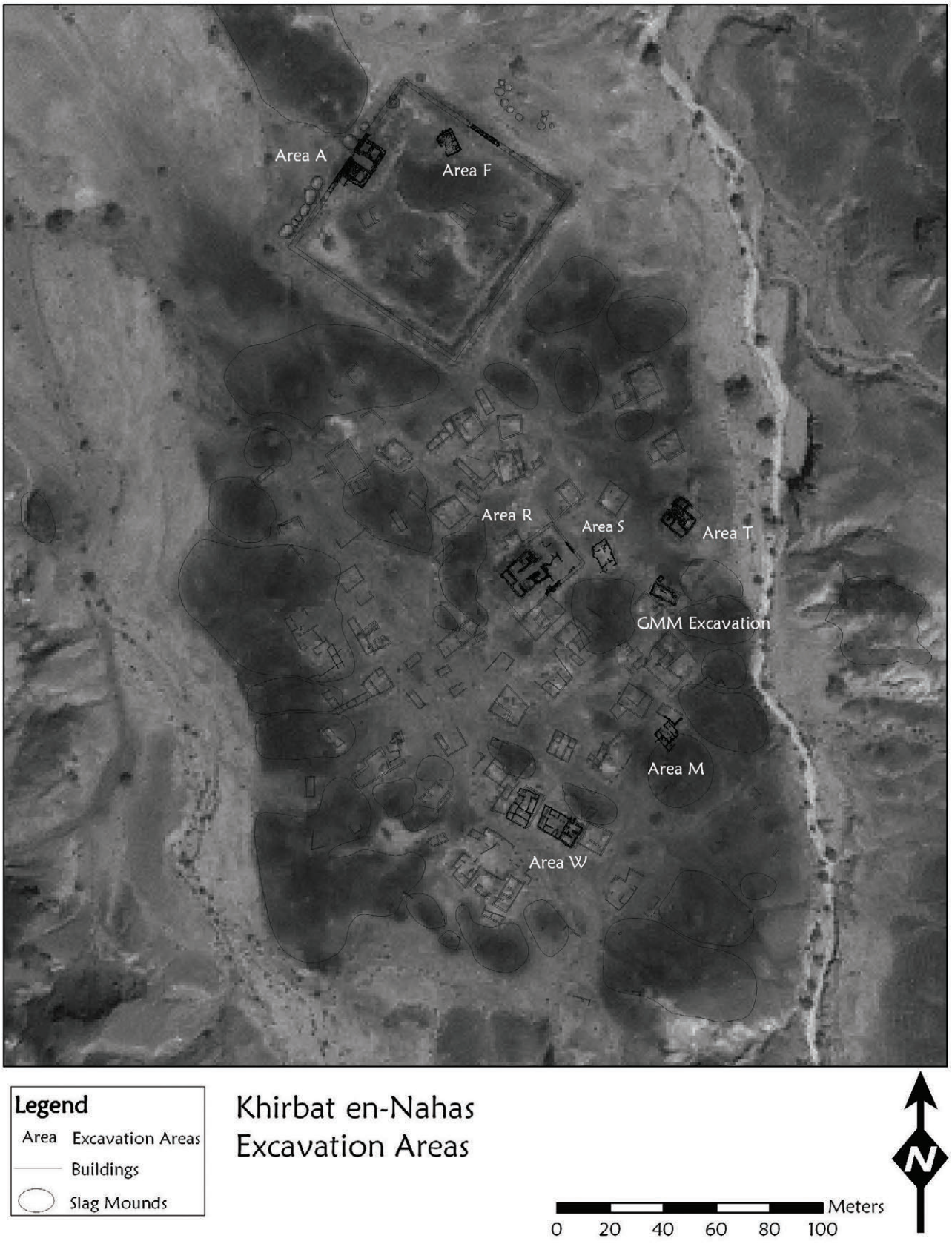

Figure 2.4 (*b*) GeoEye satellite image of Khirbat en-Nahas with excavation areas.

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Table 2.2 Stratigraphic layers in Area A, KEN.

Layer	Description
A1a-b	Postabandonment collapse of gate structure (dating uncertain)
A2a	Ephemeral metallurgical installations superimposed during the ninth century BCE over the earlier intensive metallurgical activities of A2b and found only outside the gatehouse
A2b	Gatehouse and perimeter used for intensive metallurgical industry and waste disposal (ca. BCE)
A3a	Restructuring of gatehouse for possible residence use—architectural additions to original plan (ca. ninth century BCE)
A3b	Four-chamber gate structure built (ca. early tenth century); continued use into ninth century BCE
A4a	Crushed slag layers and occupation prior to four-chamber gate (tenth century and earlier)
A4b	Virgin soil

excavation season was carried out in the KEN gatehouse in 2006, some minor changes were observed in the gatehouse stratigraphy in light of the much larger exposure. As will be shown below, by 2006, three of the four "guard rooms" were excavated, shedding important light on changing social, political, military, and industrial activities at KEN during the tenth to ninth centuries BCE. To give future researchers a chance to explore the gatehouse with better methods, one pristine guardroom was left unexcavated. We should note that this guardroom is the best preserved and may contain evidence of a stairwell. Much of what is said in this introduction of Area A follows the reanalysis of the stratigraphy at KEN for a recent preliminary study of the ceramics at the site (Smith and Levy 2008).

During the 2006 excavation season, the main roadway or passageway separating the two sets of guard chambers was excavated, making it possible to view the outside of the doorways leading into all four guard chambers (Figure 2.6). This large excavation revealed two distinct building phases in the gatehouse: Layer A3b, the original tenth-century BCE construction of the gatehouse and fortification wall (KEN Stratum IV), and Layer A3a, a major ninth-century BCE restructuring of the gatehouse that included narrowing all the doorways leading into various guard chambers, building balustrades in the gateway entrance to block the passage of wheeled vehicles and large animals, and closing the other end of the roadway that passes directly into the fortress with a well-built wall first exposed during the 2002 season (Levy et al. 2004) (KEN Stratum III). The reorganization of the architecture in Layer A3a represents a "decommissioning" of the gatehouse from its former military function into a possible large residence or public building of some kind. In light of the 2006 excavations, it is now clear that inside the guard rooms, our original division of slag layers into Layers A2a and A2b was artificial and that they in fact represent one massive phase of metal production and debris now referred to simply as Layer A2b—a phase that reflects a decision to change the use of the A3a residence/public building into a copper production facility. The 2002 ascription of Layer 2a to a later, more ephemeral phase of metal production that took place only on the exterior of the gatehouse still holds.

These minor changes in the gatehouse stratigraphy have little effect on the radiocarbon dating. Of the 15 radiocarbon dates modeled and published earlier (Higham et al. 2005; Levy et al. 2004; Levy, Najjar, van der Plicht, et al. 2005), none are later than the ninth century BCE. Thus, even without Bayesian modeling, which helps researchers attain subcentury dating, all the radiocarbon dates fall before the eighth century BCE. As far as the Bayesian modeling and the minor stratigraphic changes outlined here, only one sample out of 15 comes from a context (L58; GrA-25320), which now must be moved from Layer A4a to Layer A3 in light of the 2006 excavations. Following the 2006 excavations, when the interior of the passageway in the gatehouse was exposed for the first time (Figure 2.7), it was apparent that the context of L58 was above the Layer A4 crushed slag horizon that predates the construction of the fortress gatehouse but below the major Layer A2b metallurgical activities in the guard rooms.

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Figure 2.5 Overview of the stone collapse on top of the gatehouse at KEN prior to excavation in 2002. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

When the suite of 15 Area A dates obtained during the 2002 excavations is run again with the Oxford Bayesian model placing GrA-25320 in Layer 3, little change occurs in the model (see original model in Higham et al. 2005). The boundary transition between Layer A4a, which is a thin layer of metallurgical activity predating the original construction of the fortress gatehouse in Layer A3, is during the mid-tenth through the mid-ninth centuries BCE (95.4 percent probability). These data are illustrated in Table 2.4 and discussed in more detail in the summary of the radiocarbon dates from Area A below. While these data do not contribute directly to subcentury historical issues during this part of the Iron Age, they demonstrate conclusively that the fortress was not built during the eighth or seventh centuries BCE as some scholars have suggested (Finkelstein 2005). In light of the discussion above, the basic stratigraphy and dating for the gatehouse can be delineated as follows according to layers (see also profile in Figure 2.8; see Appendix 2.A.9,10 for Harris matrix of Area A):

In summary, during Layer A4a and perhaps earlier, metallurgical activity and occupation occurred at the site. Crushed slag layers from this occupation were used as a foundation on which the gatehouse was initially built and used during the tenth century BCE (Layer A3b) and as shown in the 2006 excavations (Figure 2.8). Following the initial building phase, the gatehouse was modified and redesigned in the ninth century BCE (Layer A3a—based on evidence discovered during 2006 season). After the decommissioning of the gatehouse and fortress in the ninth century BCE, the gatehouse (no longer part of a defensive system) and the fortress area were used for intensive metallurgical activities (Layer A2b)—nothing to do with military activities. Layer A2b (mid-ninth century BCE) was the last layer of Iron Age occupation inside the gatehouse, after which it was sealed by massive collapse and/or intentional filling in of the gatehouse superstructure. The Layer A1 collapse of the gatehouse superstructure consists of massive stone blocks that accumulated shortly after the A2a ninth-century BCE occupation. This precludes the possibility that squatters from the eighth century BCE or later centuries used the gatehouse area as it was sealed by the stone collapse. Thus, the latest Iron Age occupation around the gatehouse occurred in Layer A2a, which shows limited metallurgical activity, as evidenced by very small shallow installations radiocarbon dated to the end of the ninth century BCE.

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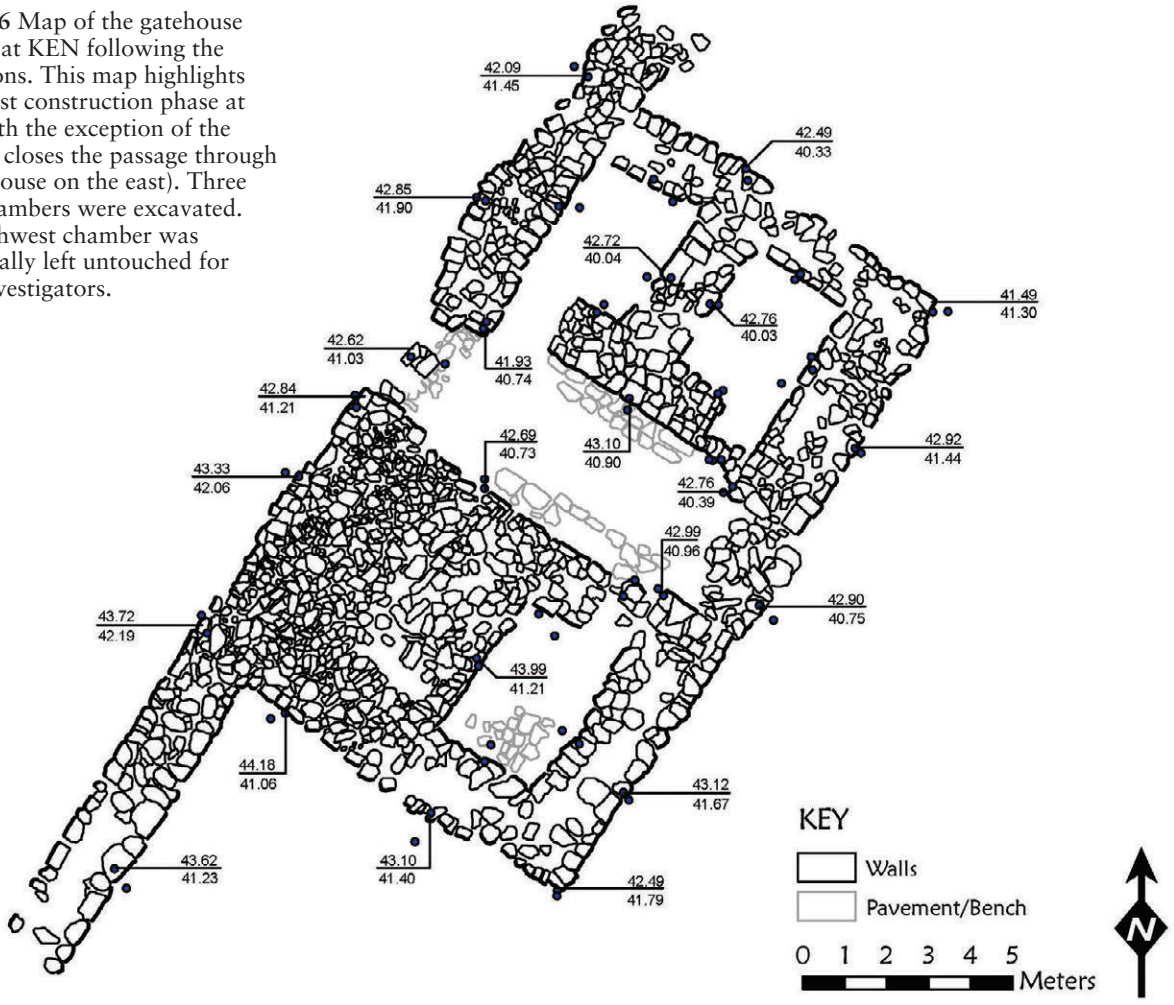

Figure 2.6 Map of the gatehouse (Area A) at KEN following the excavations. This map highlights the earliest construction phase at KEN (with the exception of the wall that closes the passage through the gatehouse on the east). Three of the chambers were excavated. The southwest chamber was intentionally left untouched for future investigators.

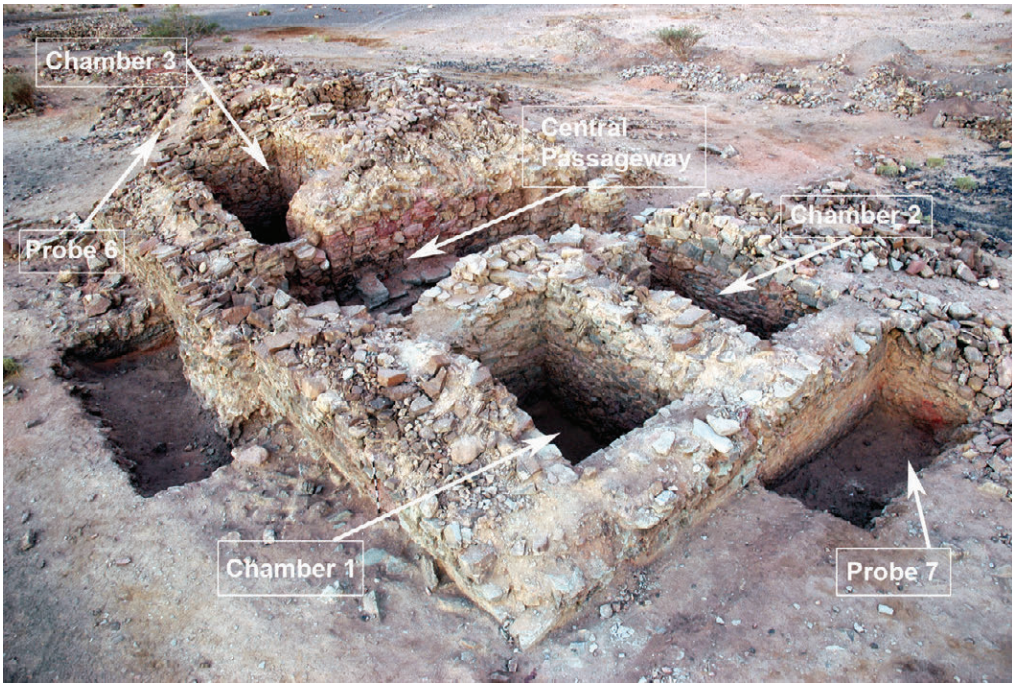

Figure 2.7 Overview of the gatehouse excavations in Area A at Khirbat en-Nahas following the 2006 UCSD ELRAP expedition. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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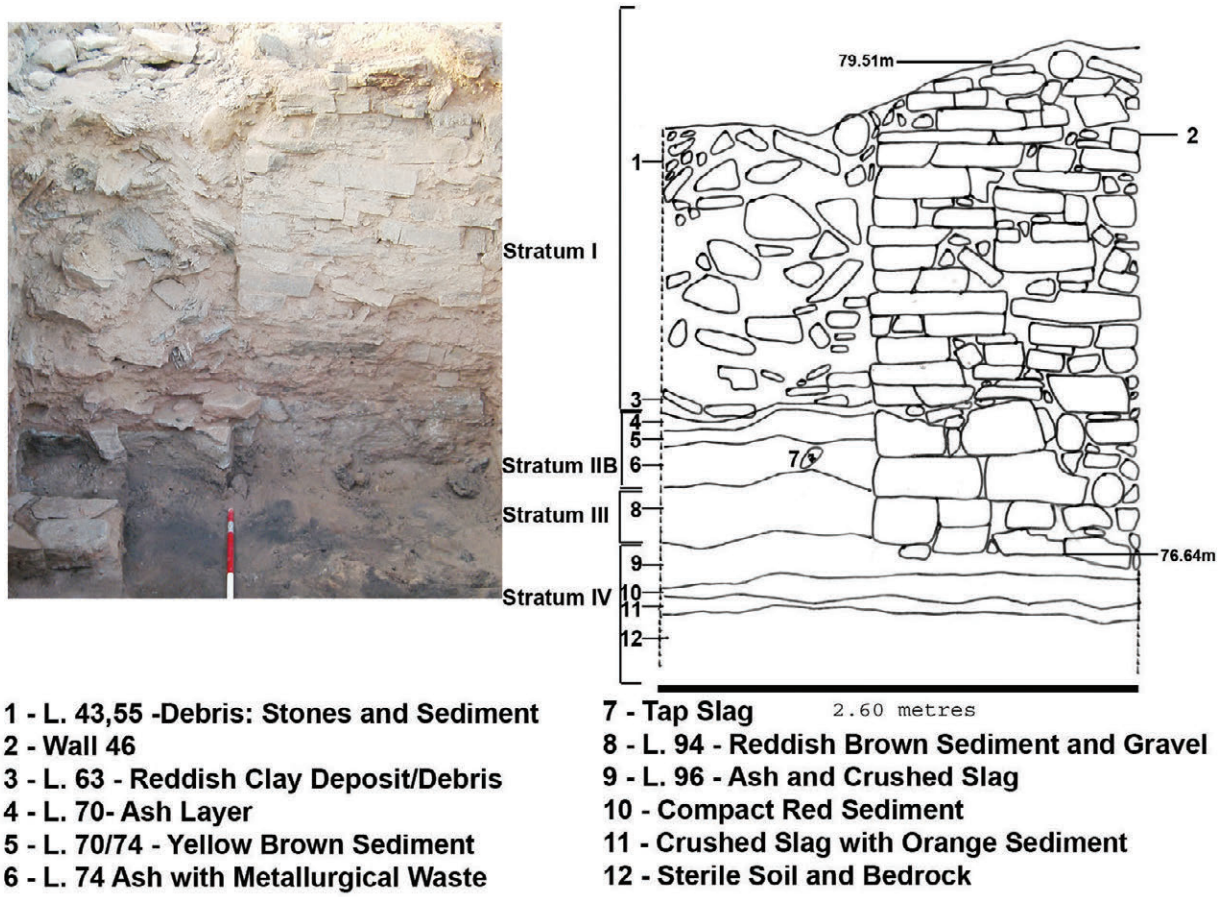

Figure 2.8 Stratigraphic profile in Chamber 1 of the Khirbat en-Nahas gatehouse, 2002 excavation season. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

Iron Age Gatehouse Typology

Before discussing our stratigraphic observations in detail, we will provide an overview of the gatehouse's form and place it within the broader context of southern Levantine gates. One of the hallmarks of the renewed wave of urbanization in the southern Levant that began at around 1000 BCE is chambered gatehouses. The typical gatehouse is a rectangular building with a passage directly through the center, with piers projecting toward the central passage and chambers in between the piers. These gatehouses, built with two, four, or six chambers, are the standard gatehouse type, used almost without exception in the southern Levant until the end of the Iron Age. Many of the gatehouses discussed below are from cities, and others, such as Khirbat en-Nahas, are from fortresses. Whether this is significant in terms of Iron Age architectural planning is beyond the study presented here.

The gatehouse at KEN is a typical four-chambered gatehouse and one of the earliest such gates in the region (see Table 2.3 for a list of tenth-century gates). The gatehouse's overall dimensions are 16.8 m wide (as one faces the façade) and 10.6 m deep; in this respect, its closest parallels are the Palace 1567 gatehouse at Megiddo St. VA-IVB, 'En Haseva St. V, the inner gate of Tell en-Nasbeh, and the inner gate at Tel Dan (see Table 2.3 for a list of all IA four-chamber gates). The gate passage, at 3.6 m in width, is slightly narrower than the average 4.0-m-wide gate passage.

A few particular features of this gatehouse require comment. First, the gate is built such that the entrances to the chambers are partially blocked (see Figure 2.9). What is more, the walls, which narrow the chamber entrances, are integral to the original design of the gatehouse and appear to be load bearing: they are around 1.5 m thick, which is not substantially different from the walls of the rest of the gatehouse, which vary between 1.5 and 2.0 m thick.

Similar blocked chambers have been found at four of the five excavated Transjordanian gatehouses, including at Tall Jawa (Daviau 2003:382–384), Khirbat

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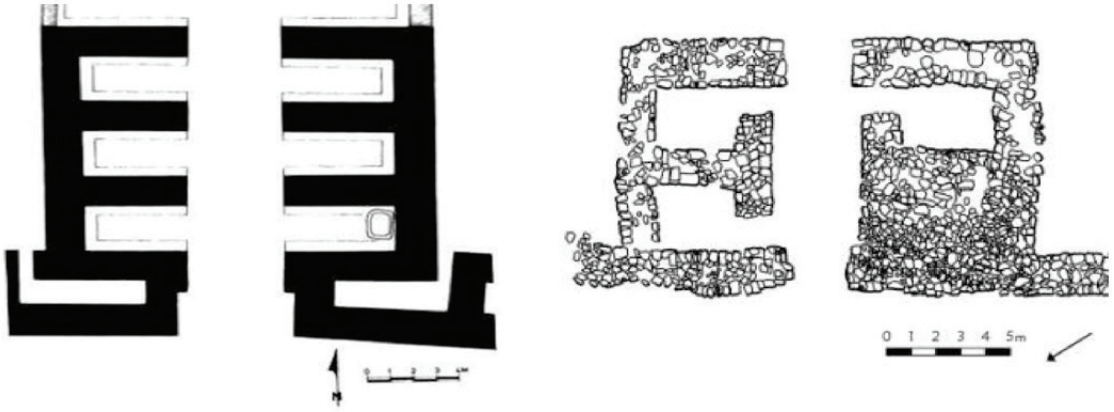

Figure 2.9 The gatehouse of KEN with its partially blocked chambers (right) compared with a typical open-chambered design from Gezer (left) (Dever et al. 1971).

al-Mudaybi (Andrews et al. 2002:134), and Khirbat al-Mudayna ath-Thamad. The only gate in which walls along the passage have not been discerned—Tall Jalul—is preserved very poorly, to the extent that its basic floor plan cannot be determined. On the other hand, a few Cisjordanian gates have been excavated with similar walls blocking at least some of the chambers—namely, at Beersheba St. II (Aharoni 1973:pls 8, 84), both the outer and inner gate of Tel Dan (Biran 1994:236), Tel Kinneret (Fritz 1996:197), and Lachish St. III (Ussishkin 2004:640–641). In the Cisjordanian examples, however, the walls are never found blocking all of the chambers (as they are for all of the Transjordanian gates, save Khirbat al-Mudaybi) and, because of their relatively thin construction, do not seem to have played an important structural purpose.

It seems, then, that these walls along the gate passage constitute a feature that is characteristic of Transjordanian (Moabite and Edomite) gatehouses. Although the specific purpose for this construction technique is not clear, it must have affected the construction of the wood-beamed roof and, because of the extra load-bearing walls, the floor plan of the second story as well.

Another noteworthy feature of the gatehouse at KEN is the pair of two-tier benches that line the sides of the gate passage (see Figure 2.31). The benches lie at the feet of the walls discussed above and thus do not block the doorways into the chambers. They range from 0.6 to 0.9 m wide and are topped by medium-sized dolomite slabs. Significantly, these benches are part of the original A3b stratum—that is, they were part of the original phase of the gatehouse's use—and were thus not added in the later domestic or industrial phases. Benches are well-known features of Iron Age gate complexes; they appear within gate chambers, along the façades of gatehouses, and along the walls of interior and exterior plazas. It is somewhat unusual, however, to have benches that line the gate passage itself. In fact, the only other gate with similar benches thus far excavated is from Khirbat al-Mudayna. The benches at Mudayna, which also run along the bottom of the walls along the gate passage and are topped with stone slabs, are from 0.4 to 0.6 m wide. Thus, two of the five gates unearthed in Transjordan have passage benches. Since this feature has not been found in any of the 30-plus excavated gates from Cisjordan, these benches also appear to be characteristic of Moabite and Edomite gates.

Finally, we should also note the role of a city gate within the urban context of the Iron II period. One of the characteristic features of Iron Age urban centers is not simply that they had a chambered gatehouse but that the gatehouse itself was built within a larger gate complex, consisting of plazas (both intramural and extramural), bastions or blocking walls, and often a secondary outer gatehouse. The purpose of such a gate complex must have been military in the first instance—creating a defensive gauntlet for would-be attackers—but it also accommodated the vast array of social functions that were typically carried out in a gateway. Since KEN is not an urban center and the gate was thus not the civic center, we shall focus on the military aspect here, where two points deserve consideration.

First, it is a nearly universal feature of gatehouses that they have towers projecting from their façade, flanking the entrance. Towers are described in the Hebrew Bible as being built "on" or "next to" gates

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(2 Chron 26:9), they are depicted in the Neo-Assyrian reliefs of Syro-Palestinian towns without exception, and are attested archaeologically at nearly every city gate that has been excavated. The purpose of these towers was to recess the gatehouse entrance, so that the town's defenders—stationed atop the city wall and towers—could give flanking fire toward the gatehouse doors in the event they were under assault. Without the ability to give such flanking fire, the defenders on the city wall would be forced to lean precariously over the wall to fire on those at the foot of the same wall, thus exposing themselves to enemy fire or a fatal fall. In the absence of towers, the same effect was achieved by recessing the entire gatehouse relative to the city wall, such that the gap between the two ends of the city wall formed the same small court immediately in front of the gate doors (see Figure 2.10).

Second, as mentioned above, outworks such as blocking walls, plazas, approach ramps, and outer gatehouses are common features in Iron Age settlements. There are a number of gatehouses where such features have not been found, but outworks were, nonetheless, a common feature. It is therefore interesting to note that the KEN gatehouse has no defensive towers, is not recessed relative to the circumvallation wall, and has no outworks. These curious omissions would have handicapped the defensive capabilities of the KEN fortress. The main difference is that KEN was designed specifically as a military installation—a desert fortress closely linked to the activities associated with the organization of copper production in tenth-century BCE Faynan.

A few parallels exist for the KEN gatehouse in this respect. The closest parallel is Tell el-Kheleifeh, which is also an independent fortress whose gatehouse has no outworks or towers (Pratico 1993:173, pl. 4). Similar cases are the royal compound gate at Tel Jezreel (Ussishkin and Woodhead 1997:Figure 5), and the gates of palaces 1567 and 338 from Megiddo (Lamon and Shipton 1939:Figures 12, 49). These latter three are functionally similar to a fortress—since they are surrounded by their own defensive walls—and also have no towers or outworks. On the other hand, many small fortresses or gated compounds do have defensive towers or even outworks, such as Kuntillet 'Ajrud, Vered Yericho, and Ramat Rachel. Thus, the lack of towers or outworks at Tell el-Kheleifeh and KEN remains a rather puzzling element in their construction and warrants further investigation and explanation. That said, the stone collapse covering the unexcavated southwest chamber at KEN may reflect the presence of a single tower. The stairways discovered in Areas R and T demonstrate that the architects at KEN were fully capable of constructing second floors on large buildings.



Figure 2.10 Typical Levantine "chamber" gates of the Iron II period (not to scale). From left to right: (*a*) Megiddo St. III, (*b*) Bethsaida St. V, and (*c*) Hazor St. IXa. Note the projecting towers—or, in the case of Megiddo III, the recessed entrance which produces the same effect (Arav and Freund 2009; Ben-Tor and Ben-Ami 1998; Lamon and Shipton 1939).

Stratigraphic Observations

Layer A1a

This layer consists of the upper layer of debris that accumulated over the entire gate structure (Figure 2.11). Similar layers of debris appear over most of the structures at the site, in particular the large buildings (Areas R and T; see below), as well as by the collapsed defensive wall of the fortified compound (L152). The destruction may have been due to earthquakes over the generations but was probably not the direct cause of the abandonment of the site (see Layer A3). The debris layers, represented in Layer 1, are subdivided into two parts: the uppermost layer (Layer A1a) and the lower debris (Layer A2b) beneath this. The division is technical, aimed at isolating the lower layers from the possibly contaminated surface debris that remained exposed to the elements over the years.The main distinction of Layer A1a is the lack of sediment between it and the debris below in A1b. The layer consists entirely of large, roughhewn stones (the building blocks) that accumulated on one another after having fallen from the upper courses of the building. The lack of sediment between the stones can be explained by natural formation processes (Schiffer 1987, 2010)—its drainage into the lower courses of the debris by rain and removal by wind. Stones in this collapsed debris comprise the wide variety of geological types present in the local and regional environment: dolomite, monzogranite and other granites, and sandstone used in the gatehouse

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Table 2.3 Comparative table of Iron Age four-chamber gates from the southern Levant.

	Date of Construction, BCE	Used Until	Overall Gatehouse[1] Width	Depth	Passage Width	Chamber[2] Width	Depth	References
Ashdod Xa	End of eleventh century	First half of tenth century	16.5	13.8	4.2	2.5	3.8	Dothan 1972a, 1972b; Dothan and Porath 1982
Beersheba V	Early tenth century	Late tenth century	21.0	13.0–16.0	4.0	2.5	6.0	Aharoni 1972, 1973; Herzog et al. 1977
Nahas, Kh. en-	**Early tenth century**	**Ninth century**	16.8	10.6	3.6	2.6	3.4*	Levy et al. 2004; Levy, Najjar, van der Plicht, et al. 2005; Smith and Levy 2008
Qeiyafa IV, Kh. (West)	Early tenth century	Tenth century	13.0	10.5	3.9	2.4	3.2*	Garfinkel and Ganor 2009; Garfinkel et al. 2009
Qeiyafa IV, Kh. (South)	Early tenth century	Tenth century	?	?	?	?	?	Garfinkel and Ganor 2009; Garfinkel et al. 2009
Dor VII[3]	After 925	733	20.0	16.5*	4.5	3.5	6.0	Stern 1993, 1994
Megiddo VA-IVB (Palace Gate 1567)	Tenth century	Tenth century	15.0	10.0	5.0	3.0*	4.2*	Lamon and Shipton 1939; Ussishkin 1970, 1994
Beersheba III–II	Mid-ninth century	End of eighth century	17.0	14.0	3.5	2.7*	5.6*	Aharoni 1972, 1973; Herzog et al. 1977
Bethsaida V	Ninth century	Eighth century	30.0	17.0	4.0	3.3*	9.5–10.8	Arav 1999; Arav and Freund 2009; Arav, Freund, and Shroder 2000
Hazeva V	Ninth century	Eighth century	15.0	12.8	4.0	2.5	3.3	Cohen 1991, 1994; Cohen and Yisrael 1995a, 1995b
Gezer VII[4]	Ninth century	733	17.0	16.8*	4.1	2.5–6.3[5]	4.7	Dever 1985, 1986, 1993; Dever et al. 1971; Yadin 1958
Jezreel[6]	Ninth century	Ninth century	14.5	17.5	4.0	3.3*	4.7*	Ben-Tor 2000; Ussishkin and Woodhead 1994, 1997
Megiddo IVA[7] **(city gate)**	Ninth century	Eighth century	24.6	16.3	4.2	3.0	8.0	Lamon and Shipton 1939; Shiloh 1980; Yadin 1972, 1980
Megiddo IVA (Palace 338 Gate)	Ninth century	Eighth century	10.1	8.0	3.1	2.4*	3.0*	Lamon and Shipton 1939
Nasbeh, Tel en- (inner)	Ninth century[8]	586[9]	14.0	12.0	4.1[10]	2.7*	4.2*	McCown 1947; Zorn 1993, 1997
Dan (outer)	860–850[11]	733	29.5	17.8	4.0	3.4–4.5	9.3	Arie 2008; Biran 1980, 1994
Dan (inner)	775–750	733	17.5	11.5	4.0	2.6–3.3	4.5	Arie 2008; Biran 1980, 1994
Jawa, Tall St. VIIIb–VIIb	Eighth century	Eighth century (?)	15.5[12]	16.0	4.5	2.4–5.7[13]	2.5*	Daviau 1993, 2003
Kheleifeh II–III	Eighth century	Early sixth century	12.8*	10.5	1.7[14]	2.2*	3.9*	Glueck 1938, 1939b, 1940b, 1965, 1993; Pratico 1993
Tel Batash II	Seventh century (?)[15]	Seventh century	17.3	16.3[16]	4.0[17]	2.0–2.6	5.0	Kelm and Mazar 1995; Mazar 1997
Mudaybi', Kh. Al-	Iron II	Iron II	19.7[18]	14.6	4.1	3.5	6.4	Andrews et al. 2002; Drinkard 1997; Mattingly et al. 1999; Routledge 2004

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Figure 2.11 Layer A1a debris accumulation over the two southern chambers. Probe 1 can be seen in the foreground (2002 season; view northwest—see person on left for scale). P*hoto: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

architecture. Basalt and flint are rarer and appear primarily in the form of small stones used for consolidation between wall courses. Occasionally, these rock types are represented as grinding stones in secondary use contexts. This is different from Area S (see below), where the majority of ground stones can be associated with industrial activities. In other areas at KEN (Areas T and R), the relative height of debris accumulation may indicate variations in the original plan of the building, including evidence of second floor construction. This is readily seen in the Area R monumental building (see below) where a well-preserved stairway was found leading to a second floor level. In the gatehouse, the three excavated guard rooms and passageway showed little evidence of a second floor. However, the unexcavated guard room (southwest) may have had a second floor. Collapse debris in the southwest guard room was twice as high as the other areas, suggesting a second floor "tower" of some kind. Artifacts were retrieved from Layer A1a loci and include occasional sherds—three painted (B4223, B4227, and B4243) and one incised (B4226) (see Chapter 4, this volume)—and some grinding stones that may have been abandoned on the later collapsed floors or were later incorporated in the construction of the walls of the gate.

It should be noted that roughly circular installations made of rocks from the upper layer of debris were detected in two places in the area: above the blocking of the inner access between the passageway and the inner compound of the fort and over the upper crust of debris in the southwestern chamber, which remains unexcavated. A similar installation was found and systematically removed in Chamber 1 of Area R (see Area R report below). In a recent analysis of remote sensing data from the research area, Ian Jones notes that in earlier satellite imagery of the KEN gatehouse dating to 1971, these circles are absent. By 2000, the circles are readily seen, providing a terminus post quem. Thus, the stone line pens were probably constructed by local Azazmeh Bedouin herders as small corrals to house their goat herds (see Figure 2.12).

Layer A1b

Layer A1b potentially contains information about the time and circumstances of the final destruction, or destructions, of the site. Covered by the upper crust of debris of Layer A1a, A1b represents the lower debris covering all rooms of the gate structure as well as the grounds adjacent to the gate walls. Layer A1b also covers the fortified compound perimeter wall (see Probe 7, L169, L175, where deep debris layers were found descending along the wall). This layer also provides evidence for the latest activity phase within the structure. This lower debris fill includes the full assortment of rocks and found in Layer A1a (Figure 2.13S).

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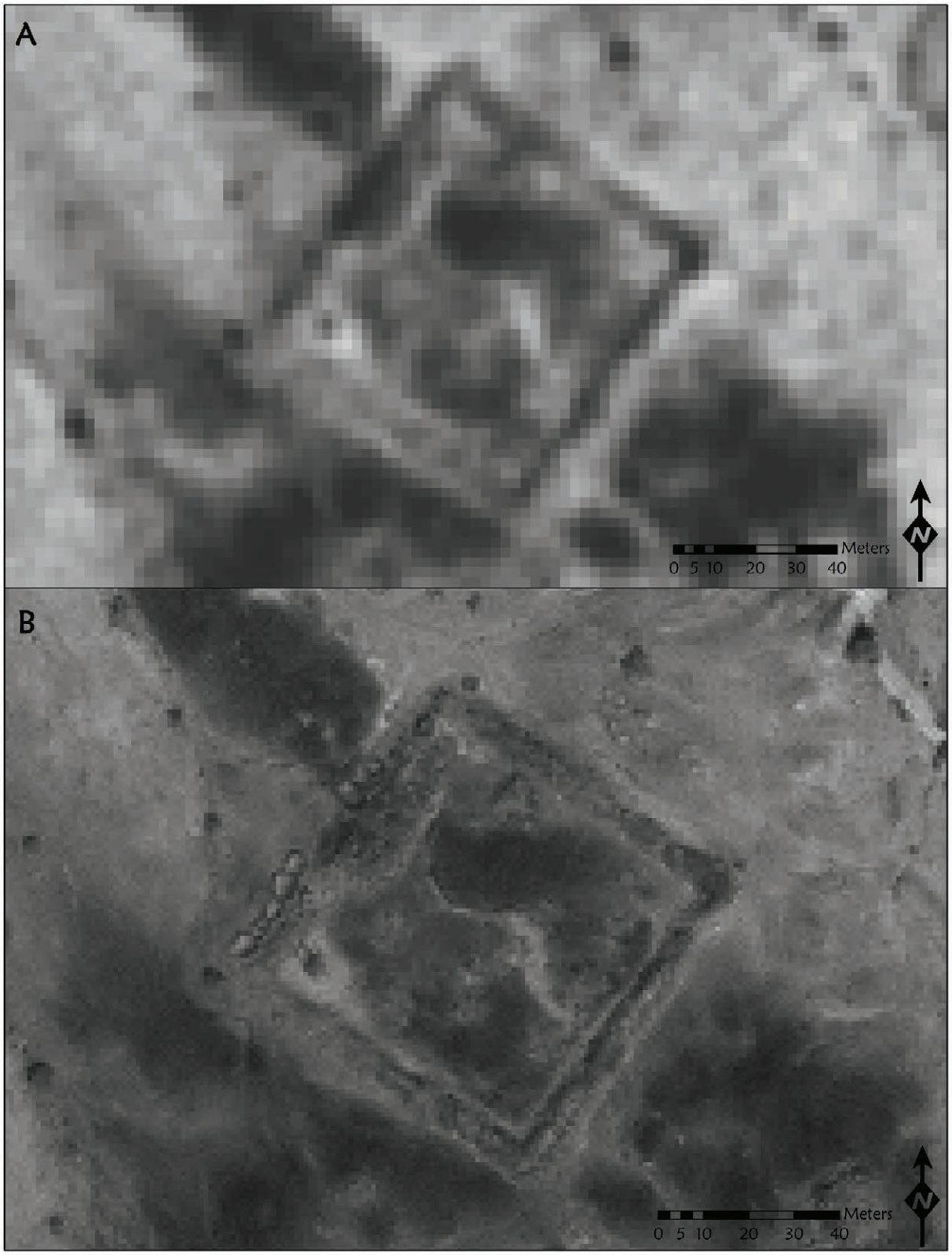

Figure 2.12 Two satellite views of the KEN Gatehouse, 1971 and 2000. Although at a lower spatial resolution, the upper image, taken by the CORONA KH-4B satellite (mission 1115, launched September 10, 1971) does not show any evidence of stone circles on the western side of the gatehouse. Twenty-nine years later, the IKONOS satellite image (taken October 19, 2000) shows the circles. Thus, the stone circles are a very recent phenomenon.

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The A1b debris inside the gatehouse (Figure 2.16) passageway contained more finds than the upper collapse, although the quantity and quality were poor.[19] Due to the nature of the layer, it is difficult to determine the origins of the finds. Notable are a tube-like object of undetermined material carrying stamped or carved botanical impressions (L153, B4120), a stamped sherd (L157, B4030), a piece of crucible (curiously rare at this industrial site—L163, B4130), and a Busayra ware sherd found in the western perimeter wall of the central passageway (L158, B4147) (see DVD photographic archive). Other finds include scattered pottery (including some painted sherds), grinding slabs, and copper industrial waste such as furnace fragments, tuyère pipes, and some slag. It should be emphasized that the amount of copper waste is nowhere near the volume of copper industrial debris found in the occupation ninth-century BCE levels of Chambers 1 and 2 excavated in 2002. Here they were sporadic.

Layer A2a

This layer represents the latest phase of activity in and around the gate structure, after its military function ceased and an intermediate phase in which several architectural changes and additions were introduced perhaps to serve a residence (Layer 3a). This latest phase appears immediately beneath the debris of Layer A1b (Figure 2.15S).

This layer does not show sign of trauma—rather, it seems that activities had long ceased and the structure was abandoned by the time the final infilling of the gatehouse super-structure occurred, most probably by an earthquake. Layer A2a consists of limited evidence of copper production activity, both inside the gate and next to it. During this Iron Age phase, the gatehouse was no longer an active structure and was used for industrial waste dumping and sporadic production activity.[20]

No A2a surfaces were detected in either the central passageway or in the southeastern chamber—only outside the gatehouse (Figure 2.16). Superimposed layers of ash lacking surfaces between them were found along the inside of the main blocking wall used to decommission the gatehouse passageway and in probes along the eastern, northern, and southern sides of the structure (Figure 2.17).

In addition, two unusually compact concentrations of ash (L170, L171) were discovered covering the southern bench that belongs to the previous phases of utilization (A2b–A3b; Figure 2.18S). Metallurgical installations were also unearthed in Layer A2b (Figures 2.19S and 2.20).

It seems, therefore, that all three phases of utilization of the gate structure can be placed within a relatively short period during the tenth through the early ninth centuries BCE, leaving no time for decay and formation processes to produce new surfaces for the later occupations (see radiocarbon discussion for Area A below).[21]

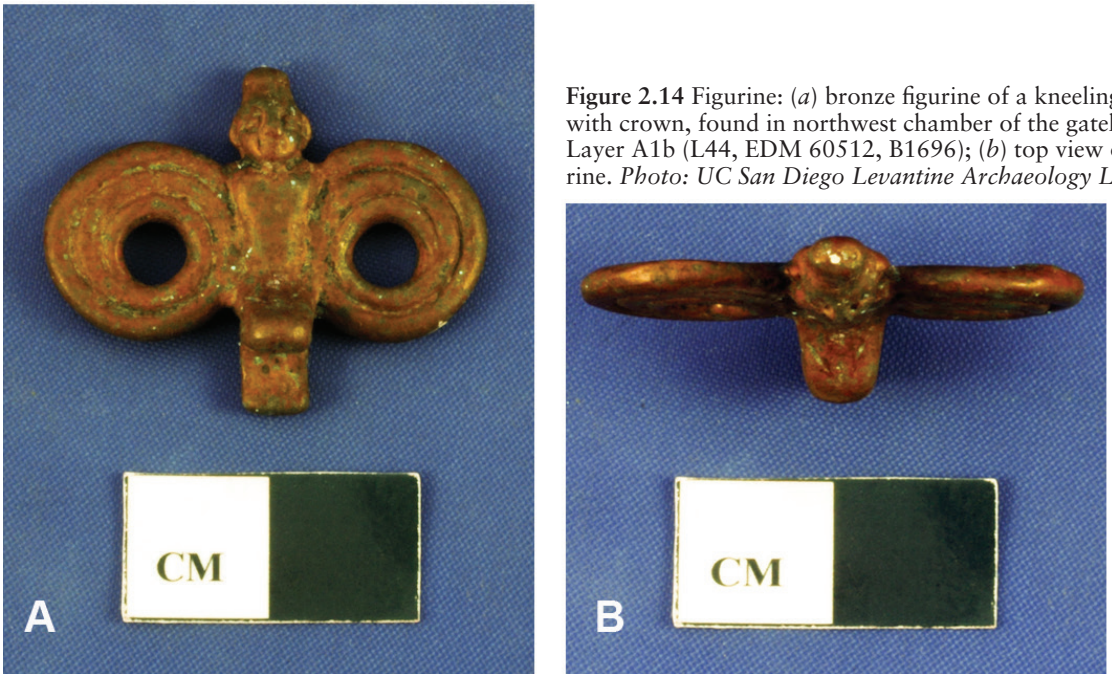

Figure 2.14 Figurine: (*a*) bronze figurine of a kneeling male with crown, found in northwest chamber of the gatehouse in Layer A1b (L44, EDM 60512, B1696); (*b*) top view of the figurine. *Photo: UC San Diego Levantine Archaeology Laboratory.*

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Figure 2.16 The northern section of the southern Probe 6 with the gatehouse in the background. Above: the debris from the compound wall. Layer A2a is represented by the dark layer sandwiched beneath the debris from the fortification wall (seen on left) and the lighter tenth-century BCE material associated with the base of this massive wall. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*



Figure 2.17 Layer A2a industrial ash layers under the superstructure debris layer (A1b), eastern end of the central passageway interior. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

During the ninth-century BCE Layer 2b occupation of the gatehouse, the guard chambers fell out of use as both military and residential structures. Instead, they were used as dumps and possible work surfaces for metallurgical activities. This can be seen in the northeast chamber (L70) where a well-defined surface of stones was laid on top of an ashy fill deposit (Figure 2.21). This pattern was found in the other chambers and reflects the "demilitarized" function of the structure when metal working activities were carried out. This pattern is highlighted in the Layer A2b deposits found in the northwestern chamber where large in situ tuyères, typical of the late tenth to early ninth centuries BCE, were discovered in close association with a furnace base (Figure 2.22). This furnace base is similar to a virtually complete example found in the Layer R3 courtyard, which dates to the same occupation phase at KEN.

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Figure 2.20 Detailed view of the Layer A2b metallurgical installation, Area A, L39, EDM 60118. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*



Figure 2.21 Stratum IIb surface (L70), northeast guard chamber. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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Figure 2.22 Tuyères found in situ, northwestern chamber (L103; Layer A2b). These tuyères are the large diameter type typical of the late tenth to early ninth centuries BCE. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

Layer A3a

The layer represents a series of improvisations inside and along the perimeter of the gate structure, probably carried out after the building no longer served its original military function. The improvisations are apparent mainly at the entrances, both to the complex itself and between the central passageway and at least two of the chambers. The exact purpose of the changes (i.e., the function of the rearranged structure) remains unclear, although an analysis of the final plan and comparisons with Areas R and T (see below) seem to indicate a possible residence of one of the supervisors, administrators, officers, or some other official resident at the site during that phase of occupation and copper production.

Four main architectural changes occurred inside the passageway in Layer A3a:

1. The narrowing of the entrance from outside the fortress into the central passageway
2. The erection of a massive blocking wall that closed the passageway and the gate in general from the former fortified compound
3. The construction of a stone doorway considerably narrowing the entrance between the central passageway and the northeastern guard chamber
4. The partial blocking of the entrance between the central passageway and the southeastern guard chamber

During the original (tenth century BCE) phase of the gatehouse, there was a wide entrance (3.5 m) capable of allowing pack animals and equipment to pass. This was transformed in A3a into two parallel entry accesses (ca. 0.90–1.10 m) between three pilasters (L164, L178, and L186). Two of the A3a pilasters associated with the original gate frame. An additional pilaster was built in the middle of the entrance space (Figures 2.23–2.27).

People would have had no problem using the narrowed A3a entrance into the gatehouse structure (Figure 2.23), but, as noted above, it was not wide enough for pack animal traffic. It seems, therefore, that the readjustment had been aimed at changing the function of the gatehouse from a defensive/military one to a closed residence where mostly human traffic was allowed. The blocking of the inner end of the passageway may have been done for the same reason (Figure 2.25S).

Additional alterations were done inside the gatehouse structure in Layer A3a. The access between the central passage and the northeastern chamber was narrowed with the construction of a small and relatively low doorway (L162), which is perfectly preserved (Figure 2.26). The doorway measures 0.92 m in height and 0.60 m in width. The full width of the constructed structure reaches 1.19 m. Human access through this narrow entrance would have been uncomfortable due to its narrow size. The chamber may have therefore

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Figure 2.23 The three A3a pilasters at the gate's entrance that would have prevented the entrance of large animals and wheeled vehicles into the gatehouse passageway. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*



Figure 2.24 Overview (west) of the gatehouse after closing the main passage leading to the interior of the fortress compound with a large wall built in Layer A3a. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

been used as a storage place or for other purposes. No evidence survives to indicate the A3a function of the former guard room chambers due to later large-scale utilization of the chamber for the accumulation of copper industrial waste.

The access between the central passageway and the southeastern chamber was also narrowed (L195), but in this case, the new space was created by constructing a pilaster inside the western doorframe (Figure 2.27S).

The pilaster resembles in both style of construction and dimensions those constructed at the main entranceway to the gatehouse structure passageway that are dated to the ninth century BCE. The lack of artifacts in this chamber precludes identifying its function at the time of abandonment.

Layer A3a occupation levels are represented mostly by light ashy layers or lenses above the surfaces and below the industrial related layers of Layer A2b. It

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Figure 2.26 The later Layer A3a ninth-century BCE secondary doorway (L162) between the tenth-century BCE passageway and the northeastern chamber of the Khirbat en-Nahas gatehouse. The inside narrow doorway measures 0.92 m in height and 0.60 m in width. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

is not possible to isolate the occupation layers of the two sublayers. Industrial waste was found in both, as were ground stones that were presumably used in the extraction of copper metal from slag. Layer A3a probably represents a relatively short period in the history of the gatehouse structure. For reasons still unclear, the gate and probably the whole fortified compound it had accessed became obsolete as military-defensive structures, and this monumental tenth-century BCE complex was readjusted to serve a civilian function in the ninth century BCE. There is no apparent military purpose in narrowing the entrance and some of the accesses to the chambers, yet such changes would have prevented incoming animal and wheeled vehicle traffic from entering the former gatehouse.[22]

Despite the large-scale excavations in the gatehouse, there is no evidence for large-scale smelting having taken place in the A3a structure, nor could the relatively narrow chambers accommodate it. Small-scale activity, attested in the compact ash layers in the passageway (L170 and L171), would not be affected by the narrowing of the entranceway. At the same time, small-scale production would not provide an incentive to narrow the entrances in the first place, which led us to search for a sublayer where there was a domestic (nonmilitary and nonindustrial) purpose to the gatehouse structure. However, there was a lack of domestic finds. Even the ashy layers or lenses associated with Layer A3a should be treated with suspicion as domestic layers, due to the presence of some industrial waste in each. It should also be noted that in Area R and T structures that date to the tenth century BCE, no industrial activity has been definitely detected within the structures; rather, unlike ninth-century BCE Area A, some domestic artifacts have been retrieved in those buildings (see corresponding reports below).

Layer A3b

Layer A3b represents the original construction and military phase of the gatehouse structure and fortification wall that can be dated definitively to the tenth century BCE based on radiocarbon dates from both the 2002 excavation season and for the first time with new ^{14}C dates published here from the 2006 season. While most of the architecture of the structure belongs to Layer A3b, the actual tenth-century BCE occupation layers are poorly preserved due to later utilization of the original floors for domestic use and, finally, industrial activities related to copper production in Layer A2b.

The massive tenth-century BCE walls excavated in 2006 are similar in plan and style and correspond to a single building plan and style. However, there are variations in the type and size of building stones that were used. The distinctions are particularly clear in the two interior walls of the central passageway. The northern wall (L151) is built of small- and medium-size dolomite stones (Burj formation), with no consolidation other than trimmed small stones and some sediment. It

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should be noted that dolomite, with an occasional insertion of granite and sandstone, is also the common construction stone for the walls of the chambers. The opposite southern wall used larger monzogranite stones (ca. 40 x 50 cm), consolidated with sediment (Figures 2.28, 2.29S, and 2.30S).

No apparent structural reason could be determined for the difference between the passage walls, which may be due to the availability of building material when the gate was constructed. In general, while the gatehouse was structurally solid, little attention was paid to aesthetics or construction symmetry, which would not be expected at a remote site dedicated to industrial activities. Preservation was relatively good, up to 7 courses on the southern wall (ca. 3.5 m in height) and 11 courses on the northern wall (over 2 m). As noted earlier, the only portion of the gatehouse that may have had an upper floor was the unexcavated southwest chamber. Other than the walls and doorways, there are few other architectural elements belonging to Layer A3b. Along the base of the two interior passage



Figure 2.28 Overview of the inner passageway northern wall (L151) of the gatehouse dating to the original tenth-century BCE construction phase at KEN. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*



Figure 2.31 The tenth-century BCE "benches" along the perimeter walls of the central passageway. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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walls, two platforms or benches were exposed (L172, L173). The "platforms" are elongated (ca. 4.5 x 1.0 m) and made of flat dolomite slabs (Figure 2.31). Both are built over a lower line of stones that helped consolidate the foundations of these features. Smooth wear marks are visible on many of the stones.

It is likely that during Layer A3a, no changes were made on the benches, as they could have served various functions in domestic contexts at that time. During the industrial phase (Layer A2b), the southern bench was used for some undetermined function, as a thick layer of white-gray ash accumulated over it (Figure 2.32).

Pavement stones (L194) exposed near the ninth-century BCE northern pilaster addition to the central passageway in the main entrance were first used during Layer 3b as they penetrate below the original northern gate frame (Figure 2.33S). However, no other pavement stones were discovered elsewhere in the passageway whose surface seems to have been made of a layer of packed earth over natural soil (L179) when the gatehouse was first constructed.

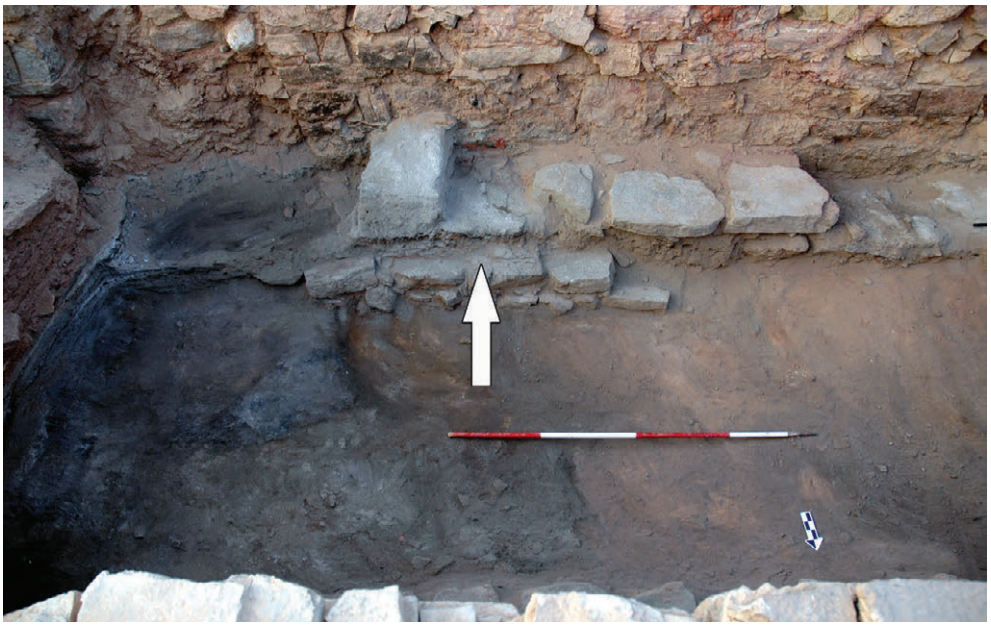

Figure 2.32 Ninth-century BCE A2b industrial ash accumulations over the southern tenth-century BCE "bench" (L170). The white arrow indicates part of the foundation of the original tenth-century BCE bench. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*



Figure 2.34 Layer 3 installation (L191) at the southeastern part of Chamber 4. Note ash from Layer A2a limited copper industry activity. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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A rectangular platform (L191) constructed of flat stones found at the southeastern corner of the southeastern chamber is also associated with Layer 3b (Figure 2.34). The platform (ca. 2.2 x 1.8 m) is one course deep and abuts both southern and eastern inner walls. Function is unclear. A small concentration of ash to the west of the platform (L192) is probably associated with Layer A2a, as it contains some slag, yet it seems to be a later addition to the context and originally disassociated with the installation.

Layer A4

Two features are associated with this layer. In the southern probe (Probe 6), a packed earth surface covered the virgin sediment (L166), where the remains of a small hearth (L167) were found with a lens of crushed slag (L188) below the main Layer A3b walls of the gate structure (Figure 2.35S).

The fact that layers of crushed slag were not found throughout the gate structure implies that the material was introduced as a foundation bed for the walls rather than being the remains of localized copper production activities.[23]

Area A—Radiocarbon Dating

A total of 28 dates are now available from the gatehouse excavations at KEN. The 2006 excavations produced 13 new dates that come from the passageway between the two sets of guardrooms and Chamber 4 and are published here for the first time (Table 2.4). These new dates come from the best contexts for dating the construction of the gatehouse and other occupation layers. The previously published dates appeared in two publications—4 dates in the journal *Antiquity* (Levy et al. 2004) and 11 dates in *The Bible and Radiocarbon Dating* conference volume (Higham et al. 2005; Levy, Najjar, van der Plicht, et al. 2005). When comparing the new Area A dates to the previously published ones for A2b in the original publications, there is a great deal of overlap between these dates and those first series.

A few radiocarbon samples were defined in the field as belonging to Layer A3/2b because during the excavation, it was difficult to determine exactly to which layer they belonged. In preparing this chapter, we wanted to reexamine the spatial context of these samples to determine their exact location within the respective loci where they were collected. By the spring of 2011, our team was able to develop several tools for using a Leica Scan Station 2 to produce georeferenced point-cloud visualization (Petrovic et al. 2011). Since all artifact and sample data were collected at KEN using the Geographic Information Systems (GIS)–based methods described in Chapter 1 (this volume), we could drop those data into the +1.5 billion georeferenced point-cloud laser scans we made of the gatehouse during the 2009 expedition. The laser scan data serve as a georeferenced scaffold in which to situate all cultural material data (see Figure 2.36 and 2.37). Consequently, it

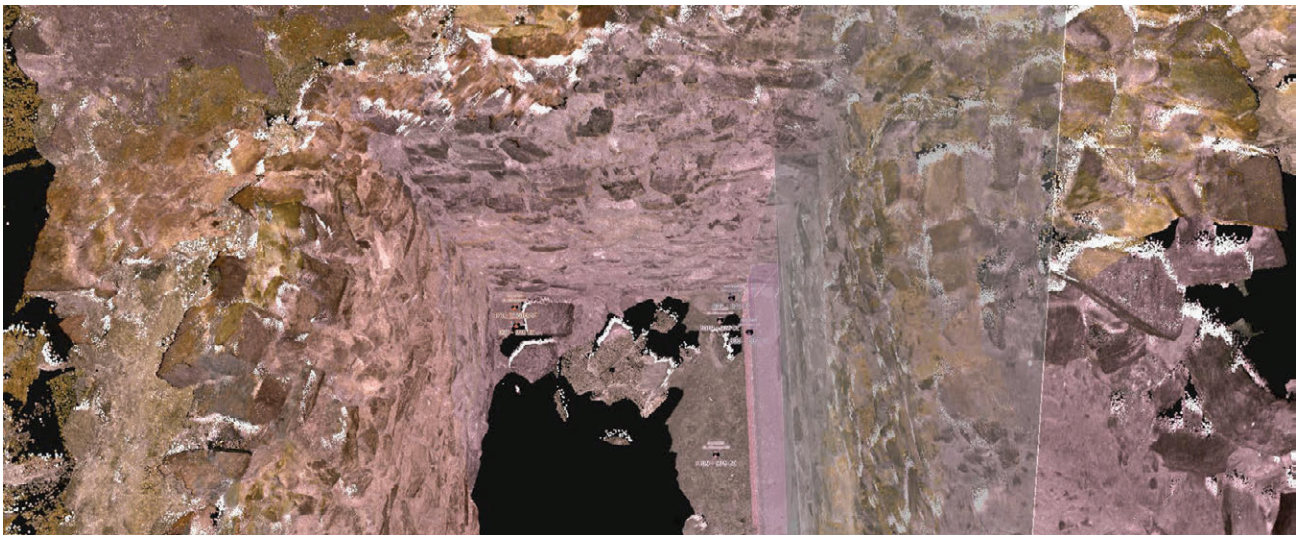

Figure 2.36 Overview of plot of problematic ^{14}C dating samples recovered from the earliest layers in the southeast guard room in the Area A gatehouse. Using laser scanning and modeled GIS data of loci polygons and point data for ^{14}C sample location, it is possible to revisit the locations of these samples three-dimensionally. *Source: UC San Diego Levantine Archaeology Laboratory, thanks to V. Petrovic.*

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was possible to revisit the exact location of where the problematic dates came from and ascribe them to their correct layer (see radiocarbon dating discussion for Area A below).

We have built Bayesian models incorporating the new radiocarbon data along with the sequence data described above. While it is tempting to simply build one integrated model incorporating the layer and stratum data, the archaeological evidence shows that linking the sequence within the gatehouse and outside it in Area A may be challenging. Outside the gatehouse, for example, it was impossible to identify Layer 2b. We decided initially, therefore, to err on the side of caution and build two models for these locations and then compare the probability distribution functions (PDFs) for each key boundary. The two models are called Area A Gatehouse and Area A Outside Gatehouse, respectively. In Figure 2.38, the precise location and layer attribution of all of the dated samples is shown. We used outlier analysis in the Bayesian modeling (after Bronk Ramsey 2009) to evaluate the agreement between the radiocarbon likelihoods and the priors used in the model. We used the *t*-type outlier model with prior probability set at 0.05 because the charcoal that we dated was well identified and predominantly short-lived.

The gatehouse model is shown in Figure 2.39. In this model, there were no significant outliers. This model allows us to estimate the start and end boundaries for certain key events in the archaeological sequence of Area A. One specific boundary of interest is the start distribution for Layer A3b. This dates the original construction and use of the gatehouse and fortress. The modeling suggests that this occurs in the tenth century BC, with the boundary corresponding to 962 to 921 BCE (68.2 percent probability) and 999 to 910 BCE (95.4 percent). Phase A3a represents a radical restructuring of the gatehouse for its use in A2b as a facility for smelting and metallurgy. The start of phase A3a, corresponding to this, is 925 to 890 BCE (at 68.2 percent probability) and 948 to 872 BCE (at 95.4 percent). This probably was not a transformation that took a great span of time, and in fact when we consider the start of the successive phase, A2b, the two are broadly coeval (start of A2b is 908–875 BCE [at 68.2 percent probability]). The modeling tells us that this phase lasted from 0 to 19 years (at 68.2 percent probability) and 0 to 41 years (at 95.4 percent); in other words, it is a very intensive phase of metallurgy. A2a represents small installations attached to the outer parts of the gatehouse, superimposed on top of the intensive

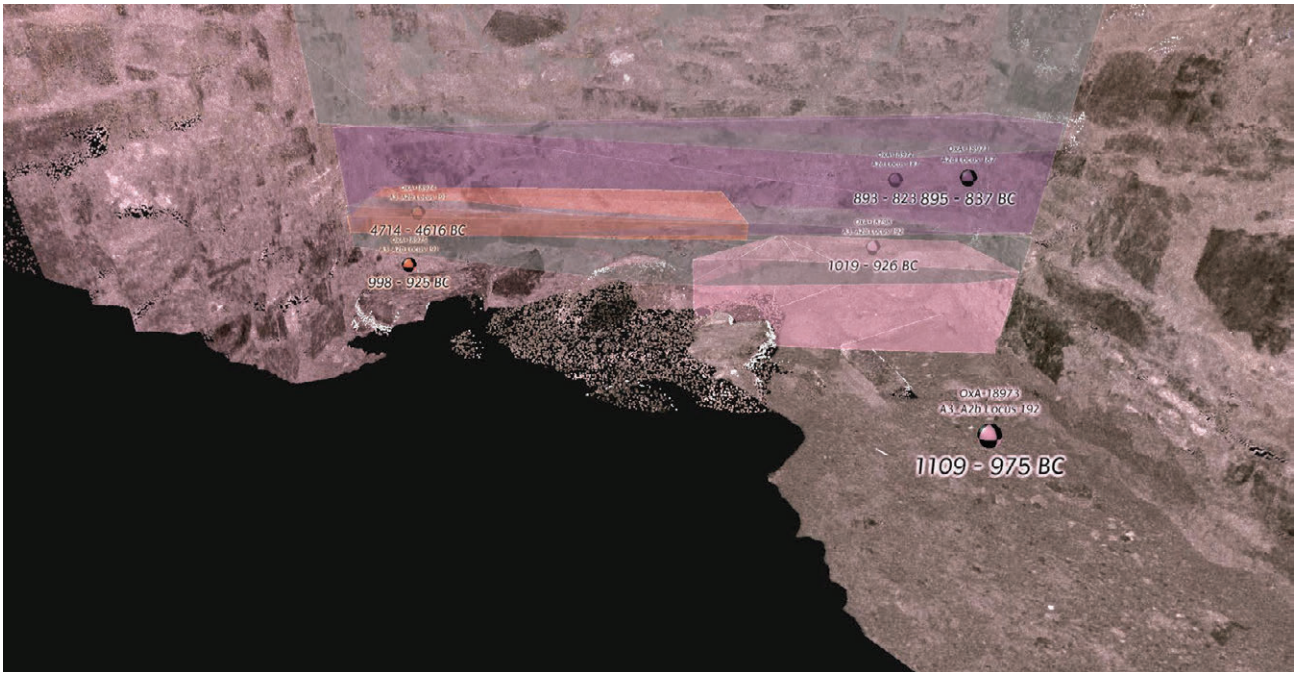

Figure 2.37 Detail of three-dimensional view of problematic ^{14}C samples from the southeast guardroom at the Khirbat en-Nahas gatehouse. In the field, it was difficult to determine whether samples OxA-18975, OxA-18798, and OxA-18973 belonged to Layer A2b or A3. Seen three-dimensionally, it is clear they belong to Layer A3. *Source: UC San Diego Levantine Archaeology Laboratory, thanks to V. Petrovic, CISA3, UC San Diego.*

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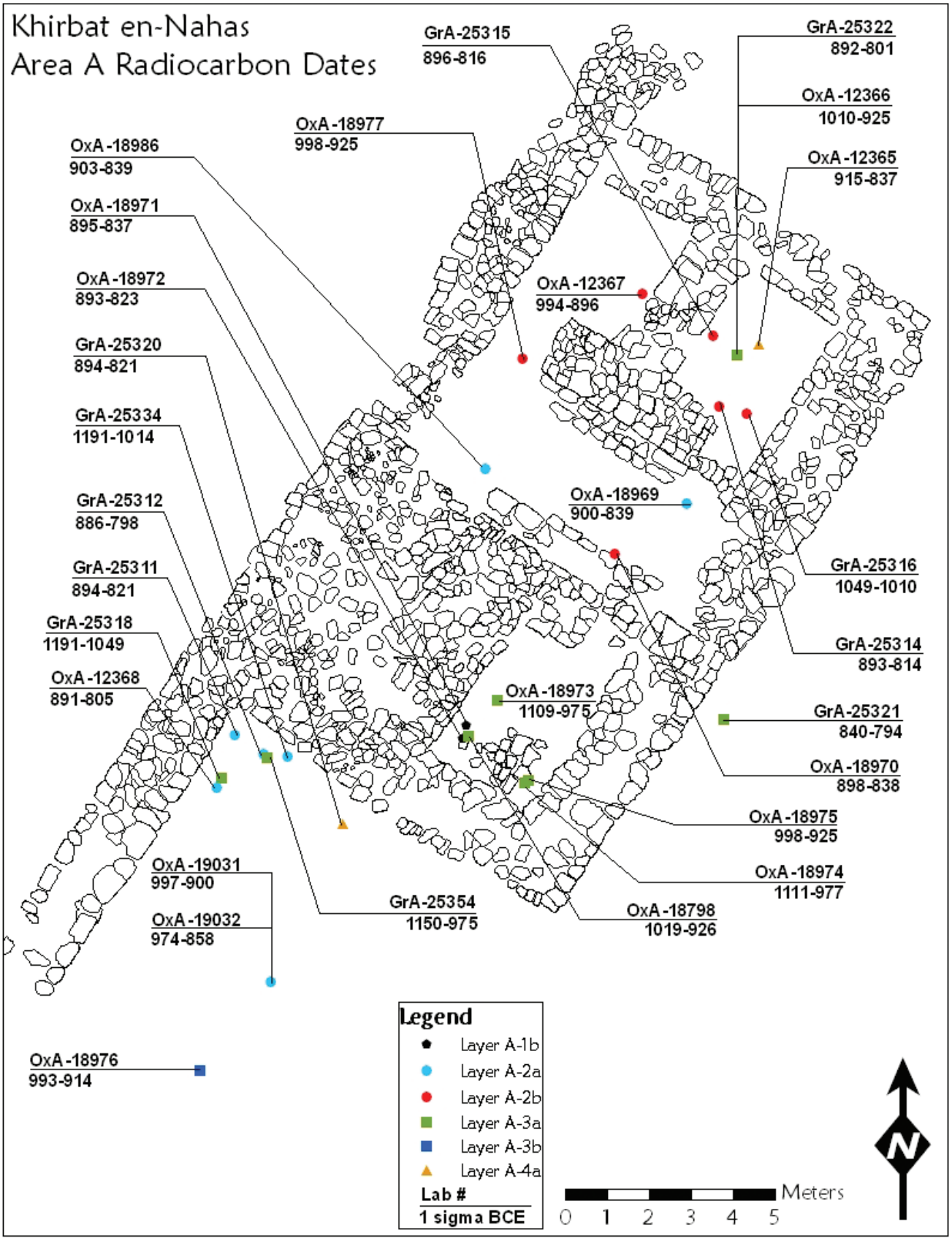

Figure 2.38 Location of dated samples in Area A by layer and provenance.

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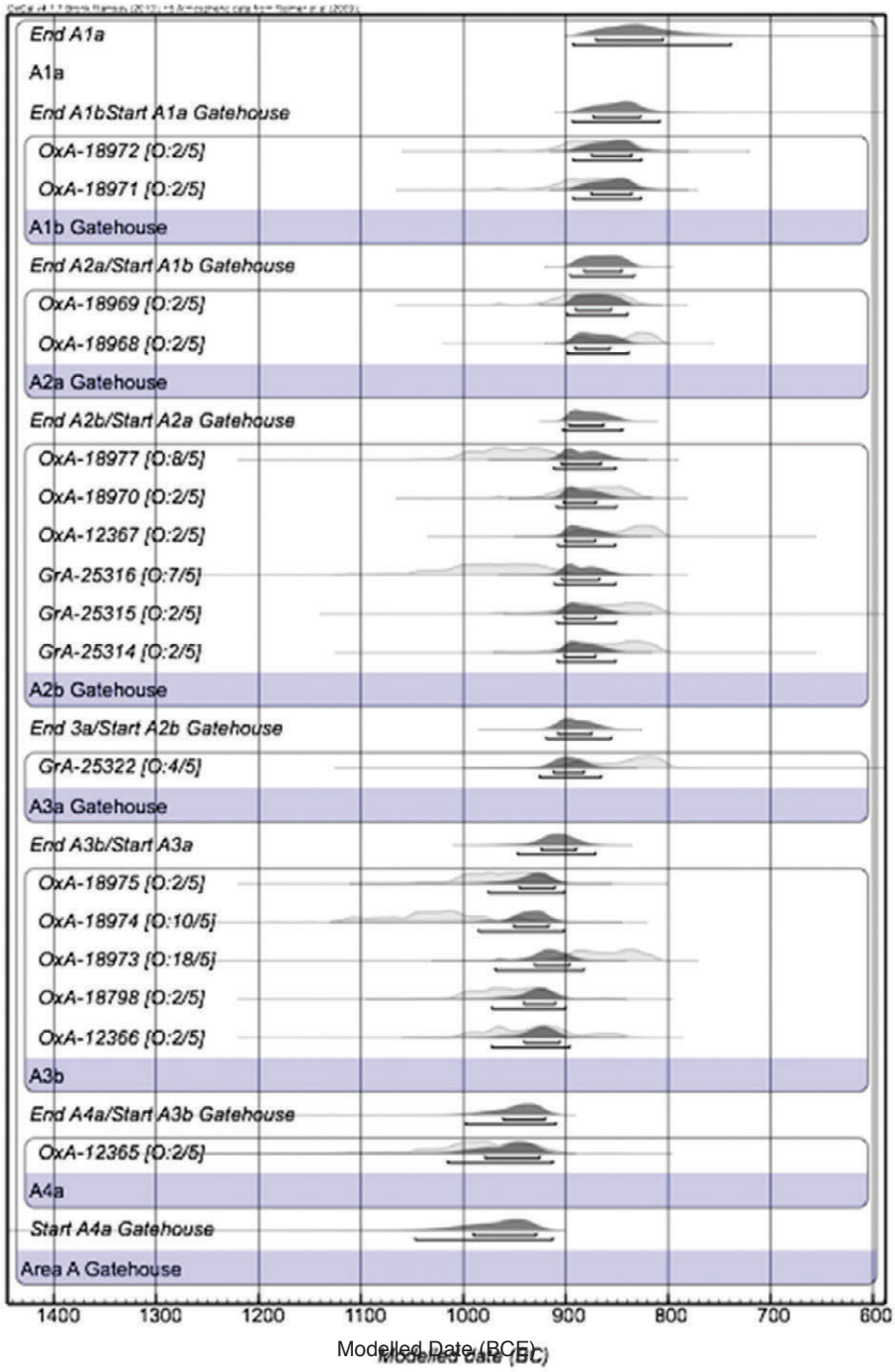

Figure 2.39 Bayesian model for the gatehouse at Area A.

activities of A2b. Our analysis shows that this too was a short-lived phase. The end of A2a came between 883 and 846 BCE (at 68.2 percent probability). Taken together, then, the entire sequence here could represent a handful of decades. Our modeling suggests that occupation from the beginning of the construction of the gatehouse to the end of phase A2a lasted for 37 to 102 years (at 68.2 percent probability). The spans of occupation for the relevant phases in between are shown in Figure 2.41. These spans highlight the rapid reorganization and changing use of the gatehouse that is no doubt intricately linked to sociopolitical processes that occurred during the tenth to ninth centuries BCE in the southern Levant.

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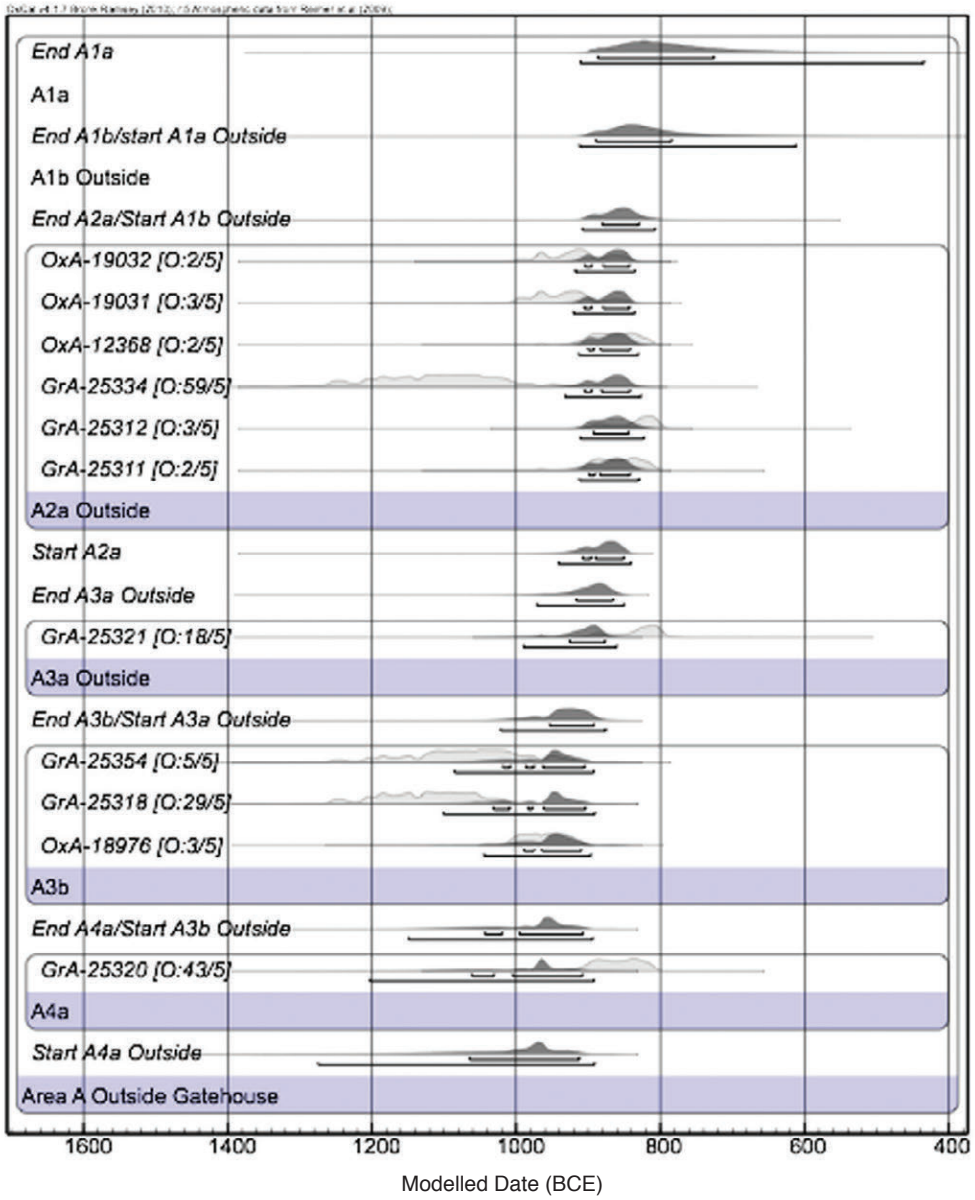

Figure 2.40 Bayesian model for Area A Outside Gatehouse; see Figure 2.38 for the precise location of each of the dated samples.

Our Area A Outside Gatehouse model is shown in Figure 2.40. This model had three outliers, GrA-25334, 25318, and 25320. Outlier analysis down-weights the significance of these likelihoods within the model. GrA-25354, for example, with an outlier value of 59 percent, is excluded from the Markov chain Monte Carlo (MCMC) modeling in ~6 of 10 iterations.

How do the two models for the Area A Gatehouse and the Area A Outside Gatehouse compare? In Figure 2.42, we show the comparison between the two. In general, the agreement is excellent, indicating that, as suspected archaeologically, the beginning and ending of each major building and occupation phase are closely similar. As mentioned above, the fewer determinations for the outside gatehouse sequence mean that there is less precision on the results for that model.

We also ran a final model, in which we cross-referenced certain events from both inside and outside the gatehouse to one another. We assumed, for example, that the start of the A4a occupation was the same in both locations and that the start of A3a was coeval in both locations. Finally, we modeled the start of A2a as

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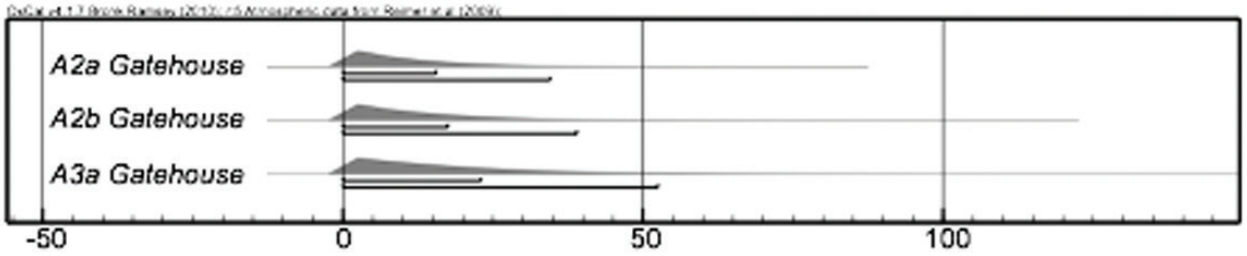

Figure 2.41 The span of elapsed time for three of the key phases in the Area A Gatehouse model sequence.

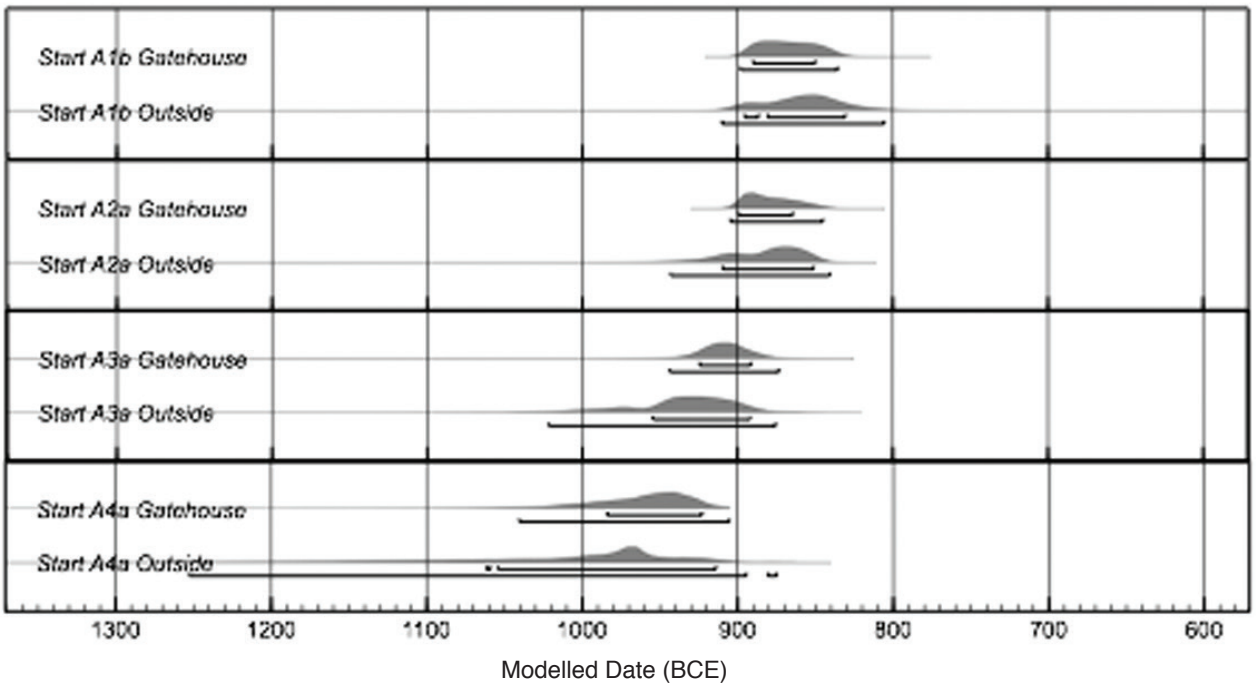

Figure 2.42 Comparisons between key boundary events within the Area A excavation. The boundaries come from the two models for Area A Gatehouse and the area outside the gatehouse complex. Comparisons show a good level of agreement between the two models for the boundary events.

occurring at the same time. As mentioned previously, this model should be approached with some caution, since we have one missing level, but there are grounds for considering the start of certain phases as being contiguous. The model is shown in Figure 2.43. It shows that with these assumptions incorporated, the start of A4a is 946 to 901 BCE, level A3 starts from 922 to 900 BCE, and the start of A2a ranges from 908 to 880 BCE (all at 68.2 percent probability). This cross-referenced model of the gatehouse area that combines dates from both inside and outside the structure highlights the importance of tight contextual assessment when modeling radiocarbon dates, even from a single excavation area at a site. Different natural and cultural formation processes (cf. Schiffer 2010) operated in the relatively small gatehouse area. Inside the gatehouse, it is possible to link floors and layers to its construction history where well-contained rooms and other spaces were homogenously sealed by A1a–b collapse. The depositional situation on the outside of the gatehouse is different; during the short phases of abandonment, the area was open to the elements and human activities that make it impossible to identify the full sequence (i.e., no evidence of Layer A2b). Thus, with the 2006 excavations inside the passageway and southeast guardroom, it has been possible to more precisely identify site formation process needed to build more reliable Bayesian models (Figures 2.39 and 2.40).

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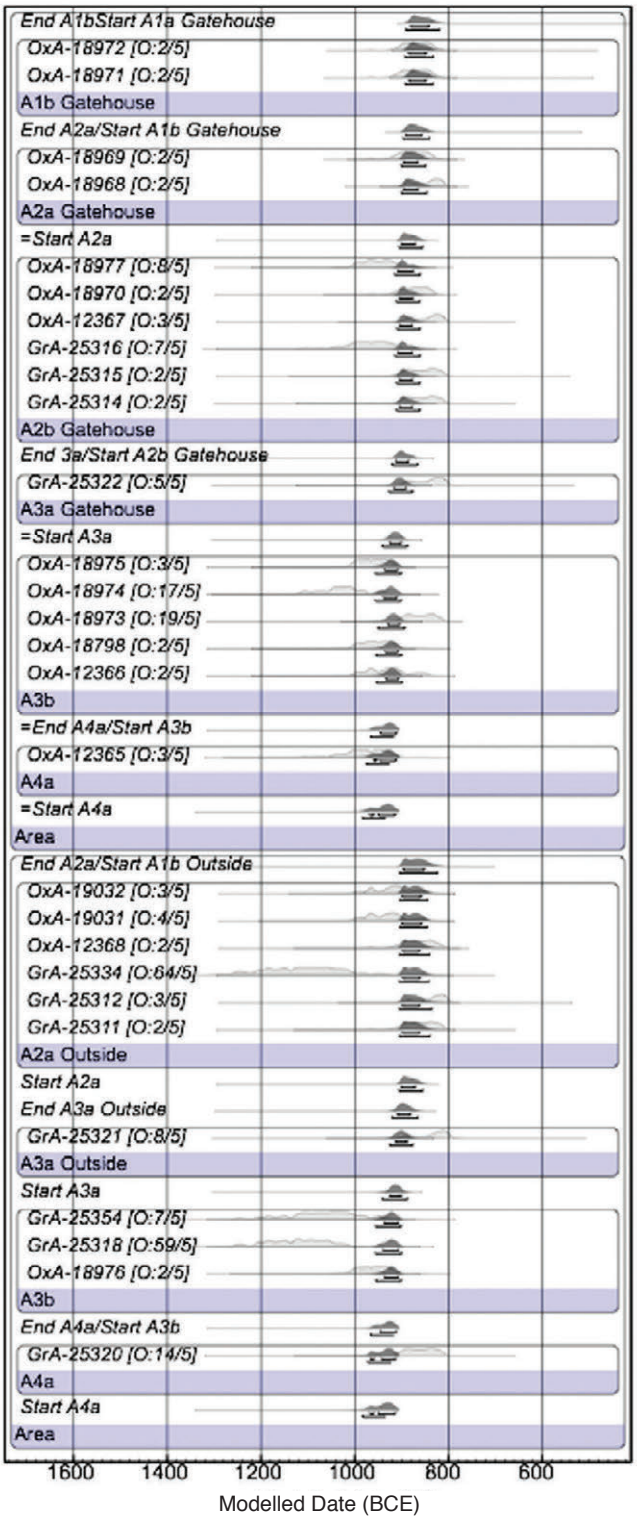

Figure 2.43 Final age model for Area A. This model is cross-referenced at certain key boundaries (see text), so the assumption here is that the beginning of certain important phases in the gatehouse is the same as the start of the same inferred phase outside the building. Cross-referenced boundaries are denoted with an "=" sign, of which there are three.

Summary of Area A

Based on the 2002 and 2006 excavations in the gatehouse in Area A at Khirbat en-Nahas, three main phases of occupation took place that can be summarized as follows:

A. *Military*. The initial function of the Layer A3b tenth-century BCE gatehouse was military when the structure served as the main access to the fortified compound (ca. 73 x 73 m; Figures 2.4a, 2.4b) that would have controlled and scrutinized incoming traffic into the site. Analysis of the possible function of the fortified compound should take into consideration the lack of an additional access into the walled compound. The inside of the compound was sampled in Area F (discussed below) where a building also dating to the late tenth to early ninth centuries BCE was excavated along with a section of th e perimeter fortification. On the basis of his survey of the site in the 1930s, Glueck (1940a:60–61) suggested that the fortress served as a "large prison camp." For reasons outlined below in the discussion of the Area F building, it seems improbable that the fortress functioned as a prison. The gate structure may have served not only for controlling the flow of goods into the site but also for some basic administration, perhaps from its upper room above the southwest chamber. Finds from the gate provide little information associated with tenth-century BCE occupation, due to later domestic and industrial use of the area. When the monumental building of the gatehouse and fortress compound are considered in relation to large-scale construction activities linked to the buildings in Areas R and T, the magnitude of tenth-century BCE architectural power and copper production can be seen dominating the landscape of the Edom lowlands.

B. *Domestic*. During the early ninth century BCE, the military function of the former gatehouse was abandoned and the building was architecturally restructured, probably to serve a domestic use beginning in Layer A3a. The discovery of the bronze anthropomorphic seated figurine—possibly of a crowned king—was found in these collapse layers linked to this period. This complete biography of this small artifact is impossible to reconstruct—how it was ultimately incorporated into the fill of the northwest chamber. However, as the only bronze artifact found at IA KEN and one imbedded with social

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significance, there is no doubt that it functioned as a prestige object during the tenth- to ninth-century BCE sequence in the fortress area (Levy and Najjar 2006) (see Figure 2.14).

C. *Industrial*. The domestic phase was followed in Layer A2b–a by industrial activities, in which parts of the structure were used for the discarding of industrial waste and others for what seem to be small-scale pyrotechnological activities, perhaps melting. This phase is probably related to the construction of buildings such as the one excavated in Area F, where industrial activities related to the production of copper were conducted, and to the scatter of slag that can be seen on the topsoil of the compound, all dating to the late tenth to early ninth centuries BCE.



Figure 2.44 Overview of Area F excavations showing building devoted to metallurgy and probe through the fortress wall. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

Table 2.4 Radiocarbon dates from 2002 and 2006 excavations at Area A gatehouse, Khirbat en-Nahas.

Lab Number	EDM	Season	Locus	Inside/ Outside Gatehouse	Sample Material	Species	Layer	Stratum	Date BP	Cal Date BCE Percent (68.2 and 95.4 percent probability)	Bibliography
GrA-25311	60055	2002	21	Outside	Charcoal	Indeterminate	A2a	II	2710 ± 35	894–821 917–803	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
GrA-25312	60298	2002	21	Outside	Charcoal	*Acacia* sp.	A2a	II	2670 ± 35	886–798 897–794	Levy, Najjar, van der Plicht, et al. 2005: Table 10.1
GrA-25314	60483	2002	74	**Inside**	Charcoal NE guard room	Indeterminate	A2b	II	2705 ± 35	893–814 913–802	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
GrA-25315	60488	2002	74	**Inside**	Charcoal NE guard room	*Tamarix* sp.	A2b	II	2705 ± 40	896–816 925–800	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
GrA-25316	60474	2002	74	**Inside**	Charcoal NE guard room	*Tamarix* sp.	A2b	II	2815 ± 40	1010–1049 1257–1009	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
GrA-25318	60624	2002	89	Outside	Charcoal	*Tamarix* sp.	A3b	III	2920 ± 35	1191–1049 1257–1009	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
GrA-25320	60291	2002	58	Outside	Charcoal	*Tamarix* sp.	A4A	V	2710 ± 35	894–821 917–803	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
GrA-25321	60227	2002	53	Outside	Charcoal	*Tamarix* sp.	A3a	III	2660 ± 40	840–794 899–788	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
GrA-25322	60697	2002	94	**Inside**	Wood NE guard room	*Phoenix dactylifera*	A3a	III	2680 ± 40	892–801 905–794	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
GrA-25334	60335	2002	21	Outside	Charcoal	Indeterminate	A2a	II	2910 ± 50	1191–1014 1265–935	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
GrA-25354	60674	2002	89	Outside	Charcoal	*Tamarix* sp.	A3b	III	2880 ± 50	1150–975 1251–919	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
OxA-12365	60742	2002	95	**Inside**	Charcoal NE guard room		A4a	V	2825 ± 32	915–837 974–813	Levy et al. 2004:Table 1; Higham et al. 2005:Table 11.1
OxA-12366	60697	2002	94	**Inside**	Wood NE guard room		A3b	III	2783 ± 31	1010–925 1109–899	Levy et al. 2004:Table 1; Higham et al. 2005:Table 11.1
OxA-12367	60682	2002	92	**Inside**	Charcoal NW guard room		A2b	II	2689 ± 31	994–896 1005–841	Levy et al. 2004:Table 1; Higham et al. 2005:Table 11.1
OxA-12368	60362	2002	61	Outside	Charcoal		A2a	II	2719 ± 33	891–805 900–800	Levy et al. 2004:Table 1; Higham et al. 2005:Table 11.1

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Lab Number	EDM	Season	Locus	Inside/ Outside Gatehouse	Sample Material	Species	Layer	Stratum	Date BP	Cal Date BCE Percent (68.2 and 95.4 percent probability)	Bibliography
OxA-18798	50511	2006	192	**Inside**	Charcoal SE guard room	*Tamarix* sp.	A3b	III	2801 ± 27	1019–926 1109–907	This volume
OxA-18968	50267	2006	171	**Inside**	Charcoal Passage	*Tamarix* sp.	A2a	II	2691 ± 26	903–839 967–819	This volume
OxA-18969	50220	2006	168	**Inside**	Charcoal Passage	*Tamarix* sp.	A2a	II	2740 ± 25	900–839 926–818	This volume
OxA-18970	50307	2006	174	**Inside**	Charcoal Passage	*Phoenix dactylifera*	A2b	II	2737 ± 26	898–838 924–814	This volume
OxA-18971	50445	2006	187	**Inside**	Charcoal SE guard room	*Tamarix* sp.	A1b	I	2733 ± 26	895–837 917–815	This volume
OxA-18972	50454	2006	187	**Inside**	Charcoal SE guard room	*Tamarix* sp.	A1b	I	2728 ± 25	893–823 904–809	This volume
OxA-18973	50523	2006	192	**Inside**	Charcoal SE guard room	*Tamarix* sp.	A3b	III	2711 ± 26	1109–975 1120–932	This volume
OxA-18974	50524	2006	191	**Inside**	Charcoal SE room installation	*Phoenix dactylifera*	A3b	III	2860 ± 26	1111–977 1122–934	This volume
OxA-18975	50528	2006	191	**Inside**	Charcoal SE room installation	Indeterminate	A3b	III	2812 ± 25	998–925 1040–900	This volume
OxA-18976	50155	2006	161	Outside	Charcoal	Indeterminate	A3b	IV	2812 ± 27	993–914 1019–847	This volume
OxA-18977	50529	2006	193	**Inside**	Charcoal NW guard room near entrance	*Tamarix* sp.	A2b	II	2800 ± 28	998–925 1040–900	This volume
OxA-19031	50110	2006	157	Outside	Charcoal	*Tamarix* sp.	A2a	II	2784 ± 28	997–900 1006–845	This volume
OxA-19032	50110	2006	157	Outside	Charcoal	*Tamarix* sp.	A2a	II	2772 ± 27	974–658 998–841	This volume

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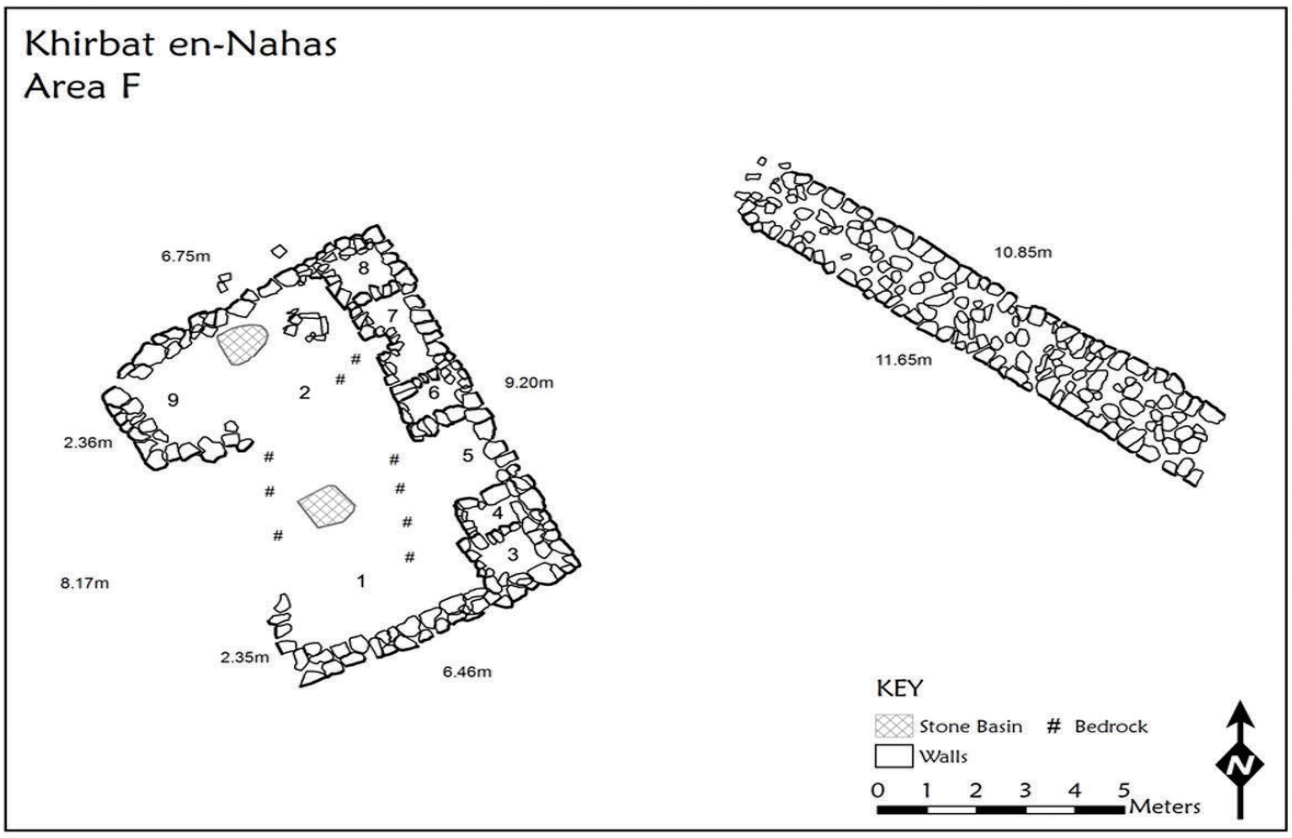

Figure 2.46 Overview of Ares F rooms, cells, and fortress wall.

Fortress Interior—Area F

Area F is located in the interior of the fortress and 40 m northeast of Area A (Figure 2.45S). The excavations centered on a structure and a portion of the adjacent northern fortress wall. The goals of the excavations in Area F were to elucidate the dating of the fortification wall and one of the structures located inside the fortress compound in relation to the overall site (Figure 2.44). The Area F excavations revealed a small building consisting of two main rooms and seven small installations or cells. In the adjacent northeastern area, the fortress wall was excavated on both sides, demonstrating a single-occupation use phase. Evidence of copper melting was found within the structure and limited smelting activities on the exterior. Numerous artifacts were excavated within the structure, including stone basins, ceramics, animal bones, bellows and tuyère pipes, numerous samples of carbonized wood, and a scaraboid. The installations within the building complex and its exterior provide evidence of a wide range of activities carried out there. However, the function of several of the excavated installations remains elusive (see Appendix 2.F.1–4 for Area F Harris matrix and other supplementary data).

The Area F Structure and Fortress Wall

The removal of collapsed stones from the area instantly revealed the outline of walls used in the construction of the Area F building. Following several weeks of excavation, a well-designed building with two main rooms and seven installations (cells) (Figure 2.46, 2.47) were revealed. No entrance was defined. A total of 122 loci (Appendix 2.F.1) were assigned to six layers at Areas F1a, F1b, F2a, F2b, F2, and F3.

The dimensions of the rooms and their possible functions are illustrated in the map of Area F (Figure 2.46 and Appendix 2.F.2). Due to the shallow nature of the sediment inside the fortress compound (bedrock can be seen protruding on the site surface in many areas), the walls of the Area F building are poorly preserved in some areas. The construction material consists mostly of blocks from the shale dolomite formations (DLS). However, dolomite rocks were used in several areas of the southwestern wall. All walls were constructed

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two courses wide and filled with medium to small stone debris. The height of the exterior walls varies across from 20 to 80 cm; in the eastern section of the building, the walls are absent. The building was constructed with two main rooms and a series of cells along the eastern wall. No walls were found dividing the two main rooms that share similar construction attributes in both style and building materials. On the other hand, the walls of the cells constructed along the interior of the eastern wall vary distinctly. The two main rooms, Room 1 (4.2 x 5.0 m) and Room 2 (4.4 x 4.62 m), were the foci of the main activities and movement in the Area F building. Subsidiary activities took place in the smaller cells that line the eastern wall of the structure.

In the southeastern corner of the structure near Room 1, Cells 3 and 4 share similar construction attributes: poorly built walls and single-course thresholds. As will be described below, Cell 3 seems to have functioned as a furnace and Cell 4 was linked to some other sort of metallurgical activities. Cell 5 is another metallurgical installation, similar in construction to Cells 3 and 4, but lacks a threshold. On the other hand, Cells 6, 7, and 8 share a west wall and their interior dividing walls are similar in construction, including type of materials used. Cell 9 is located on the northwestern interior of the Area F complex and is defined by the northwest corner of the main structure and completed by a poorly constructed single-course wall that runs perpendicular to it. A detailed discussion of the rooms, cells, and associated features is presented below after the occupation phase of the structure is presented.

Layers and Occupation Phases

Excavations at Area F identified one fairly contiguous occupation surface that was covered by a fill with compact mud (L900) that extended to bedrock. The surface was identified as the original occupation phase (Layer F2b) in the building. Above the surface, various fills associated with ash layers and installations were encountered. These activity layers and features have been assigned to Layer F2a.[24]

Layer F1a

Loci assigned to Layer F1a consist of the collapse of rocks used in the construction of the Area F structure. The collapse consists of a large mound of stones surrounding an area of fills and foundation wall lines that extends from the area near the fortification wall to the interior of the fortress compound (Figure 2.48S, 2.49S). The stone mantle consists of shale, dolomite, and limestone rocks interspersed with wind-blown sediment. The loose rocks (L0) were removed before the wall collapse.[25]

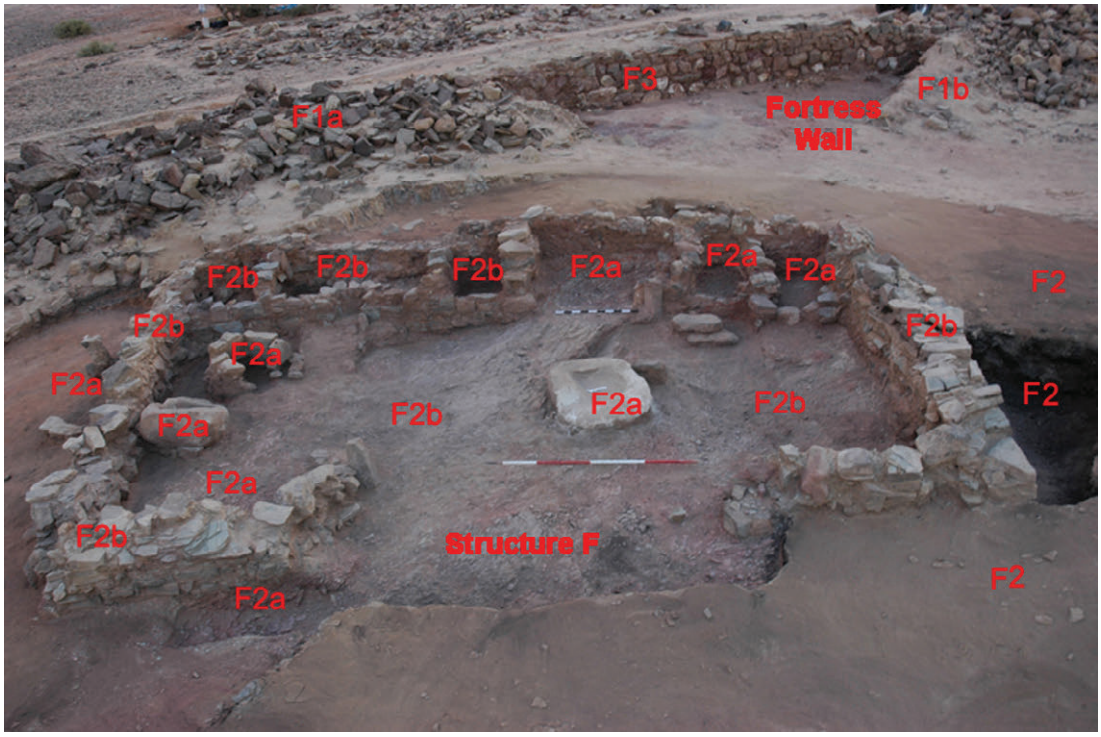

Figure 2.47 Strata assigned to the main structure in Area F and the fortress wall, *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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Layer F1b and the Fortress Wall

The probe through the northern wall of the fortress enclosure in Area F penetrated through a number of loci associated with Layer F1b. These include L839, L841, L849, L851, L867, and L871, which cover both the north and south sides of the fortress wall. The fill and wall collapse removal associated with the fortress wall assigned to Layer F1b are illustrated in Figure 2.50. Once the upper-layer stones from the wall collapse were removed, loose accumulated wind-blown sands mixed with stone debitage and structural collapse from the main fortress wall were found below. It was not possible to identify a well-defined occupation surface in association with the fortress wall in Area F.

Layer F2a

The Area F structure in Layer F2a measures around 6.5 x 9.2 m that includes well-defined rooms, cells, and installations (Figure 2.51). Layer F2a represents the main occupation phase of the Area F structure. There are several areas and features associated with this layer. A layer of wind-blown sand mixed with stone debris from the wall collapse covered the structure (L860, L890, L833, L812, L817, L816, L842, L840, L844, L847, L854, L859, and L814). After removing these fills inside the structure, several room areas, installations, and cells appeared.

Cell 3, 4, and 5 are located in the southeastern quadrant of the structure. The fill inside all three cells consisted of a reddish sediment mixed with heavy traces of chipped shale covering a compact layer of clay. All three cells appear to have been filled with the chipped stone material in antiquity. In Cell 3 (L812 and L816), fragments of bellows and tuyère pipes were found in association with small pieces of copper metal. Especially important was the discovery of a furnace base found in association with partially complete pieces of bellows pipes and slag (Figure 2.52S).

Cell 4 (L812 and L817) contained four small pieces of copper metal, a bellows tube fragment, and one prill.

Cell 5 (L833, L875, and L878) has no wall separating it from the main rooms of the workshop. It yielded one furnace fragment and one piece of charcoal. Cell 9, also assigned to Layer F2a, had concentrated ash and includes the best evidence of melting activity. The loci associated with this cell are L842, L883, L895, and L901. Many types of artifacts, including copper metal, anvils, glassy slag, ceramics, special pottery (EDM 20413 and 20593), tuyère fragments, and worked stone, were recovered from this area. Adjacent to the cell is a large rock-lined basin (L869) and a stone installation (L876) (Figure 2.53). The basin contained traces of copper and slag on the inside. Complete bellows pipes were recovered next to

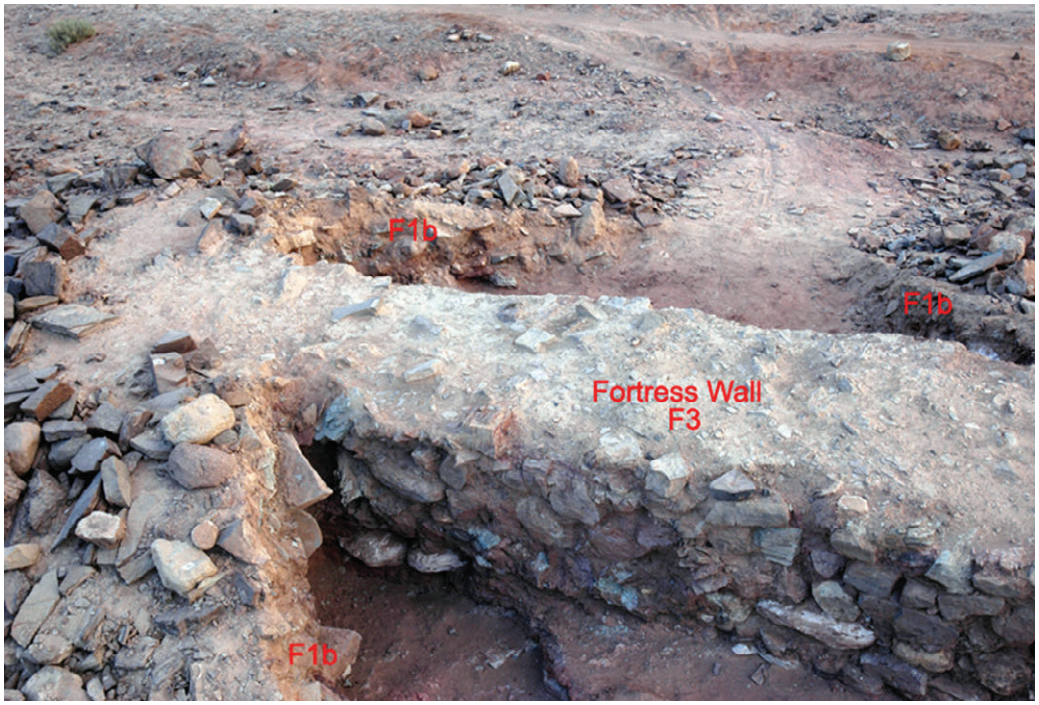

Figure 2.50 The section through the northern fortress wall in Area F. The collapse linked to the fortress wall superstructure is attributed to Layer F1b. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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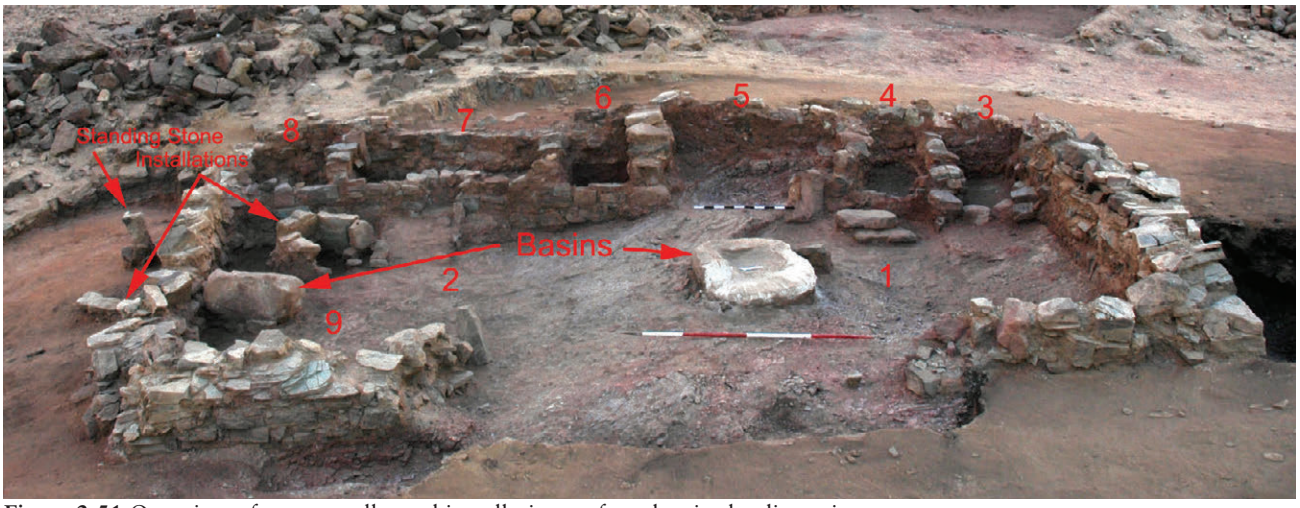

Figure 2.51 Overview of rooms, cells, and installations referred to in the discussion. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*



Figure 2.53 Partially exposed basin with evidence of copper melting (Area F, Cell 9, Room 2). Note the fragment of bellows pipe located above the basin. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

the basin. A stone installation was located next to the basin, without any direct evidence of production or processing activity.

Cell 9, also assigned to Layer F2a, is an activity area adjacent to several installations. The area had concentrated amounts of ash and has the best evidence for melting activity. The loci associated with this cell are L842, L883, L895, and L901. Many types of artifacts, including copper metal, anvils, glassy slag, ceramics, special pottery (EDM 20413 and 20593), tuyère pipe fragments, and worked stone, were recovered from this area.

Immediately adjacent to the cell is a large basin (L869) and a stone installation (L876) (Figure 2.53). The basin contained traces of copper and slag on the inside. Complete bellows pipe were recovered next to the basin. Similarly, a stone installation was located next to the basin. Excavation of the stone installation did not contain evidence of production ore processing activity.

A separate activity area was associated with another stone basin located in Room 1. The basin, made of limestone, was situated next to a fire installation containing traces of ash. Significant pieces of copper metal

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Figure 2.55 Basin in poor state of preservation found adjacent to fire installation. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*



Figure 2.56 Ceramic sherd from a decorated fenestrated stand with "Edomite" elements found in Area F Layer F2b. EDM 20340, Basket 1183, L861. This special ceramic element is associated with the tenth-century BCE occupation of the fortress interior. *Photo: UC San Diego Levantine Archaeology Laboratory.*

and bellows pipes were recovered on the room surface between the basin and the rock installation.

Another set of installations were excavated outside the main structure along its north wall. These consisted of two features—a fire installation (L898) composed of a poorly constructed semi-circular hearth and a standing stone (L884). It is not clear whether the two installations are related. The standing stone is unique and is interpreted as a possible altar or a specialized utilitarian surface that was part of the metal working in this area. A unique pottery fragment from a fenestrated stand found in Layer F2a has similar characteristics to the pottery from the seventh-century BCE Edomite shrine of 'Ain Hazeva (Figure 2.56). This may also indicate some kind of cultic activity associated with the Area F workshop. A similar fenestrated stand was found in Area A (Chapter 5, this volume).[26]

In Room 1 of the main structure, a similar fire installation (L820) with an ash layer was unearthed. The installation (Figure 2.54S) was found in association with fragments of bellow pipes and ceramics. A small depression covered with a white sandstone fill was found mixed with the ash layer. After further cleaning, a large basin (L856) was unearthed. The basin, made from white sandstone, contained evidence of burning on the western section where it was breaking down.

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Figure 2.58 Traces of compact mud found above bedrock by walls of Cells 6, 7, and 8 under meter stick. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

The primary evidence for Layer F2b, the main occupation on phase of the structure, comes from the two main rooms that make up the interior of the structure. It is in these two areas that the best evidence for a surface was found (L900) (Figure 2.57S). In Room 1, layers of paving stones with patches of compact clay were found throughout the room's floor surface. Beneath the paving and fill, bedrock was reached. Excavations yielded similar results in Room 2, especially around the basin and Cell 7 (Figure 2.46). Traces of compact clay mixed with fill were uncovered (Figure 2.57). Due to the slope of the bedrock that makes up the foundation of the structure, fill was required to level the surface for the Area F building. The second distinct evidence that separates Layer F2b from F2a is found in Cells 6, 7, and 8 (Figure 2.58). Although the fill making found in these cells was very similar to that found in Cells 3, 4, and 5, the construction of these cells corresponds the initial construction phase of the main walls of the structure.[27]

Layer F2

Layer F2 was assigned to the slag mound (Figure 2.60) situated to the south of the main Area F structure. This layer represents smelting activity within the fortress compound. The crushed slag was deposited in antiquity against the southern wall of the Area F building complex. Traces of slag were also located underneath the south wall, indicating that construction in this area of the structure postdates the smelting activity. A probe was initiated in this section of the structure, and bedrock was reached around 45 cm below the slag layer.

Layer F3

Layer F3 was assigned to the fortress wall (Figure 2.59S). Following the removal of the wall collapse, the fill and wall collapse, and the ash layers associated with the fortress wall, the shale bedrock was reached both in the north and south sections of the wall.

Area F—Radiocarbon Dating

A total of 122 loci (Appendix 2.F.1) were assigned to the six layers in Area F (F1a, F1b, F2a, F2b, F2, and F3). Loci in Layer F1a represent the mound of wall collapse. The loci assigned to Layer F1b consist of the fill and wall collapse around the fortress area. Loci-associated production and activity areas have been assigned to Layer 2a. This includes the ash layers and basins associated with copper melting. Layer F2b is associated with the main occupation phase of the multicelled building in Area F. These include the two main rooms and the walls of the main structure. Layer 2 has been assigned to the mound of crushed slag that is found against the structure. Finally, Layer 3 is represented by the fortress wall. A total of five radiocarbon dates were processed for Area F. Like all the other

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Figure 2.60 A mound of slag butts against and beneath the south wall of the structure.
Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory

Table 2.5 Radiocarbon dates from 2006 excavations at Area F, Khirbat en-Nahas.

Lab Number	EDM	Season	Locus	Sample Material	Species	Layer	Stratum	Date BP	Cal Date BCE (68.2 and 95.4 percent probability)	Bibliography
OxA-18987	20423	2006	819	Charcoal	Indeterminate	F1a	I–II	2710 ± 26	895–824 906–811	This volume
OxA-18988	20501	2006	819	Charcoal	Indeterminate	F1a	I–II	2765 ± 26	970–846 979–835	This volume
OxA-18989	20590	2006	895	Charcoal	Indeterminate	F2a	III	2782 ± 25	976–899 1004–846	This volume
OxA-18990	20780	2006	900	Charcoal	Indeterminate	F2b	IV	2831 ± 26	1014–932 1071–907	This volume
OxA-19061	20540	2006	860	Charcoal	*Phoenix dactylifera*	F2a	III	2728 ± 28	899–837 923–814	This volume

excavation areas at KEN, there are no radiocarbon dates that are later than the ninth century BCE (Table 2.5). Unfortunately, the shallow nature of the deposits in Area F adversely affected the preservation of organic remains suitable for dating. Thus, some fill deposits had to be sampled for dating. Two determinations were made on the outside rings of charcoal from the Layer F1a collapse and date to 906 to 811 BCE and 979 to 835 BCE (at 95.4 percent probability), respectively. We used a Bayesian model to assess more reliably dating the phases in this area (Figure 2.61a). There were no measurable outliers in the data set. The modeling showed that the Layer F1a collapse occurred between the start boundary for F1a, which ranges between 913 and 869 BCE (68.2 percent probability), and the end boundary for F1a, which ranges from 896 to 830 BC (68.2 percent probability), corresponding to the end of the tenth and mid-ninth centuries BCE. The modeling results indicate the second use phase of the structure (i.e., Layer F2a) occurred shortly before the abandonment and collapse of the building's superstructure in Layer F1a. The start boundary for F2a corresponds to 951 to 901 BCE (at 68.2 percent probability). Only one sample was secured from the main occupation in Layer F2b. The modeling

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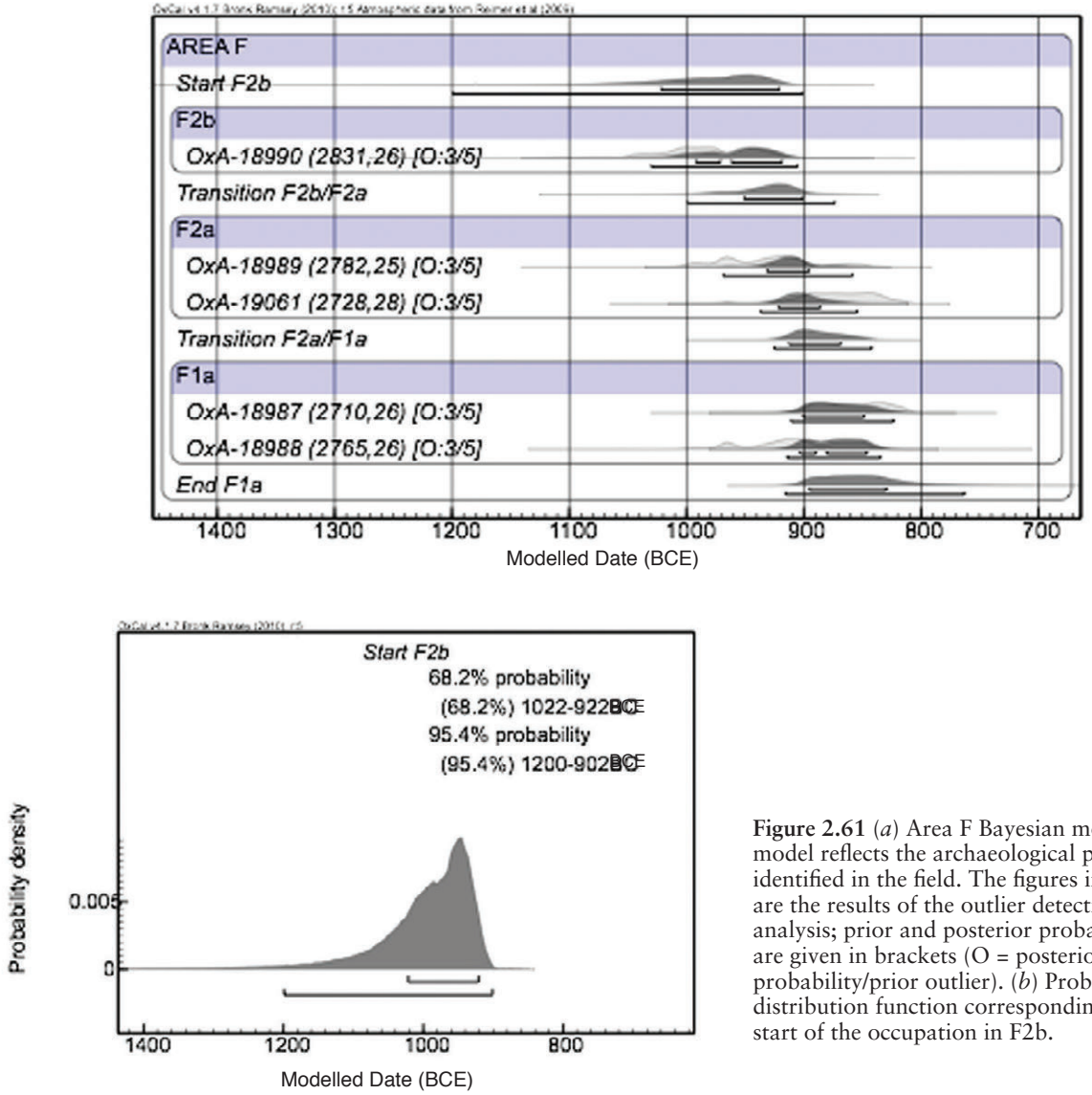

Figure 2.61 (*a*) Area F Bayesian model. The model reflects the archaeological phases identified in the field. The figures in brackets are the results of the outlier detection analysis; prior and posterior probabilities are given in brackets (O = posterior outlier probability/prior outlier). (*b*) Probability distribution function corresponding to the start of the occupation in F2b.

suggests that the start of this phase began between 1022 and 922 BCE at 68.2 percent probability (Figure 2.61b), but due to the limited data, precise dating is difficult. On the present evidence, one can only say with confidence that the occupation is within the tenth century BCE.

Summary—Area F

The excavations at Area F provided an opportunity to excavate one of the many structures visible in the interior of the fortress compound and sample a section of the fortification wall. The Area F building was situated at an unusual angle in relation to the main fortress wall, suggesting that the two were not built at the same time. The fills inside the building were shallow and consisted mostly of wind-blown sediments. The lower layers consisted of fill mixed with patches of compact clay that accumulated around the numerous installations in a rectilinear building. Inside the structure, a single-occupation phase was identified (F2b). The structure was built with two main rooms associated in the east with seven installations or cells mostly connected to copper production. The presence of a slag layer below the foundations of this building indicates that prior to the construction of the Area F building, copper production took place inside the fortress compound in this area.

The cells accumulated a fill mixed with crushed red shale that resembles the bedrock beneath the main structure, the adjacent slag mound, and the fortress wall. The

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shale chips may have been included in building materials used in the wall superstructure of the building in Area F. Three of the cells (3, 4, 5) indicate a distinct construction style different from the neighboring cells (6, 7, and 8). The walls of the latter are well defined and better designed. The walls of the former cells are smaller and less distinct. The function of the cells is not clear. However, given the furnace base found in Cell 3, it is possible that this part of the structure once did serve as an industrial area, and some of the cells were used as storage facilities. The well-constructed cells near Room 2 did not provide evidence of their use. The semi-circular wall built between Room 2 and the cells is also an anomaly (Figure 2.46 Area F map). It is possible this part of the room had been used as a cultic or ritual area. The evidence comes from the basins, the square installation, and the standing stone on the northern exterior of the building that could have served as an altar. At a later time, the basins appear to have been moved to the current location as they were not leveled on the floor but were resting at an angle on the floor. It was during this time the basins were used for industrial purposes. The evidence comes from the many copper objects, tuyère, and bellows pipes found in association here. Complete and partial bellows pipes were the most common artifacts recovered at this structure. Very few furnace fragments were identified at Area F. Given these types of artifacts and the use of the basins in association with Cell 9 and in Room 1, the most plausible hypothesis is that the room was used not for smelting but for melting or recycling copper. This is most evident by a medium-size artifact that was located in Room 2 (Figure 2.60). The metal object (EDM 20285) contains pieces of copper and pins. This piece of metal came from the fill (L819) in Room 2 along with many well-preserved partial bellows pipes. This area also yielded copper metal, copper objects, hammer stones, prills, reconstructable pottery, worked stones, and a scaraboid.[28]

Area M: Deep Sounding of a "Slag Mound," a Building Complex, and Stratigraphic Key for KEN

Excavations in Area M represent the first careful stratigraphic excavation of an Iron Age slag mound in Jordan coupled with a large suite of high-precision radiocarbon dates. Area M consists of a deep sounding into one of Khirbat en-Nahas's typical "slag mounds" and a wide exposure of an adjacent building complex in the southeast of the site (Figures 2.4a, 2.4b). The "slag mound" was first excavated to a depth of about 1 m in 2002 (supervised by E. Monroe) and probed all the way to virgin soil in 2006 (supervised by M. Beherec and E. Ben-Yosef). The main goal of the deep sounding was to examine Iron Age copper production through time by exposing artifacts from different diachronic contexts. Other goals were to clarify the chronological framework for Khirbat en-Nahas in general by exposing and dating fine sequences of culturally and ^{14}C-rich deposits from the surface to the deepest layers. A corner of a room was exposed underneath the slag mound already during the 2002 field season; in 2006, it was found to be part of a large building complex described below (see Appendix 2.M.1–8 for Harris matrix and other supplementary data for Area M).

The 2002 Probe of the "Slag Mound" in Area M

The results of the 2002 excavations at Area M complement the data from the deep sounding of the 2006 field season. They are particularly interesting because they represent the latest phase of copper production at Khirbat en-Nahas and correspond to the most advanced Iron Age technological achievements (Ben-Yosef 2010: Chapters 8-10, Chapter 13, this volume). The original probe was a 2.5 x 5–m rectangle located on the northwestern slope of one of the large slag mounds in the southeastern part of Khirbat en-Nahas (Square GGG27 in the general grid of the site). An extension of 0.5 m to the east (Square HHH27) was added during the excavation to fully expose a furnace feature. The original surface of the "mound" was covered with large slabs of tap slag and fragments of tuyères, indicating extensive smelting activity in this area (or adjacent to it), corresponding to the last phase of occupation. Although the Deutsches Bergbau-Museum team had dug limited probes into several such "mounds" (e.g., Hauptmann 2007) at the site (and in other Iron Age smelting sites in Faynan), this is the first time that an attempt to carefully examine the stratigraphy of such a mound has been done using state-of-the-art archaeological field methods.[29]

Slag mounds constitute the primary type of archaeological deposits in the smelting sites of the southern Levant (and elsewhere), and thus investigation of their composition and formation processes is important for understanding the smelting sites in both technological and socioeconomic contexts. In particular, some basic assessments regarding the amount of processed ore and copper produced in the smelting sites are based on estimations of volumes and contents of such slag mounds, usually with the assumption that the main component of the mounds

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is slag material (e.g., Hauptmann 2007). This assumption has been found to be incorrect (see below), and as will be shown here, the detailed investigation of the slag mound in Area M resulted in detailed descriptions of what we consider to be a "typical" slag mound.

At the beginning of the 2002 field season, virtually every single artifact in Area M was recorded separately with the Jabal Hamrat Fidan (JHF) ELRAP digital recording system, resulting in a very slow excavation. Only later in the 2002 excavation season was it decided to collect the bulk of the furnace and tuyère fragments in general baskets. In addition, the southeast corner of the probe was used as a control area for measuring the amount of slag in the area as a whole. Slag was collected from the entire excavated area and then sorted (large furnace slag, small furnace slag, large tap slag, small tap slag, and granule) and weighed. In the 1 x 1–m control area, however, all of the sediments were sieved, and the sieved material was sorted. All of the slag from this control area was kept, including the very small pieces of crushed slag, and was subsequently weighed. This method was used to provide a better understanding of how much slag of all sizes was found in the area overall.

To differentiate distinct horizons of smelting activity, contexts with large tap slag fragments were used as a marker, assuming that each of such concentration represents one smelting cycle. This was more a convenience for separating the layers than a real reconstruction of activity, but it has proved useful. Using this model, we were able to determine six distinct smelting horizons throughout the excavation area as well as a seventh, lower activity layer of slag crushing.

Three preliminary "contexts" were excavated in 2002 at Area M, of which Context Ib represents the metal production debris and consists of seven different horizons.[30] Context Ia consists of two small installations, which are probably intrusive and later than the copper production horizons excavated in 2002. The production horizons, the fill directly underneath them, and the fill and rubble in Room 1[31] represent Context Ib. The occupation layer of Room 1 represents Context IIb. The fill under the surface of Room 1 represents Context III.

Context Ia has two small stone installations visible on the surface in the northwestern part of the excavation unit. These were excavated as part of L506. Note that furnace debris associated with the third horizon of smelting activity and located in between these installations and W519 was also excavated in this locus. One installation was semi-circular with a diameter of around 60 cm. It was made up of six stones with one large flat stone in the middle. The stones and material surrounding the installation appear to have been burnt.[32] It appears from the excavation of the furnace debris to the east of the installations that these were

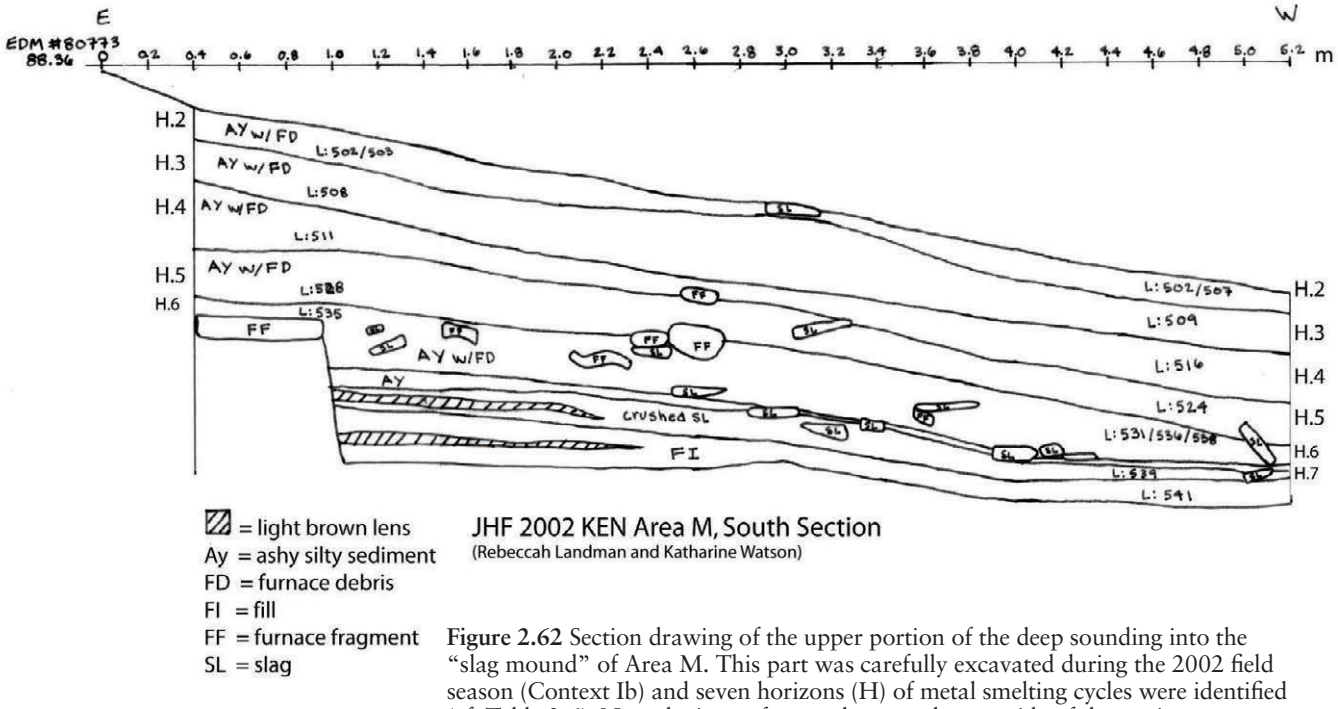

Figure 2.62 Section drawing of the upper portion of the deep sounding into the "slag mound" of Area M. This part was carefully excavated during the 2002 field season (Context Ib) and seven horizons (H) of metal smelting cycles were identified (cf. Table 2.6). Note the intact furnace base on the east side of the section.

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Table 2.6 Area M, 2002 excavations, metallurgical horizons in Context IB (corresponding to Layer M1/M2a of the 2006 excavation season) (cf. Figures 2.62, 2.63).

H.	Description
1	The bottom of the first smelting horizon was defined by the tap slags located on the surface of the excavation area. Evidence from the first smelting horizon was collected in L501 and L513.
2	The second smelting horizon consists of L502, L503, L505, L507, L514, and L515. The bottom of the smelting horizon was determined by large tap slags. Most of the furnace and tuyère fragments found were fragmented and not very well preserved. The southern part of the probe was somewhat ashier and had a higher concentration of metallurgical ceramics. Many of the furnace fragments were charred. Several large fragments were found in situ in the northeastern part of the probe, but these were unfortunately removed before they were properly recorded. These fragments were probably the in situ remains of a furnace that had been broken during the smelting process to extract the copper from inside.
3	The third smelting horizon consists of L504, L506, L508, L509, L510, L517, and L518. The bottom of the smelting layer was determined by large tap slags. As in the second horizon, there was more ash and a higher concentration of metallurgical ceramics in the southern part of the probe. In the fourth horizon, separate loci were opened for the northeastern area and for the southern and western areas to show this differentiation. The northeastern part of the probe was excavated separately (L504) to attempt to discern more of the furnace that was removed in the locus above (L507). This was not possible, but another, better preserved in situ furnace was discovered directly to the south of the first one. This furnace and the furnace debris directly associated with it were excavated as part of L510. The intact part of the furnace was semi-circular in shape and had an interior diameter of around 70 cm. The walls of the furnace were 15 to 20 cm in width and preserved to a height of 20 to 30 cm. The furnace extended into the eastern balk of the probe, and accordingly the probe was extended half a meter east into Square HHH27 (L517). The furnace, however, was not preserved more than a few centimeters into Square HHH27. Inside the furnace was an extremely high concentration of furnace fragments with almost no sediment. Under these was ashy sediment with a very high concentration of charcoal. Some wood was also found and collected (EDM 80337). The bottom of the furnace was not found, probably because it was ripped out after the smelting to extract the copper. Large tap slags were found directly under the furnace.
4	The fourth smelting horizon consists of L511, L512, L516, and L526. The bottom of the smelting horizon was determined by large tap slags. Separate loci were given for the northeastern (L512) and southern and western (L516) areas to distinguish the difference in ash and metallurgical ceramic concentration between the two (the southern and western areas appeared to have somewhat higher concentrations than the northeastern area).
5	The fifth smelting horizon was collected in L522, L524, L526, and L528. The bottom of the smelting layer was determined by large tap slags. The furnace and tuyère fragments in this horizon (and the sixth) were larger, less fragmentary, and better preserved than those from the later horizons above. In the northeastern area (L522), several cut stones were found similar to those used in W519 and W520. It is possible that these are rubble from W520 and represent the destruction of the wall. If this is indeed the case, L521, which is fill and rubble inside Room 1, is probably contemporary with the fifth smelting horizon.
6	The sixth smelting horizon was collected in L523, L529, L530, L531, L535, L536, and L538. The bottom of the smelting horizon was determined by large tap slags. Because of difficulties in following the exact layers due to the slope of the unit and the layers within the unit, the western part of L531 and L536 probably represented the fifth horizon instead of the sixth. Horizon 6 was excavated in the western part as L538, although again due to difficulties determining the slope of the horizons, part of the fifth horizon was excavated within L538.
7	A horizon of fine crushed slag consists of L530, L533, L535, L537, L539, and L540. This horizon had a much lower concentration of metallurgical ceramics. A thin layer of ashy sediment with much looser crushed slag was found directly on top of around a 5- to 10-cm layer of extremely hard-packed crushed slag. The crushing activity is more prominent in the southern area. There is some evidence of crushed slag in the northeastern part of the probe (L533) but none in the northwestern part. Directly under the crushed slag, a significantly greater amount of pottery and bone was found. Also, directly under the crushed slag in the 1 x 1–m control area (L540), a thin lens of decomposed organic material was found. Several large fish vertebrae as well as small pieces of textile (EDM 80711) were collected from this lens.
Fill	A fill horizon that does not seem to be directly related to production activities was found under the seventh production horizon. This fill consists of L532, L541, L542, and L543. The fill was a medium brown silt with some ash although much less than in the production horizons. There was significantly less slag and metallurgical ceramics than in the production horizons and more pottery and bone. Because this fill marked an end to the first levels of production in the excavation area, all excavation in the probe was ceased after excavating only around 10 cm into this horizon.

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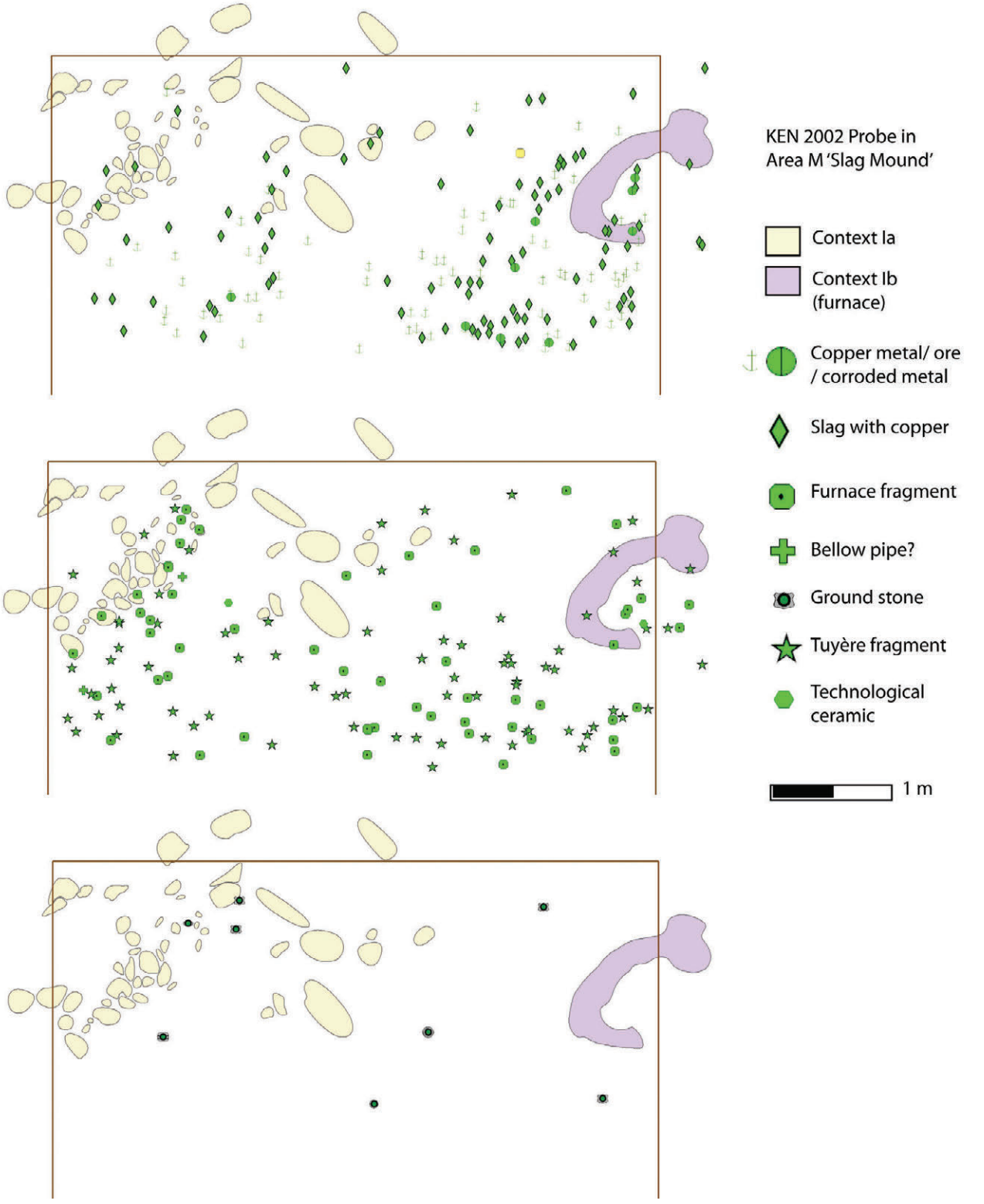

Figure 2.63 GIS map of the 2002 probe into the "slag mound" at KEN Area M. The ephemeral installations of Context Ia and the furnace base of Context Ib are shown together with the distribution of various metal production-related artifacts. Note that not all of these artifacts were collected as separate finds, and thus the maps represents the upper horizons only (see text for detail).

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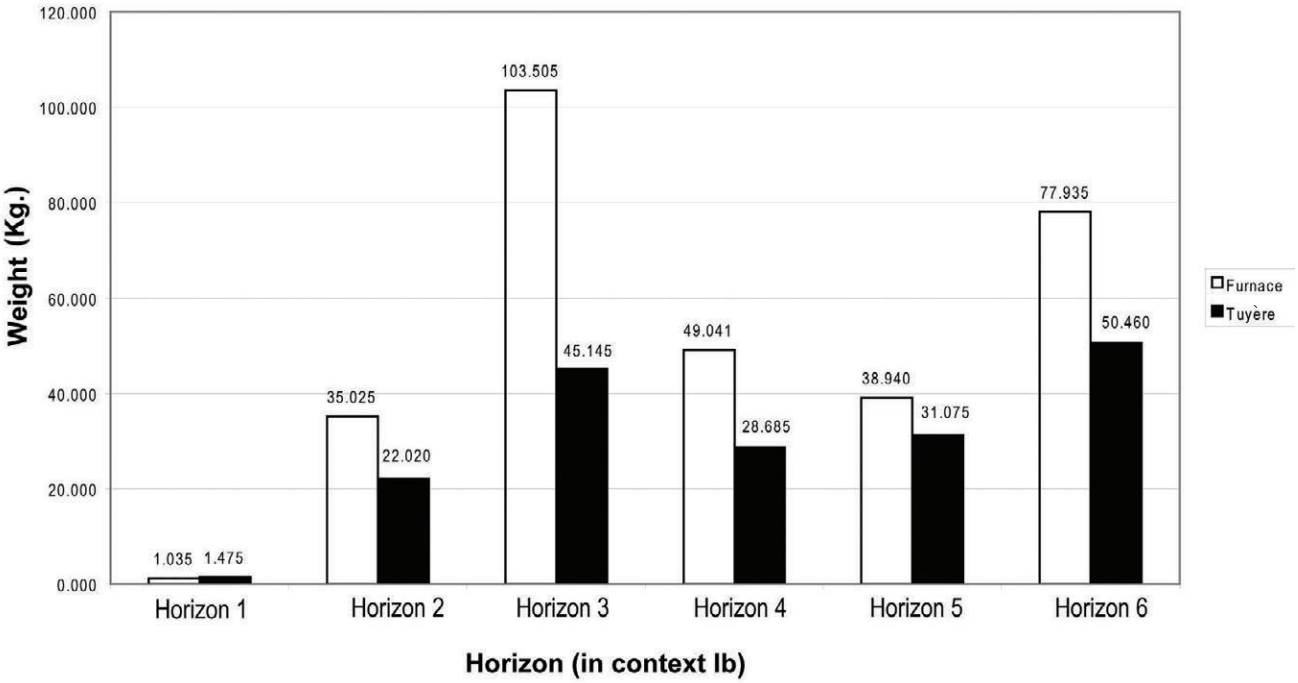

Figure 2.64 Weights of tuyère and furnace fragments by horizon (KEN, Area M, 2002 season); total weight of tuyère fragments = ~179 kg; total weight of furnace fragments = ~305.5 kg (see also Chapter 13, this volume).

later intrusive features, although it is possible that they are associated with one of the horizons of smelting activity (probably the third).

Context Ib has six horizons related to copper smelting and one horizon of crushed slag (Table 2.6, Figure 2.62). The smelting horizons were distinguished by high concentrations of furnace and tuyère fragments, slag, ash, and other artifacts related to copper smelting (Figure 2.63). Weights of tuyère and furnace fragments are summarized in Figure 2.64. As mentioned above, tap slag fragments were used to distinguish the bottom of these horizons. The slag-crushing horizon was a very hard patch of fine crushed slag with low a low concentration of metallurgical ceramics. Below this sequence, a fill horizon was distinguished by a relatively low concentration of slag, ash, and metallurgical ceramics and a higher amount of pottery and bone than in the production layers above.

Context IIb of the 2002 excavations in Area M represents the occupation level of the structure, of which only one small corner was exposed (cf. Layer M2 below; Context II represents the collapse inside the room). Room 1 was defined by walls W519 and W520. It has been concluded that the room predates the production horizons (Context Ib) because of the wall collapse found in the fifth horizon of production and the fact that the occupation layer of the room is around 1 m lower than the last production horizon excavated.

W519 runs from northwest to southeast and meets with W520 at its southern end to form the southern corner of Room 1. It is preserved in this location up to 8 courses (ca. 1.05 m in height) on its outer side and to up to 12 courses (ca. 2 m in height) on its inner side. It is around 1.90 m in length and approximately 39 cm thick. The wall is primarily made of well-cut stones that range from around 16 x 11 cm to 46 x 19 cm. A grinding slab (EDM 80649) was found on the wall at its northern end. This was probably not part of the original wall but was placed there later after the wall ceased to support the building. W520 is preserved up to 6 courses (ca. 0.95 m in height) on its outer side and up to 11 courses (ca. 1.85 m in height) on its inner side. It is around 2.06 m in length and approximately 37 cm thick. Like W519, it is primarily made of well-cut stones. The size of the stones ranges from around 14.5 x 10 cm to 57 x 16.5 cm. There is also one very large stone measuring around 84 x 30.5 cm.

The exterior of both walls of Room 1 appear to have been burnt as evidence for smelting extends right up to them and the stones demonstrate heat impact. Under

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the production horizons outside the room, reddish silt was found adjacent to both walls. This was excavated as L532 next to W520. There were almost no finds in this locus, and after around 10 cm of excavation, it became very hard and densely packed. It was thought that it could be a surface, but it only extends from the wall 15 to 20 cm. Another possibility is that it is part of a mud brick installation or a mud brick superstructure along the walls. A sample of it from west of W519 was collected to be analyzed (EDM 80744).[33]

The results of the 1 x 1–m "control area" for precise measurement of slag (weights by basic types) are summarized in Table 2.7. The excavated volume is approximately 1 m^3 (the depth of the probe in the southeastern part is approximately 1 m). This volume contained 1,152 kg of slag material. Given an average density of 3,000 kg/m^3 for slag material (more or less similar to solid basalt), out of the excavated volume (which consisted mostly of smelting debris, without "fills" of domestic quality such as the one exposed beneath the lower horizon), only around 38 percent was slag (vol.-%). This calculation of slag concentration (volume) results in even lower values when the entire sounding is evaluated (see below).

The approximately 1-m probe of 2002 provides well-recorded data of the latest smelting phase at KEN (Figure 2.65). Artifacts obtained directly from the walls of the pit (the exposed sections) were analyzed as part of the current research and demonstrate an advanced technology that belongs to the latest smelting activities (Chapters 13, this volume). Radiocarbon samples from L502/503, L511, and L539 (2746 ± 35 BP) (obtained from the walls of the pit) were processed in the Oxford Laboratory and indicate a ninth-century BCE date for the 2002 excavation contexts (2764 ± 25 BP, 2659 ± 32 BP, and 2746 ± 35 BP, respectively); these dates were incorporated into the general age model of Area M (see below).

The 2006 Excavations of Area M

The deep sounding of the slag mound and the excavations of Structure 1 and parts of the adjacent Structure 2 resulted in the identification of five major layers, replacing the 2002 "micro"-stratigraphic division of the 2002 excavation[34] (Table 2.8, Figure 2.66).

The results of the 2002 excavations demonstrate that the final metallurgical horizons of the upper portion of the slag mound represent activities that are later than Room 1 of Structure 1. It is not entirely clear whether the other rooms of Structure 1 were still in use simultaneously to the last phases of copper production in the area of the slag mound; however, a blocking of the doorway to Room 1 suggests that it went out of use while the rest of the building was still occupied. Being adjacent to the smelting area, Room 1 suffered the most from heat damage, and its walls

Table 2.7 Weights of slag fragments (in kg) per locus in the 1-m^3 "control area" of the 2002 probe in the "slag mound" of Area M; note that type definitions is slightly different from the 2006 field season and include "crushed" (patches of compact and hard fine-crushed slag), "granule" (separate grains of fine-crushed slag), furnace slag, and tap slag in two different sizes.

Locus	Crushed	Granule	Furnace Slag	Tap Slag	Tap Slag	Total
503		31.85	358.43	14.65	8.42	413.35
508		26.15	30.6	50.74	12.31	120.8
511		58.79	54.49	58.59	23.96	195.83
528		32.67	23	32.35	28.85	116.87
535		8.64	35.41	42.1	11.7	97.85
540	4.73	32.62	24.53	15.63	1.78	79.29
543		41.44	33.15	49.26	5.2	129.05
Total	4.73	232.16	559.61	263.32	92.22	1,152.04

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Figure 2.65 Area M at the beginning of ELRAP's 2006 excavation season. The "metallurgical horizons" of the upper part of the "slag mound" were excavated in 2002 and represent the latest phase of copper smelting at KEN. The uppermost horizons are probably later than the building (see text). The reddish sediment adjacent to the wall is L708, possibly decomposed mud brick, and was probably placed here to protect the building from the impact of the adjacent smelting activities to the south. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

Table 2.8 Major stratigraphic units at KEN Area M.

2006 Layer	2002 Context	Description
M1a1	Ia	Surface slag, surface installations
M1a	Ib	Post building abandonment, Aeolian sediment accumulation, some metal production
M1b	Ib/IIa	Post building abandonment, wall collapse and Aeolian sediment accumulation, metal production
M2a	IIb	Last occupation phases of structures, use of plastered outside work area, metal production
M2b	IIb	"Slag mound" leveled and Structures 1 and 2 constructed
M3	III	Remains of intensive metal production beneath structures
M4		Intensive metal production, installation construction, followed by possible abandonment horizon
M5a		Decommissioning of earliest installation (L676), construction of new installation (L673)
M5b		Earliest site occupation, founded on virgin soil. Installation construction (thin horizon of crushed slag)

See Appendix 2.M.1 and 2.M.2 for locus lists.

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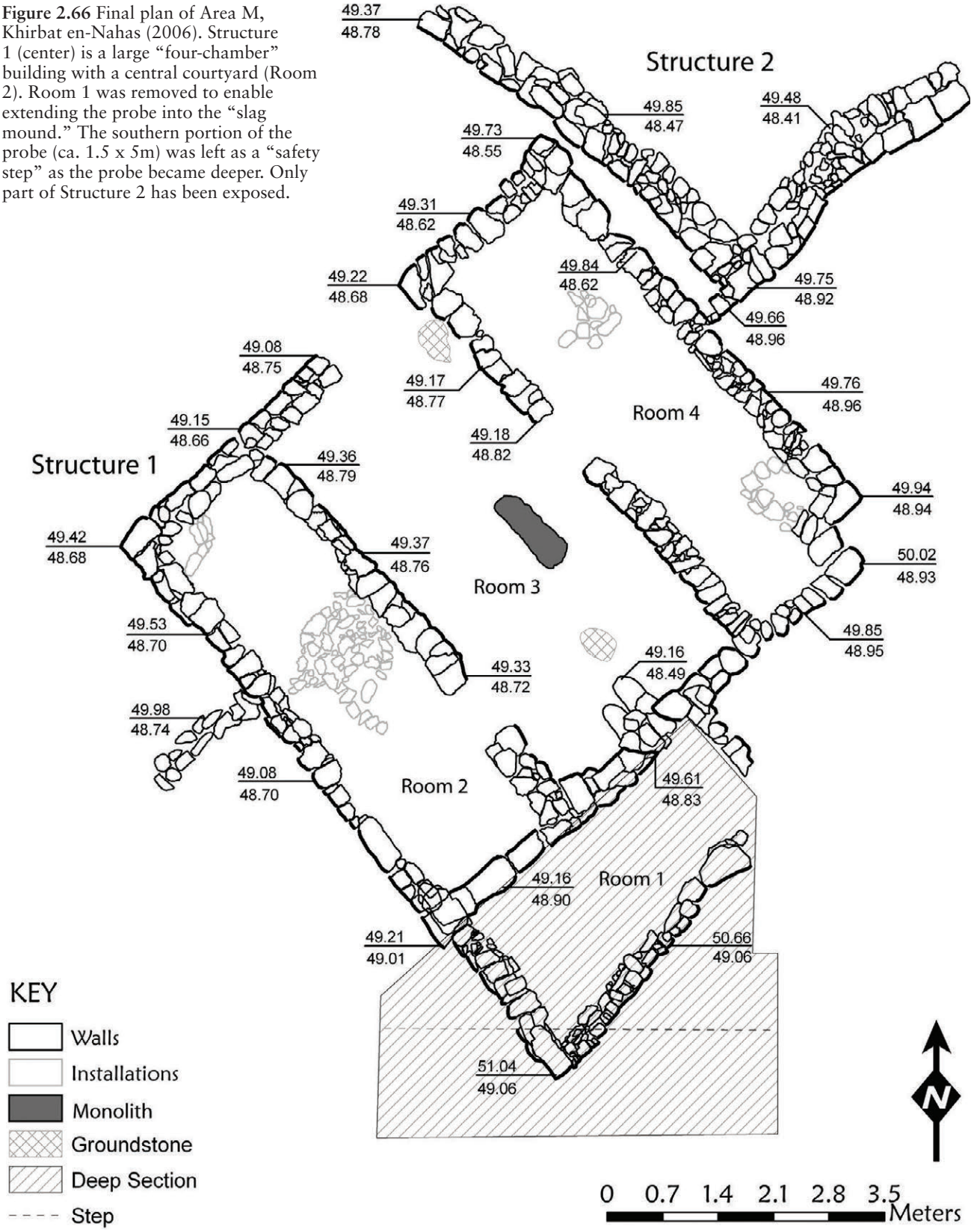

Figure 2.66 Final plan of Area M, Khirbat en-Nahas (2006). Structure 1 (center) is a large "four-chamber" building with a central courtyard (Room 2). Room 1 was removed to enable extending the probe into the "slag mound." The southern portion of the probe (ca. 1.5 x 5m) was left as a "safety step" as the probe became deeper. Only part of Structure 2 has been exposed.

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caved in under the pressure of the accumulated production debris against its northeastern and southeastern walls. The uncovered walls had a steep inclination of more than 15 degrees inward, possibly representing their original dilapidated state while metal production still took place outside of the room and the rest of the building was still occupied. The room was blocked and seems to have become a designated space for dumping copper production waste.

The copper production remains that postdate Room 1 are part of Layer M1. Layer M1a1 is an ephemeral context of surface finds, relating to the very end of metal production in Area M. Huge slabs of tap slag littered the surface of the "mound," and a fine dust of slag granules also sat atop the Aeolian yellow-brown sandy silt and loess. These slabs cover the surface of the entire site and seem to represent a product of the latest production episode during which no further processing of the tap slag was required because of the high efficiency of smelting (Ben-Yosef 2010:Chapters 8-10, Chapter 13, this volume). The snout of an equine figurine (EDM 91279) was found on the surface just outside of Area M and belongs to Layer M1a1.

Layers M1a and M1b correspond to the metallurgical horizons excavated in the slag mound in 2002 (cf. Table 2.8). In the area of Room 1, Layer M1a consists of sediments accumulated after abandonment and some remnants of metal production. The loci of this layer (L603, L604, L609, L644, L645, L649, L663, L672, L681, L687, L694, L695, L701, L718, and L724) consist mostly of Aeolian sandy silt. Layer M1a was excavated in arbitrary loci due to the lack of distinguishing characteristics. Layer M1b consists of wall collapse mixed with Aeolian sandy silt inside Structures 1 and 2, often with tap slag mixed in (L607, L613, L614, L623, L626, L633, L645, L648, L649, L664, L679, L682, L683, L688, L693, L698, L699, L705, L706, L723, L724, and L725). This layer probably also represents a long period of abandonment and was found in all rooms of both structures.[35]

In Layer M2, intense metallurgical activity resulted in the accumulation of large quantities of broken slag and furnace fragments around the structures. It is difficult to establish the stratigraphy of these deposits and to precisely correlate them with the activity remains inside the structures. In general, the metallurgical horizons were excavated in arbitrary units, and with less care to minute details as was done in the 2002 excavations (see above). Without this approach, the 2006 team would never have reached virgin soil during the approximate 2-month excavation project. Two distinct metallurgical areas of Layer M2 were excavated. One, L707 (Layer M2a), lay above the floor of Layer M2b working area L717. The other is directly south of the structure, in the core of the slag mound.[36]

Near both the northeastern and southeastern walls of Room 1, the closest walls to the metallurgical activity area, there seems to have been an attempt to protect the building from the impact of the smelting process. A thick deposit (L708) of buff or reddish sediment, relatively free of artifacts, was excavated directly next to the exterior of these walls. This seems to have been an insulation of sorts, perhaps originally mud bricks, and is not found along the other sides of the building (that are not oriented toward the metallurgical area or along the interior of the walls), where metallurgy was not practiced or was practiced to a much lesser degree (Figure 2.65). Eventually, the walls did suffer extreme damage from heat. Both wall L618 and L632 were badly impacted, including cracking and discoloration of the stones.[37]

Four similar installations were uncovered in the metallurgical deposits of Layers M2 (L616 and L643) and M3 (L651 and L678). They probably represent delineations of metal working spaces with lines of uncut (or roughly cut) stones, usually circular or semi-circular in shape (although all were exposed only to a limited degree because of the limits of the probe). L616 (probably Layer M2a) consists of a line of four exposed boulders, each about 20 to 30 cm in diameter. The line abutted wall L632 at a slight angle and on the other side continued into the section (thus we were unable to determine its entire length) (Figure 2.67S). There were no specific finds related to these installations, and the precise function of them could not be determined.

A similar installation to L616 was found in L643 (Figure 2.68S). It is located about half a meter below L616 and is probably part of Layer M2b. The stones of this installation were placed together more tightly than in L616, but the placement next to wall L632 was almost identical. L640 and L641 were excavated on either side of this feature, but also here no discernable difference in their deposits was detected.

In the structure complex of Area M (Figure 2.66), Layer M2a represents a second phase of occupation and Layer M2b represents the original construction and occupation of the complex, including major preparation works of leveling up the rugged surface of slag mounds and production debris.

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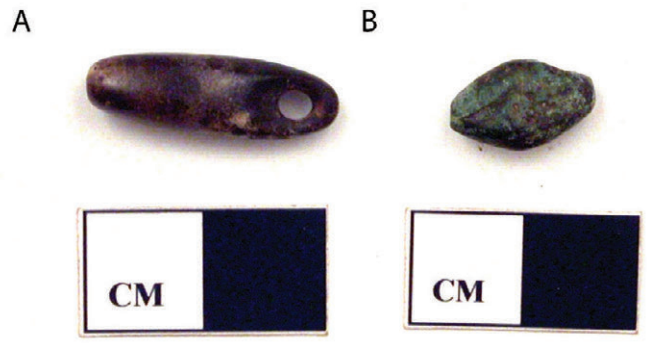

Figure 2.69 The (*a*) bead (EDM 12108) and (*b*) bead blank (EDM 12109) found in L700 at Area M. *Photo: UC San Diego Levantine Archaeology Laboratory.*

Between the two structures, there is a very narrow space (Figure 2.66) that probably was not easily accessible when the area was occupied. The excavations of this space, L700, uncovered a large concentration of artifacts mixed with some Aeolian dust (Layers M2a/M2b), including numerous pottery sherds and a few ground stones. Also found in L700 were a diamond-shaped green bead blank (EDM 12109) and a brown and black pendant-like bead (EDM 12108) (Figure 2.69).

Layer M2b is situated on top of a massive accumulation of copper production debris that was leveled up for the construction of the structures. This disruption of the local landscape is clearly visible in the walls of the pit in the slag mound (see section drawings below, especially Figure 2.85), where it is represented by horizontal thin deposits of aeolian dust and silty sediments. These deposits accumulated on a distinct surface corresponding to the first occupation phase of the structures, most probably an open space behind Room 1. On top of the leveled surface where two buildings were erected, Structure 1, a building with three rooms surrounding a central courtyard, was almost entirely excavated in 2006 (Room 1 was partially excavated in 2002; the northeastern part of this room was not exposed and is mostly covered by heavy metallurgical debris of the slag mound; see Figure 2.66). Structure 1 and its finds represent mostly domestic activities, although a high concentration of ground stone suggests some processing of slag or ore, perhaps in the courtyard.[38] Structure 1 consists of a courtyard (Room 3) with rooms opening to the south (Room 1), west (Room 2), and east (Room 4) (Figure 2.66, Appendix 2.M.3). As mentioned above, Room 1 has to be removed to allow for the excavation of the deposits beneath it (Figures 2.70a,b, 2.71).

The central room of Structure 1 is probably an open courtyard, Room 3 (L711). Room 3 was a communal space in the structure. It was the only one connected to the outside (through a 1.3-m doorway in the northeast) and the area connecting all of the other rooms (Figure 2.66). A large red granite monolith (L703), measuring 0.25 x 0.40 x 1.15 m, was found in the south center of the room. This is most likely a column that supported a roof of perishable material.

The floor level of Layer M3b in Room 3 (L756, L754, and L631; only the northern half of the room was excavated to this level) yielded a few interesting artifacts: a large pot base (EDM 91906) next to a round pestle (a dual-faced dimpled hammer stone, EDM 90452) and a round mortar (EDM 90451). Less than a meter away was a large grinding slab, perhaps a sharpener (EDM 91885) (Figure 2.72S). A figurine pendant was found at this level near these objects (Figure 2.73, EDM 90464).

To the south of Room 3 (the courtyard), Room 1 (Figures 2.71, 2.74) was apparently entered through a doorway later blocked by an installation of Layer M2a (L634, Figure 2.72). It was difficult to delineate the original outline of the doorway; however, it appears to be relatively narrow (Figure 2.66). The blocking of the access to Room 1 indicates that the room went out of use during the second phase of occupation in Structure 1, most probably as a result of the damage caused by the heat of the smelting activities and the accumulation of heavy slag layer against its walls (L632 and L618).[39]

Room 1 has a beaten earth floor in Layer M2b (L635 and L657). The floor of this room was hard packed, and buried within it was discovered a white spindle whorl (EDM 90881). Many date seeds were also collected here. There were no installations, and there is little other evidence as to the function of this room. The floor of this room was founded upon the leveled-off slag of Layer M3 and may have been a residential area.

To the east of courtyard Room 3 lies Room 2 (L712), accessed through a 0.80-m-wide doorway in the southwest wall of Room 3 (Figure 2.66). The south wall of this room (L637) measured 1.75 m in length and continued to form the south walls of Rooms 3 and 4. Its north wall (L690) measured 1.55 m. The interior of its west wall (L661) measured 4.3 m in length and continued to the southeast to form the southwest wall of Room 1. The walls and doorway of its east side (L668 and L669) measured a total of 5.8 m in length. Two

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Figure 2.70 (*a*) Aerial photo of Area M at the end of excavations. *Photo: UC San Diego Levantine Archaeology Laboratory.*

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Figure 2.70 (*b*) The three remaining rooms of Structure 1 after the 2006 excavation (view toward south). From the right (west), Room 2, Room 3, and Room 4. The place once occupied by Room 1 is now part of the deep sounding. The southwest wall of Structure 2 is in the far left of the photo.



Figure 2.71 Area M, Structure 1, Room 1 before its removal. Also visible are parts of Rooms 2 and 3 (the north arrow lies on the upper floor level of the courtyard, Room 3). The southern corner of Room 1 was excavated in 2002 (then as "Room 5") down to the levels below the floors (Context III, the triangle shallow pit visible in the photo above). *Photo: UC San Diego Levantine Archaeology Laboratory.*

patches of flat cobbles were uncovered, one around the center of the room (L748) and one at the room's northern edge (L747); these are likely the remains of pavements. The northern installation had a particularly large flat stone abutting the wall.

To the west of Room 3 is Room 4 (L710), which is accessed through an approximately 0.90-m-wide doorway (Figure 2.66). Its northern wall (L692) measures 1.85 m long in the interior. Its southern wall (L637 and L714) has a bend in it, likely associated with the unexcavated space to the south. The total length of the room's southern side is 1.70 m, but there is a 0.50-m-long intrusion in the eastern corner of a 0.35-m-thick wall at a right angle to the main wall (L714; see Figure 2.66).[40]

The layout of Structure 1 recalls the "four-rooms" houses common in the Iron Age southern Levant and usually attributed to the Israelites (e.g., Herzog 1992; Mazar 1990).[41] However, it is now clear that the link between architecture and ethnicity is more complex, and similar architectural styles may have been used by

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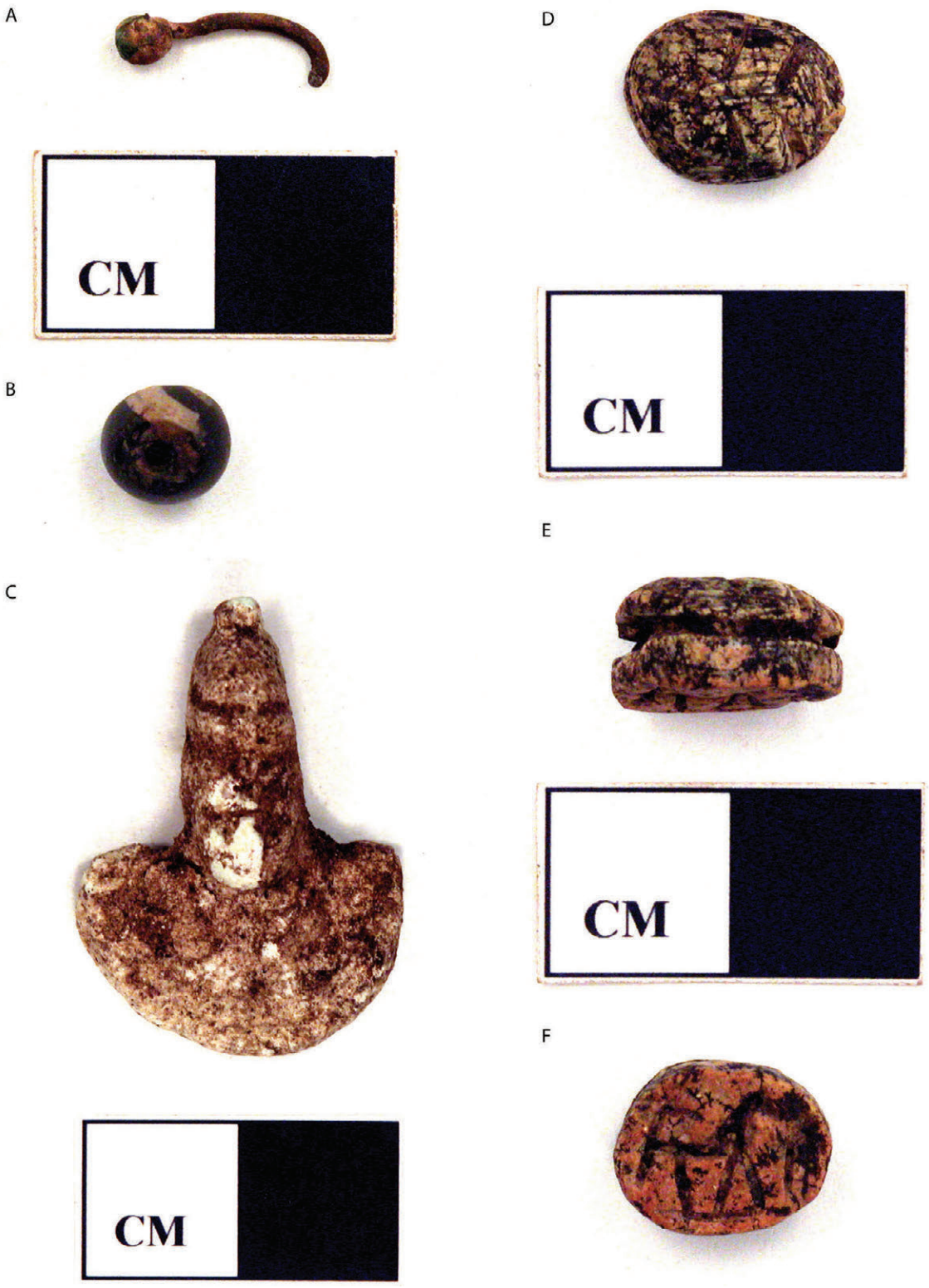

Figure 2.73 Some small artifacts associated with Structures 1 and 2 at KEN Area M discussed in the text. (*a*) A copper earring found on the surface and probably originally from L717 (EDM 91774); (*b*) a swirled glass bead from Room 4, L733 (EDM 91706); (*c*) Egyptian aegis amulet (Structure 1, Room 3, L635, EDM 90464) (Levy, Higham, et al. 2008); and (*d–f*) a scarab seal (EDM 91464; Levy, Higham, et al. 2008), found in metallurgical deposits (L707). Note: See Chapter 11 (this volume) for a study of the amulets. *Photos: UC San Diego Levantine Archaeology Laboratory.*

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Figure 2.74 Room 1 before its removal, facing north. Arrow indicates location of a pot in partially excavated Room 3 (Layer M2b). *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

other ethnic groups (e.g., see discussion in Faust 2006). It seems that Structure 1 was well planned (although not entirely symmetric) and that the walls were constructed with substantial efforts. The stones used in the walls are often very large, sometimes requiring two people to lift. They are usually roughly cut and made of the locally available assortment of rocks, especially the flat blocks of dolomite (from the Burj formation). The latter usually breaks easily along cleavage planes and is found in a crumbly state.

Although only partially excavated, Structure 2 is a much larger and more substantially built complex to the north of Structure 1 (Figure 2.66). It was also founded on metallurgical deposits but at a slightly lower elevation than Structure 1, being further north of the majority of the slag accumulation of Layer M3. Two walls (of two rows of stones, 0.6–0.65 m thick) were partially excavated here, one running northwest to southeast (L696), of which 4.80 m were exposed (1.80 m high, up to eight courses), and an intersecting wall running southwest to northeast (L715), of which 3.80 m were exposed (1.5 m high, up to eight courses). The structure has the same orientation as Structure 1 (part of wall L696 is parallel to wall L684). The finds from the excavated portion inside the structure suggest an industrial function; it is also possible that the walls delineated an extensive working space rather than a roofed building (similar to the perimeter walls in Area R).[42]

East of Structures 1 and 2 is a partially excavated courtyard with a plastered floor (Figure 2.75). A small wall (0.50 m long, 0.25 m wide, and 0.75 m high, one row of five courses) covered with thick plaster was constructed joining walls L715 and L684. Together with wall L761 (1.10 m long, 0.45 m wide, and 1.50 m high, one row of up to six courses), these walls formed the boundaries of the courtyard, while to the east, the excavation was bounded by the arbitrary exaction square. In the south of the unit, running parallel to wall L684, a well-laid pavement (L749) was uncovered with a well-preserved portion of the plaster floor (L745) next to it. Further north, chunks of plaster and large stones were uncovered surrounding a reconstructable vessel with a trefoil spout (EDM 91833). Plaster also adhered to the vessel, and it seems that a plaster and stone construction held this vessel in place on the plaster floor. Many metalworking items, including tuyère and furnace fragments and hammer and ground stones, were found here. In this courtyard, some unique artifacts were found: a bead (EDM 91762) and a small metal object, probably an earring (EDM 91774, located near the excavation area; probably fell while carrying dirt to the dumping zone) (Figure 2.73).

Layer M2a represents the last occupation phase of Structures 1 and 2 and contemporary copper production activities in the south of Area M. The beaten-earth floors and several installations inside Structure 1 belong to this context, as does a wall added to the structure in

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Figure 2.75 The eastern courtyard in Area M. Note the broken pot (EDM 91833) and the pavement (L649). *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

the west. No clear floor was uncovered inside Structure 2, but a layer of Aeolian sand above a slag layer is believed to be the work area associated with Layer M2a in that building.

Room 3, the courtyard of Structure 1, had a complicated stratigraphy. Layer M2a was excavated in several loci (L741, L742, L743, L752, and L631). This floor was recognized by a thick amount of plaster with some embedded rocks located on the western side. The granite monolith lay on this surface, as well as a well-preserved hearth (L753) and an anvil (EDM 91886).[43]

Room 1, the southern chamber, was probably not occupied in Layer M2a and used for a designated space for dumping metallurgical waste. Installation L634, which blocks the doorway to Room 1, was likely constructed at the very beginning of Layer M2a. This consists of two large stones placed on their sides with smaller stones lying atop them.

Layer M2a in Room 2 contains an installation of unknown purpose and the remnants of a storage installation. Some large ground stones were found in the fill above the floor (Layer M2a, L633), and it is likely that they were once associated with the occupation phase of this layer. The floor was hard-packed earth and excavated in three loci (L716, L719, and L735).[44]

Layer M2a in Room 4 is represented by a floor of beaten earth (L726, L727, L731, L733, and L734) lying over the slag and pavement remains of Layer M2b. A black-and-gray swirled bead was uncovered within this floor (Figure 2.73; EDM 91706). A small plastered basin in the south center of the room, L739, probably belongs to Layer M2a. This basin measured 46 x 63 cm and dipped gently to a depth of 5 cm. Some charcoal was embedded in the plaster, including a date seed that was collected from its edge.

As noted above, no floor was discovered in Structure 2 during excavation or in the section, but fine Aeolian dust with only small amounts of wall debris covering what is believed to have been the work surface was uncovered. These loci (L728 and L732) were sieved through a 1/8-inch screen and were notable for their overall lack of artifacts. A single bead, a white stone disk (EDM 91647), was uncovered in L723 just at the start of Layer M2a.

Layer M2a is represented in the eastern courtyard by a fill with remains of metal production debris. Much pottery and many ground stones were discovered in the metallurgical deposits, suggesting that this area had become a midden. Some decorative items were also uncovered here. A scarab seal with an apparent incised horse (Figure 2.73; Chapter 11, this volume) was found in L707 (EDM 91464), as were two beads, both small greenish white stone disks (EDM 91500 and 91475). In the upper part of L708, another two greenish white stone disk beads (EDM 12114 and 91459) and one worked shell bead (EDM 91460) were found.

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To the west of Structure 1, a poorly constructed wall (L662) was added in Layer M2a, perpendicular to wall L661. Only 1.70 m of its length was uncovered. It was 0.35 m wide and excavated to 0.40 m of its height in three courses two stones thick.

Layer M3 is located beneath Structure 1 (Room 1) and to the south of it in the slag mound probe (L647, L651, L658, L659, L660, L665, and L666). This is almost entirely a series of metallurgical deposits, with a few installations probably associated with metallurgical activity.[45]

L651 in Layer M3 is another stone linear installation that is probably related to the metallurgical activities (Figure 2.76S). The remains of this installation consist of a line of three exposed boulders, each about 30 to 40 cm in diameter, with one visible in the section.

Another similar stone installation was found embedded in the north section of the excavation pit in the slag mound (L678). It consists of a wall-like pile of flat stones—four stones high (resembling L643 and different from the linear installations L616 and L651; Figure 2.77S).

Layer M4 is capped by L667, a thick level of ashy sandy Aeolian silt without much charcoal or artifacts. Below this rests L670, which started with some Aeolian dust but quickly became very hard sediment derived from mud, clay, and furnace fragments, with some crushed slag mixed into it. L671, the lowest of Layer M4, has a similar composition but began with a dense amount of crushed slag, particularly in the east. Here there are spots of sandstone fragments in the fill. It seems that copper smelting was less intense in Layer M4 in Area M.

The earliest occupation phase exposed in Khirbat en-Nahas is represented in Layer M5. This layer, located right above virgin soil (red wadi sands), consists of two installations stratigraphically separated from each other by a thin accumulation of soil. This separation is the reason for dividing this layer into M5a and M5b (Figure 2.78). In Layer M5a, installation L673 was found. This is apparently a hearth or an oven, made of a circle of local limestones. Bone and ash, but no slag, were found within it. Only part of it was excavated, as the rest extended into the section.[46]

The lowest levels excavated constitute Layer M5b. These rested on red virgin wadi sand. L677 contained very little charcoal in its upper levels and then extended down into virgin sand. Founded upon this locus was an installation (L676), a rectangular small structure of flat local limestones laid as a nice pavement and then covered with a layer of brown plaster about 2 cm thick. The plaster spreads upwards, as though to act as a basin, forming upraised edges to about 4 or 5 cm in height. On the southern side, a small, thin wall was preserved. It consists of some flat stones and one rounded stone plastered to the corner that protrudes upward like a horn (EDM 91905). The form of the feature suggests that it is an altar (Figure 2.79).[47]

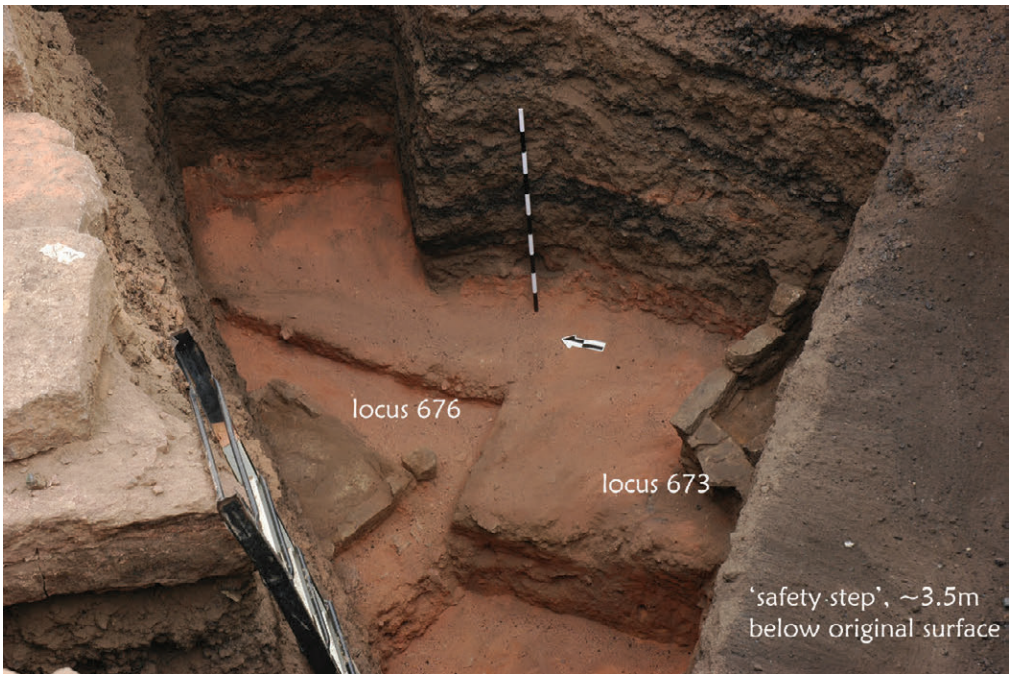

Figure 2.78 Area M, the deep probe into the slag mound and the installations of Layer M5. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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Figure 2.79 Area M, the altar-shaped installation on virgin soil at the bottom of the pit in the slag mound (L676, Layer M5b; the corner stone was originally attached to the installation with plaster). Based on the radiocarbon chronology, this installation dates sometime in the thirteenth to twelfth centuries BCE. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*



Figure 2.82 The 6-m (+) pit in the slag mound of Area M at the end of the excavation (looking south). The step was left for safety; Room 1 of Structure 1 was removed to allow the excavation of the pit (remains of the southeastern wall of the room are visible on the left). *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

The deep sounding of the slag mound exposed more than 6.5 m of metallurgical deposits (in five major layers) and provides stratigraphic contexts for detailed studies of the Iron Age copper production technology at KEN. In addition to the careful excavation and recording of the different loci in the sounding, we documented and sampled the walls of the deep section for archaeomagnetic, radiocarbon dating and other future research (Figures 2.80S, 2.81S, 2.82, 2.83S, 2.84, and 2.85). The material from the deep sounding and from its sections constitutes the basic reference for technological and socioeconomic reconstructions and models presented in the current research (Chapters 8 and 9, this volume).

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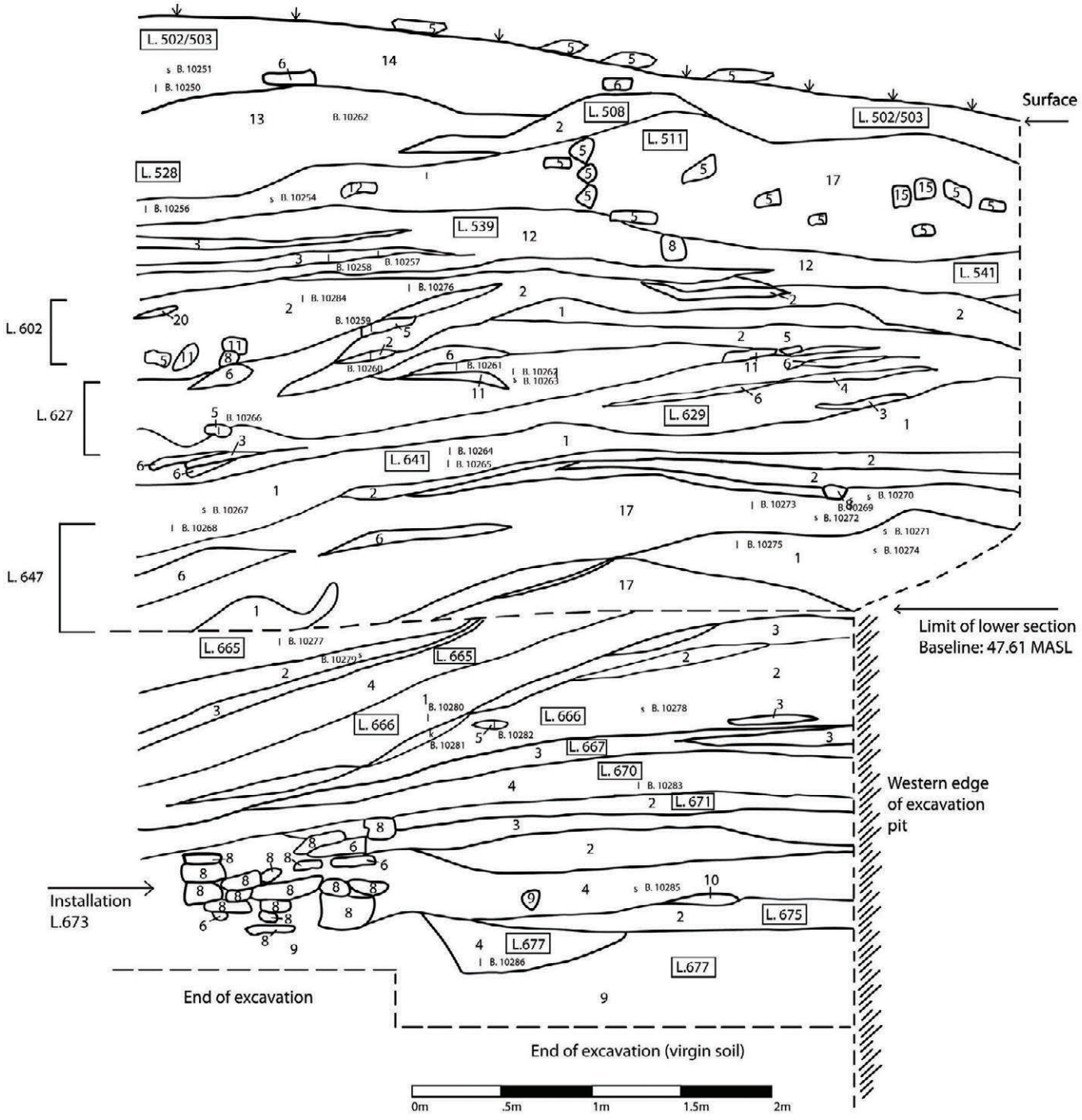

Figure 2.84 Detailed section drawing of the southern wall of the sounding in the slag mound of Area M. Location of loci is approximated. For general division into layers, see Figure 2.85. Note the horizontal dashed line representing the location of a safety step approximately 1.4 m wide (thus there is discontinuity in the section). Key: (1) broken slag fragment; (2) fine-crushed slag; (3) silt and ash; (4) ash with some slag fragments; (5) tap slag slab/fragment; (6) solid ash horizon; (7) animal bone; (8) stone; (9) wadi sand (virgin soil); (10) silt/clay; (11) furnace fragment; (12) crushed and broken slag, poorly sorted; (13) broken furnace and tap slag mixed with furnace fragments; (14) yellow/brown ashy loess with some slag fragments; (15) tuyère fragment; (16) red wadi sand; (17) compact crushed slag; (18) silt and ash with some crushed slag; (19) plaster; (T) tuyère fragment (sampled); (s) radiocarbon sample; (l) slag sample.

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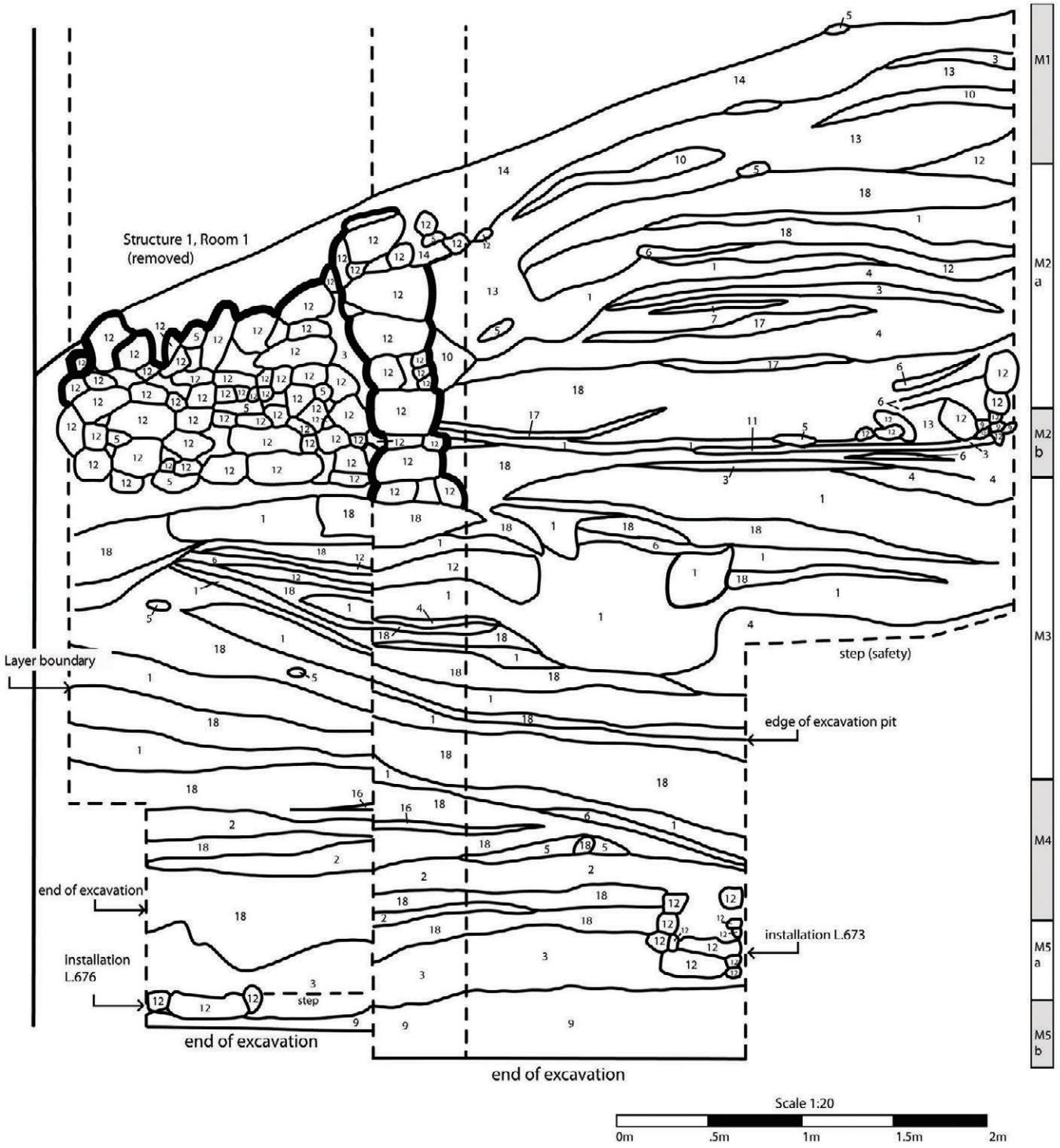

Figure 2.85 Detailed section drawing of the eastern wall of the sounding in the slag mound of Area M. General division into stratigraphic layers is shown on the right and is approximated.

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Radiocarbon Considerations—Area M as Chronological Anchor (Thirteenth to Ninth Centuries BCE) for Khirbat en-Nahas and the Edom Lowlands

From the excavations in Area M and in particular from the deep sounding in the slag mound, 22 radiocarbon dates were published in Levy, Higham, et al. (2008), and additional two dates from the deepest stratigraphic context (Layers M4 and M5) were published in Ben-Yosef et al. (2010). Two of the samples are from the 2002 excavations, and the rest are from the 2006 excavations. One sample (OxA-17646), dated to the

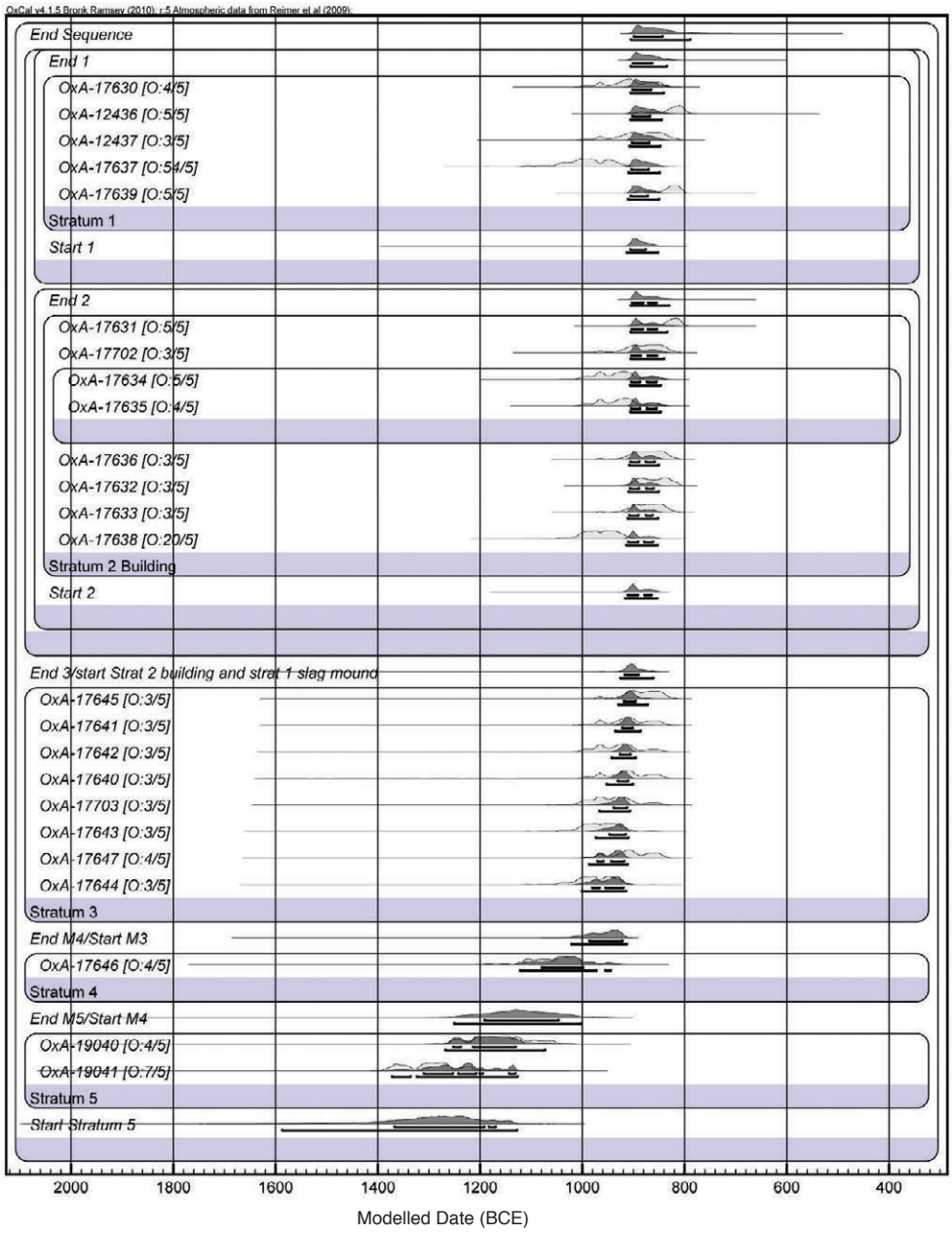

Figure 2.86 Modeled age diagram for KEN Area M (cf. Table 2.9; see text for details). The model reflects the archaeological phases identified in the field and described in this chapter. The figures in brackets are the results of the outlier detection analysis; prior and posterior probabilities are given in brackets (O: posterior outlier probability/prior outlier). Dark distributions represent the posterior probability ranges, while the lighter outlined distributions represent the radiocarbon likelihoods that are the nonmodeled calibrated ages.

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eleventh century BCE, was considered an outlier in the 2008 publication. However, reexamination of its context shows that it originated from Layer M4 and not M3, and its date corresponds well to its stratigraphic location. The new Bayesian model, incorporating all of the 24 dates, was first published in Levy et al. (2010) and is presented in Figure 2.86, together with the original dates and their context (Table 2.9).

The results of the radiocarbon dating for Area M indicate that the original occupation of the site was probably already in the last phase of the Late Bronze Age (Layer M5b, fourteenth to thirteenth centuries BCE, and Layer M5a, thirteenth to twelfth centuries BCE). As mentioned above, already in this context, fine-crushed slag fragments were found mixed with the wadi sands. The first substantial accumulation of metallurgical debris in Layer M4 dates to the eleventh century BCE, although there are few determinations and the precision is poor, as well as the massive production waste of Layer M3 to the tenth century BCE. The activities in the structures and the contemporary metallurgical activity to the south of them (Layer M2) probably date to the early to mid-ninth century BCE, and the last phases of copper production in the site (Layer M1) probably date to the later part of this century.

Area S—Specialized Ground Stone Processing Complex and Copper Production Area

The excavations in Area S (supervised by Lisa Soderbaum) exposed a rectangular building, metallurgical deposits surrounding it, some deeper layers related to copper production, and an unusually large collection of ground stone artifacts. The Area is located 15 m northwest of the DBM excavation (Fritz 1996) and between the massive structures of Areas T and R (Figure 2.87). It was selected for excavation to retrieve a better stratigraphic record of this portion of the site (Smith and Levy 2008). The main use of the building is represented in Layer S2b, with minor changes and additions in Layer S2a. Layer S3 consists of crushed slag horizons that were the foundation deposits for the building, and Layer S4 consists of minor metallurgical activities and mostly domestic debris (cooking and other installations). Based on radiocarbon measurements (see below and Higham et al. 2005), the building dates to the mid-ninth century BCE, probably similar to the nearby structure excavated by Fritz (1996).

The building in Area S measures 15.4 x 8.4 m and was slightly visible on the surface before the excavations (JHF, 2002 field season) (Figure 2.90S). The building is semi-subterranean and consists of four rooms that were sunk approximately 50 to 60 cm below the ground surface. The activities associated with the building were identified as metal processing, including casting (clay casting mold of a goddess [see below], copper chunks, copper prills) and crushing (various ground stones).

While Fritz (1996) sampled one of the many buildings visible on the site surface, he did not manage to produce a well-documented stratigraphic sequence. As part of our initial excavations at KEN in 2002, we decided to excavate a building west of Fritz's excavation (referred to here as the Deutsches Bergbau-Museum or DBM excavation) to establish a better stratigraphic sequence for this part of the site as well as to clarify some of the functions carried out there during the Iron Age. The well-preserved surface architecture in Area S indicated the presence of a square-shaped building below the exposed rubble. The stratigraphy for Area S was first published in a report and preliminary ceramic study (Smith and Levy 2008). Following the 2006 excavations in Areas R and T (see below), Area S was shown to conform to the same general site formation processes of these areas, negating any need to reexamine the radiocarbon dates or conduct a Bayesian analysis for this area (see below and Higham et al. 2005; Levy, Najjar, van der Plicht, et al. 2005). Thus, the following stratigraphic sequence characterizes Area S (see Table 2.10, stratigraphic profile).

The earliest occupation of Area S (Layer S4) reflects domestic activities with minor copper production. Very few diagnostic ceramics and other artifacts were recovered from this layer. At some point, crushed slag from an earlier metallurgical production layer (Layer S3) was leveled in this area and used as a foundation for the construction of the Layer S2b building (Figure 2.88 plan). The stratigraphic sequence in Area S shows conclusively that the building (Layer 2b) was established on top of this crushed slag foundation. The buildings in Areas R and T were both built on slag mounds that had been leveled as part of the foundation process. The gatehouse (Area A) foundations were more similar to Area S in that only limited quantities of crushed slag were used, rather than the intentional leveling of an entire slag mound. Based on radiocarbon analyses, the Area S building dates to the mid-ninth century BCE like the nearby one excavated by Fritz (1996). Following the last Iron Age use of this building in Layer 2a (mid to late ninth century BCE), the walls collapsed, forming

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Lab Number	EDM	Season	Locus	Sample Material	Species	Layer	Stratum	Date BP	Cal Date BCE (68.2 and 95.4 percent probability)	Bibliography
OxA-12436	80372	2002	511	Charcoal	*Tamarix* sp.	M1	II	2659 ± 32	895–830 923–805	Levy, Higham, et al. 2008:Table 1; Levy et al. 2010:Figure 3
OxA-12437	80705	2002	539	Charcoal	*Tamarix* sp.	M1	II	2746 ± 35	917–839 976–815	Levy, Higham, et al. 2008:Table 1; Levy et al. 2010:Figure 3
OxA-17630		2002	535	Charcoal	*Retama raetam*	M1	II	2764 ± 25	839–801 894–798	Levy, Higham, et al. 2008:Table 1; Levy et al. 2010:Figure 3
OxA-17631	91837	2006	753	Charred seed	*Phoenix dactylifera*	M2a	II	2676 ± 26	894–826 906–809	Levy, Higham, et al. 2008:Table 1; Levy et al. 2010:Figure 3
OxA-17632	91808	2006	749	Charred seed	*Phoenix dactylifera*	M2b	III	2713 ± 26	898–839 923–817	Levy, Higham, et al. 2008:Table 1; Levy et al. 2010:Figure 3
OxA-17633	91641	2006	727	Charred seed	*Phoenix dactylifera*	M2a	II	2734 ± 25	974–898 1003–844	Levy, Higham, et al. 2008:Table 1; Levy et al. 2010:Figure 3
OxA-17634	90466	2006	631	Charcoal	*Haloxylon persicum*	M2b	III	2783 ± 25	974–858 998–842	Levy, Higham, et al. 2008:Table 1; Levy et al. 2010:Figure 3
OxA-17635	90466	2006	631	Charcoal	*Haloxylon persicum*	M2b	III	2777 ± 25	897–838 920–817	Levy, Higham, et al. 2008:Table 1; Levy et al. 2010:Figure 3
OxA-17636	90378	2006	635	Charred seed	*Phoenix dactylifera*	M2b	II	2732 ± 25	1020–931 1108–911	Levy, Higham, et al. 2008:Table 1; Levy et al. 2010:Figure 3
OxA-17637	90395	2006	629	Charcoal	*Phoenix dactylifera*	M1	II–III	2836 ± 26	999–926 1036–902	Levy, Higham, et al. 2008:Table 1; Levy et al. 2010:Figure 3
OxA-17638	91773	2006	717	Charred seed	*Phoenix dactylifera*	M2b	III	2814 ± 25	839–802 874–799	Levy, Higham, et al. 2008:Table 1; Levy et al. 2010:Figure 3

Table 2.9 *(continued)*

Lab Number	EDM	Season	Locus	Sample Material	Species	Layer	Stratum	Date BP	Cal Date BCE (68.2 and 95.4 percent probability)	Bibliography
OxA-17639	91462	2006	707	Charred seed	*Phoenix dactylifera*	M2a	II	2678 ±26	970–849 994–838	Levy, Higham, et al. 2008:Table 1; Levy et al. 2010:Figure 3
OxA-17640	91098	2006	666	Charcoal	*Tamarix* sp.	M3	IV–V	2770 ± 25	969–846 944–835	Levy, Higham, et al. 2008:Table 1; Levy et al. 2010:Figure 3
OxA-17641	90754	2006	647	Charcoal	*Acacia* sp.	M3	IV–V	2767 ± 25	974–896 1001–844	Levy, Higham, et al. 2008:Table 1; Levy et al. 2010:Figure 3
OxA-17642		2006		Charcoal	*Tamarix* sp.	M3	IV–V	2781 ± 25	976–898 1003–846	Levy, Higham, et al. 2008:Table 1; Levy et al. 2010:Figure 3
OxA-17643	91175	2006	670	Charcoal	*Tamarix* sp.	M4	VI	2813 ± 26	1001–927 1041–903	Levy, Higham, et al. 2008:Table 1; Levy et al. 2010:Figure 3
OxA-17644	91211	2006	674	Charcoal	*Tamarix* sp.	M5a	VII	2824 ± 25	1008–932 1047–912	Levy, Higham, et al. 2008:Table 1; Levy et al. 2010:Figure 3
OxA-17645	90832	2006	652	Charcoal	*Tamarix* sp.	M4	VI	2747 ± 25	913–843 972–827	Levy, Higham, et al. 2008:Table 1; Levy et al. 2010:Figure 3
OxA-17646		2006		Charcoal	*Tamarix* sp.	M3	IV–V	2871 ± 26	1112–1005 1129–936	Levy, Higham, et al. 2008:Table 1; Levy et al. 2010:Figure 3
OxA-17647	91192	2006	673	Charcoal	*Haloxylon persicum*	M5a	VII	2764 ± 25	904–839 970–814	Levy, Higham, et al. 2008:Table 1; Levy et al. 2010:Figure 3
OxA-17702	90181	2006	621	Charcoal	*Retama retama*	M2	II–III	2740 ± 30	991–904 1011–843	Levy, Higham, et al. 2008:Table 1; Levy et al. 2010:Figure 3
OxA-17703	90527	2006	636	Charred seed	*Phoenix dactylifera*	M3	IV–V	2792 ± 30	799–671 808–564	Levy, Higham, et al. 2008:Table 1; Levy et al. 2010:Figure 3

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Figure 2.87 Aerial view of Area S, KEN; the ninth-century BCE building complex was related to slag crushing and other copper production activities. Part of Area R is visible to the left of the building. *Photo: UC San Diego Levantine Archaeology Laboratory.*

Layer S1. Like the Area A Gatehouse, the Area S building and its immediate surrounds were not occupied after the late ninth century BCE. The five radiocarbon dates from this last layer (S1) all fall within the mid to late ninth century BCE, precluding the possibility that this building was occupied or visited during the eighth century BCE or later (see Table 2.11).

As mentioned above, the use of a Bayesian statistical modeling method to more tightly date the stratigraphy of Areas S and A has been challenged by van der Steen and Bienkowski (Levy, Higham, and Najjar 2006; van der Steen and Bienkowski 2005a, 2005b, 2006). The critique focused mostly on the earliest layers in both Areas A and S situated beneath their respective buildings (e.g., the gatehouse in Area A, Layer A4a and the metallurgical building in Area S, Layer S4). Rebuttals have been made to explain clearly and succinctly the exact methodology used in Bayesian modeling for KEN and its importance for properly dating stratigraphic layers (Levy, Higham, and Najjar 2006; Levy, Najjar, and Higham 2005, 2007). The Bayesian modeling was constructed using only the stratigraphic sequencing of the site discussed above and did not factor in other data such as epigraphic finds (scarabs; Chapter 11, this volume), Early Iron Age arrowheads, and other data. It is unfortunate that these discussions detracted from the focus on the *uncontested* primary occupation layers of the site dated, until now, using *only* high-precision radiocarbon dates to the tenth to ninth centuries BCE from which significant samples of diagnostic ceramics (Chapter 4, this volume) and other artifacts have been collected.

As shown previously, the stratigraphy of both the Area A Gatehouse and Area S building (Higham et al. 2005; Levy, Najjar, van der Plicht, et al. 2005) the main occupation layers in these two areas are securely dated to the ninth and tenth centuries BCE. In some cases, radiocarbon dates and scarabs extend the occupation back to the eleventh century BCE (see especially the discussion of the earliest layers in Area M below and Chapter 11, this volume). It is possible that these scarabs were heirlooms from the previous century that made their way into the Area S building (Figure 2.99)—however, this is not the case for the short-lived botanical samples (usually date pits or the outer growth rings/sap wood of tamarisk) used for radiocarbon dating. Our stratigraphic excavations and radiocarbon dates

Table 2.10 Stratigraphic sequence in Area S, Khirbat en-Nahas.

Layer	Description
Layer S1	Collapse of structure and possible reuse as corral or pen
Layer S2a	Minor additions to Layer 2b architecture and fill over original 2b surfaces
Layer S2b	Main architectural and occupation phase of building
Layer S3	Crushed slag foundation prior to Layer S2b building
Layer S4	Cooking and other installations, small-scale metallurgy, associated basal occupation layer

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confirm the dating framework initially suggested by the DBM soundings (Hauptmann 2000) of different slag mounds at Khirbat en-Nahas as well as the building excavated by Fritz (1996) located near the Area S excavation (Figure 2.4a, 2.4b) (Hauptmann 2007). The excavations in Area S highlight a process seen throughout KEN—that is, the complete absence of radiocarbon dates from the eighth through sixth centuries BCE, whether one uses Bayesian calibration or not, indicates that the peak of industrial scale copper production at Khirbat en-Nahas represents a relatively short occupation span. The radiocarbon dates from Area S are remodeled below.

Overview of Area S

The excavation in Area S included nine 5 x 5–m squares oriented on a north-south axis. The square designations were labeled on the *x* axis from the west to east as AAA, BBB, and CCC. The *y* axis was assigned numbers starting with 43 in the north and 42 to 41 to the south. Area S included six layers: S1, S2a, S2b, S3, S4, and S5. The ground surface (Layer S1) was covered in architectural debris, and a large structure was located on the surface as well. The surface debris and the structure (Layer S1) consisted of large wadi cobbles of limestone and sandstone, naturally rounded by stream erosion. Large rectangular shale slabs were also used, possibly trimmed, to facilitate construction. The function of the Layer S1 occupation could not be definitively determined. However, the Layer S1 structure may have served a short-term ephemeral occupation. The walls were better built on the northern, eastern, and western sides, but it is unlikely that it was a building with a ceiling during this late phase; the collapse is widespread and not substantial enough for a high building built in stone. The surface was leveled by filling the semi-subterranean building from the previous Layer 2b with large cobbles very similar to the building material of the Layer 1 structure. This S2b fill, referred to as collapse, was more than 1 m thick.

Layer S2a was represented by wall lines and blockages of entrances of the previously existing structure (Layer S2b). The wall lines probably served as dividers for a courtyard east of the structure (Layer 2b). Copper production activities, such as secondary melting and limited final product production, may have taken place here. There were no clear indications of an abandonment phase between Layers 2a and 2b; instead the main activities in S2a may have shifted slightly from inside the building in Layer S2b to the courtyards on the eastern of the building (Figure 2.89 plan of Area S). The main copper production activities in both Layers 2a and 2b took place south of the structure, where a slightly later large production waste pit was located, which penetrated earlier production levels. The blockages of the entrances of the structure (Layer S2b) most likely mark the end of Layer S2a. No evidence of a sudden abandonment was noted in Area S. Thus, Layer S2a seems to represent a modest expansion and reorganization of parts of the original S2b building complex.

Layer S2b included a well-preserved four-room building with semi-subterranean rooms, common in the Levant during Iron Age II (Figure 2.89; Hardin 2010; Herr and Najjar 2001; Schloen 2001). This is the main construction and occupation phase in Area S. The main entrance (ca. 1.2 m wide) was built in the western wall, leading into the main room (Room 2), and lacked evidence of a door socket. A smaller entrance is located in the center of the eastern wall as well, leading into Room 3 from Room 2 that may have functioned as a small courtyard. Room 1 is located in the northwestern side of the building with an entrance (ca. 1 m wide) leading to the Room 2 "courtyard." Room 4 is the southernmost and also has an entrance (ca. 1 m wide) leading to the courtyard/Room 2. Limited copper production activity took place inside the S2b structure that may be related to final product manufacture. The discovery of a casting mold, probably for a south Levantine goddess figure, supports this suggestion (Figure 2.89; Levy 2008). Although this object was found in a Layer S1 fill, it was probably associated with the main occupation phase in this area. Major S2b production activity took place to the south of the building and most likely included some secondary melting. Slag-crushing activities, evidenced by numerous superimposed layers of crushed slag, were especially conducted north of the building but also to the south and southeast, as evidenced by crushed slag surfaces.

Layer S3 did not include occupation evidence. It was represented by a layer of crumbly slag used as foundation material to level the surface prior to building the S2b structure. The full extent of the layer was not exposed; however, it was identified below the foundation walls of all the rooms, courtyards, and other structures in the area. Very few artifacts were extracted from this layer, another indication that no occupation activity was involved with this layer.

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Figure 2.88 Southern section of the deepest probe in Area S. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

Layer S4 had limited architectural evidence. Like Layer S3, only limited exposures of surfaces could be made. One small wall line below Room 3 was noted. The surfaces were of hard packed mud brick/clay. A few Early Bronze Age ceramics were mixed in with the pottery from this layer. As these sherds were found mixed with IA ones on the S4 surface, it is impossible to accurately date this area. An installation below Room 4 was also exposed that possibly served as a cooking facility. Below the surfaces, virgin soil appeared as yellowish sandy sediment mixed with gravel.

Layer S5 consisted of virgin soil. It was first exposed in the deep courtyard probe (see below), where approximately 1 m of virgin sandy yellow sediment mixed with gravel was found. Below this was a layer of coarse sand. Together, these deposits represent the preoccupation geomorphological colluvial environment that existed around KEN prior to the Iron Age.

Occupational History of Area S

Layer S1

An open air rectangular structure measuring around 15.4 x 8.4 m (walls: North Wall 265, East Wall 264, South Wall 270, and West Wall 269) was visible on the ground surface of Area S. The S1 building used the wall lines of the earlier Layer S2b–2ba structure and was constructed of sandstone and limestone wadi boulders and cobbles. Occasional large slabs of shale were also included in the architecture. The structure was very poorly preserved in this upper layer, and only an eroded rectangular plan was visible (Figure 2.90S). Similar structures are visible and spread over the surface KEN, and many may be contemporary with the S1 complex. The Area S1 building complex functioned as an ephemeral structure near the end of the ninth-century BCE occupation at KEN.[48]

The largest number of loci was assigned to Layer S1 in Area S. The reason for this was the considerable depth of the layer, especially within the structure. The Layer S1 structure reused the upper portions of the walls of the semi-subterranean S2b four-room building. Prior to the S1 reoccupation of the structure, the depression left from the abandonment of the S2b semi-subterranean building was purposely filled in with large boulders and reused worked stones.[49]

While no definitive occupational surfaces were noted inside the S1 structure, a hard-packed mud brick surface (L278) was found outside the southwest corner (Figure 2.91S) that was associated with the S1 structure. The surface was located a few centimeters below the ground surface, which may explain why such surfaces were so poorly preserved and the density of finds low. L273 is the fill above the surface and L309 below.[50]

The topsoil south of the structure was ashier and contained metallurgical production waste (L263 and

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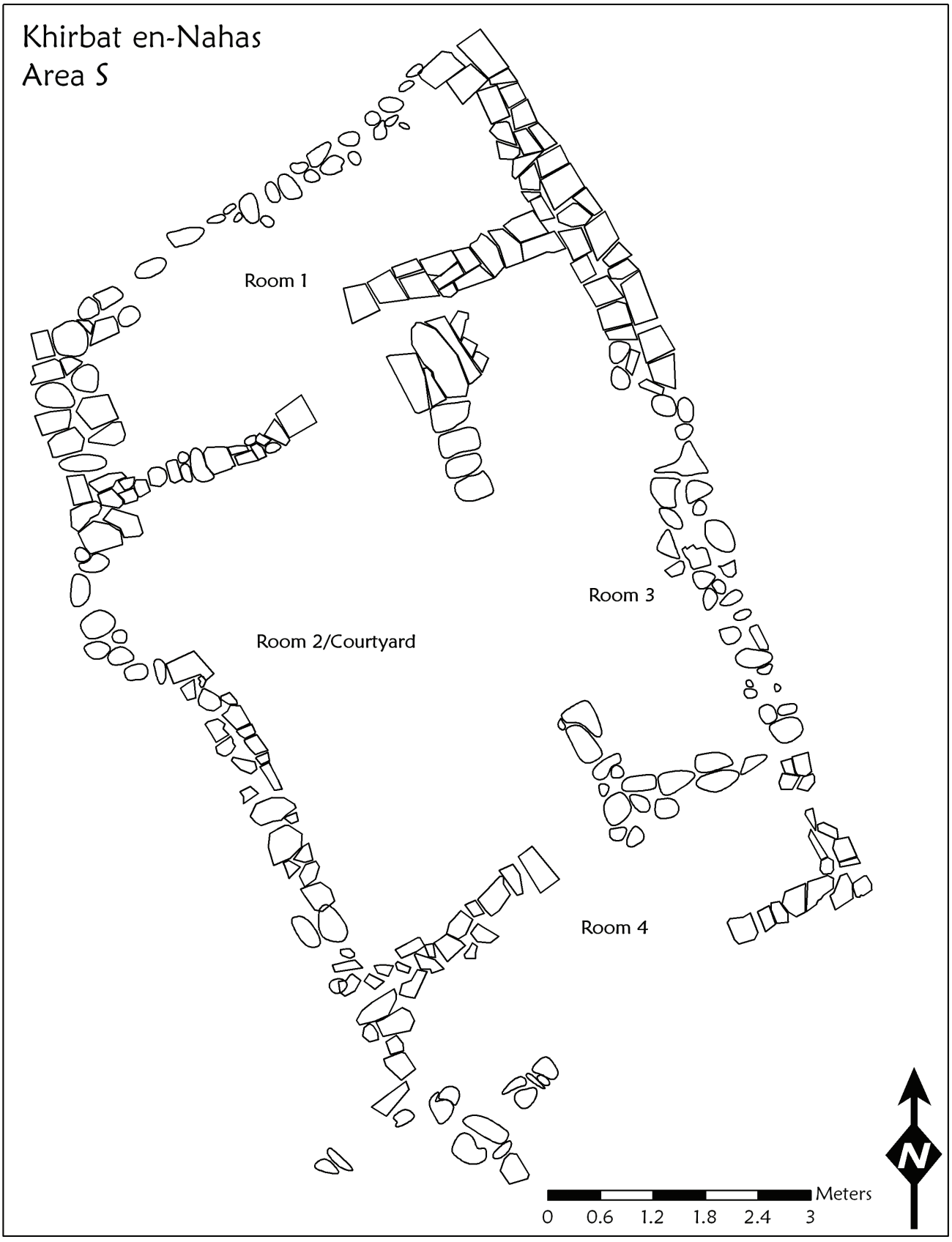

Figure 2.89 Plan of the building complex in Area S, KEN.

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Figure 2.92 Section that cuts through L263 and L310 that represent a broken slag fill that was dumped sometime during Layer S1. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*



Figure 2.93 Iron arrowhead found in Layer S1 slag pit (EDM 70615, L263, B5972). *Photo: UC San Diego Levantine Archaeology Laboratory.*

L262) possibly related to a large slag mound southeast of Area S. As the excavation proceeded, it was clear that L263 represented the top layer of a waste pit, so contemporary with the slag mound southeast of Area S. The large number of finds in L263 necessitated a shift of recording strategy. Instead of recording individual artifacts as points, they were collected as groups of finds with the bounded locus with a polygon shot in with the total station. L263 with deep and reached the Layer S2a slag waste below (L310; Figure 2.92). Large amounts of slag and other metallurgical debris were collected in the southern portion of L262.[51] An example of the metallurgical finds is given in Figure 2.93.

Room 1 (Upper Levels of Layer S1, L299 and L292)

The reuse of the Area S structure in S1 included a range of activities different from its original function. Room 1 was divided into L299 (east) and L292 (west). The division was made based on what was thought to be a threshold. The loci fill were very similar; light brown silty sediment that included very large quantities of collapse. Initially, we thought this area was used as a storage facility as several large grinding slabs and other worked stones were found. Later it was clear that ground stones were in secondary context and reused as fill material. The majority of the material in these fills was collapse that continued further below, as L305.

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Room 2 (Upper Levels of Layer S1, L302)
The thick fill that characterizes S1 is represented by L302 that extends across Room 2, the largest room in the Area S building. The collapse was very similar to the upper levels in Room 1, with light brown and silty sediment and with few finds. Several pieces of corroded copper metal and a few worked stones were found here. Like all the upper levels of Layer S1 inside the structure, the large stones were intentionally placed in the fill. The fill (L302) extended to the lowest level of Layer S1 in Room 2 (L317). On reaching the bottom of Layer S1, it was possible to begin to define the architectural details of the structure.

Room 3 (Upper Levels of Layer S1, L296)
L296 represents the upper fill of Layer S1 inside Room 3. The fill was very similar to Rooms 1 and 2, with light-colored silty sediment representing the intentional infill. Several worked stones were found reflecting their reuse for filling the abandoned depression of the semi-subterranean building from the earlier S2 structure. While few artifacts were found, more metallurgical related finds were found in the southern portion of Room 3. This room contained slightly less collapse compared to Rooms 1 and 2. The lowest layer of Layer S1 was represented by L312, opened below L296.

Room 4 (Upper Levels of Layer S1, L300)
The L300 fill contained more metallurgical finds than any other interior locus in Level S1. This may be due to contamination from L263, south of the structure, that extended below W270 of the structure. An effort was made to define the architecture surrounding the room, especially the interior western corners. Several worked ground stones were found mixed with the sediment, most likely used as part of the filling process of the S2 structure. The lowest level of Layer S1 in Room 4 was represented by L316, opened below L300.

Room 1 (Lower Levels of Layer S1, L305)
It was difficult to determine the beginning Layer 2a, so L305 was used for both the lower level fill of Layer S1 containing and the upper levels of Layer 2a. The number of artifacts increased considerably in the lower portion of the locus, indicating the beginning of Layer 2a. Several worked stones were collected from the fill layer and reused in the same manner as in the other rooms. Excavation of this locus helped in the definition of the S2 room as well as removing the remaining fill. For spatial analysis, artifacts extracted from L305 were included in Layer 2a as the majority of the finds were collected from the lower layers of the locus (Figure 2.94S).

Room 2 (Lower Levels of Layer S1, L317)
The number of artifacts increased considerably in the lower level of Layer S1 in Room 2, indicating the transition of Layer S2a. Consequently, all sediment was sieved from L317, resulting in the retrieval of a glass bracelet fragment (B6594, EDM 10283). In addition, the only final product mold fragment was also collected here. The head is preserved, revealing a female face, earrings, and hair (Figure 2.96; B6323, EDM 70879). It seems to be a representation of a south Levantine goddess such as Astarte, Ishtar, Kubaba, Atargatis, or some other. A large number of worked stones, including grinding slabs, shallow mortars, hammer stones, and polishing stones, were found mixed in these basal S1/S2a deposits. A considerable number of metallurgical artifacts were found, including partially processed copper, copper metal, and prills that may indicate melting activities (Figure 2.95S). Three radiocarbon determinations from L317 were processed at the Groningen laboratory. These dates place this locus in the ninth century BCE (see Table 2.11: GrA-25326, 900–835 BCE; GrA-25328, 890–885, 835–800 BCE; GrA-25342, 1000–895 BCE). The figurine mold, whose image is characteristic of later Iron Age Edomite iconography, highlights the "Edomite" nature of this area during the ninth century BCE.

Room 3 (Lower Levels of Layer S1, L312)
Room 3 included larger amounts of S1 fill compared to the other rooms in this layer. Like the other rooms, the density of artifacts slowly increased as the basal deposits were reached. The artifacts included several ground stones, such as hammer stones, dimpled hammer stones, and grinding slabs. Metallurgical finds were also present, such as copper metal, partially processed copper, prills, and slag with copper, all indicating a secondary melting activity. Furnace fragments and tuyère pipe fragments were also collected, reflecting pyrotechnology activities. The density of finds was lower than in Room 2, but this may be due to the smaller size of Room 3, but also the fact that more work was done in the courtyard (Room 2) than the smaller rooms. Room 3 contained more furnace fragments than the other rooms, possibly indicating the location of a furnace here (Figure 2.95S).

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Figure 2.96 Area S, Layer S1, Room 2—mid-ninth century BCE. Clay figurine mold for casting molten image, L317 (B6323, EDM 70879), found in association with metallurgical processing building. Only a fragment of the open mold containing the anthropomorphic figure is preserved. Length = ca. 7 cm, width = ca. 7 cm, thickness = ca. 4 cm. (*right*) Plastic cast of the mold interior. Shows face of woman with a large nose, hair, earring, and headdress. This could represent a south Levantine goddess such as Astarte, Ishtar, Kubaba, Atargatis, or some other. *Photo: UC San Diego Levantine Archaeology Laboratory.*



Figure 2.97 Iron arrowhead found in Room 2 (EDM 10229, B6337, L317). *Photo: UC San Diego Levantine Archaeology Laboratory.*

Room 4 (Lower Levels of Layer S1, L316)

Room 4 contained very large quantities of collapse, which may be a result of the slightly lower depth of this room compared to the others inside the structure. The density of artifacts also increased in the lower levels of the fill, indicative of the emergence of Layer S2a. All sediment was sieved here. In the sieving process, a scarab was retrieved (B6438, EDM 10243; Figure 2.99; see Chapter 11, this volume). The motif depicts a hunter with a bow chasing an animal. The preliminary analysis of the scarab points toward local production with obvious Egyptian influence, approximately dating to the middle of the eleventh century BCE.[52]

Layer S2a

When the radiocarbon dates from Area S, Layer 2a are considered along the ceramics (Table 2.11; see Chapter 4, this volume and above), the changes associated with the S2a building are firmly set in the ninth century BCE. Layer S2b is probably only slightly older than S2a as there are no indications of an abandonment phase between the two. Appendix 2.S.1 lists the main loci associated with Layer 2a. The loci inside the structure will be discussed according to room number from the four-room building (Layer 2b). In general, the walls that belong to Layer S2a are all later additions to the S2b structure. The copper production areas relating to Layer S2a are discussed separately from the rooms and fills (Figure 2.100S).

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Figure 2.98 Room 4 with a remnant of the S1/2a fill (L316) visible. A well-preserved scarab of a chariot scene, with archer and a horse with a raised tail, was found in sieved deposits from this room. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*



Figure 2.99 Amulets from Area S: (1) scarab with walking sphinx (B6974, L330) and (2) scarab with chariot, archer, and hunting scene (?) (B6438, L316). Both of these scarabs were found with sieving deposits in Room 4 (see Chapter 11, this volume). *Photo: UC San Diego Levantine Archaeology Laboratory.*

Room 1 (L305)

The lower levels of L305 related to Layer S2a, whereas the upper portion was part of Layer S1. This highlights the difficulty of distinguishing the transition between these layers. Compared with the earlier loci inside the structure (Layer S2b), there were fewer artifacts and fill here, with the exception of the central portions of the room where a concentration of collapse was recorded, perhaps relating to the S2b division of the room (L292 and L299). All sediment was sieved, and in the process, several beads were found of various shapes and material. Some pharyngeal teeth and vertebrae from Red Sea fish (parrotfish?; see Chapter 8) came to light here. Other finds included a mold fragment, partially processed copper, copper metal, slag with copper, hammer stones, and prills, all pointing toward remelting of copper.[53]

Room 2 (L331)

The fill (L331) above the S2b surface (L338) in Room 2 was very similar to that found in Room 1. A few grinding slabs and shallow mortars were found in situ in this S2a layer. Other ground stones included dimpled hammer stones, hammer stones, polishing stones, "ballistic" stones, and a round worked stone that may have served as a roof support. Large quantities of copper metal pieces and some iron metal were found in Room 2 (Figure 2.102S). Furthermore, partially processed copper, slag with copper, some copper

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ore, a few furnace fragments, and tuyère pipe fragments were also recovered. Beads of different sizes, materials, and shapes were collected along with small pieces of ostrich eggshell. The archaeometallurgical remains point to secondary melting activities and possible final production.[54]

Room 3 (L333)

The S2a occupation of Room 3 contained a fill very similar to that found in Rooms 1 and 2 that covered a Layer S2b surface (L339). A large number of ground stone artifacts were found here, including grinding slabs, polishing stones, dimpled hammer stones, and hammer stones. Raw materials for possible bead manufacture were also found here. Several beads were found of various shapes, sizes, and materials. Copper metal, partially processed copper, miscellaneous metal, and slag with copper prills were recovered, implying possible secondary copper processing. Little copper ore, tuyère pipe, and furnace fragments were found in L333. A possible small furnace was found in the northeast corner of the room in association with larger concentrations of slag. However, no ashy sediment surrounded the installation. If pyrotechnology took place within the Area S building (Layer S2b), it probably occurred in Room 3 (Figure 2.103S). A diamond-shaped arrowhead made of iron was found in this locus (Figure 2.111).

Room 4 (L330 and L334)

Layer S2a in Room 4 was excavated in two halves: L330 (west) and L334 (east). The sediment was sandier in Room 4 compared to the silty material found in Layer S2a in Rooms 1, 2, and 3. A second scarab came to light from L330 in Room 4 (Figure 2.99.1; B6974, EDM 71241; see Chapter 11, this volume) and represents another Egyptian import linked to Area S. This broken "walking sphinx" scarab originally included the now headless body of a royal sphinx on top of a *nb* sign that served as an *exergue* and apparently a hieroglyph that is now lost.[55]

Copper Production Activities and Layer S2a

Copper production activity in Layer S2a was concentrated to two main areas, both north and south, of the Area S2b structure. The loci associated with copper production in Layer S2a include L279, L301, L310, L327*, and L328*. The waste pit (L310) to the south of the building consisted of a thick layer of tap and furnace slag. Metallurgical debris (tuyère, furnace fragments) were also found in the waste. The curve in the section clearly showed that this was a dug-down waste pit (Figure 2.92). Below the thick layer of slag, a Layer S2a surface was exposed (L327). Patches of crushed slag were recorded, and limited crushing activity could have taken place here (Figure 2.105). Large amounts of tuyère pipe fragments along with several metric tons of slag were collected from this area. A furnace (L324) was situated below L327 relating to Layer S2b.[56]



Figure 2.105 The large patch of mud brick material on the surface (L328) of what may be part of a furnace base, Layer S2a. Also seen here are L327, L324, and W329. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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An ashy fill (L301 and L279) was excavated north of the structure, situated above a large slag crushing area (L284 and L318) from Layer S2b. This area was less dense in metallurgical finds than south of the structure. It may be that copper production activity in general was more limited during Layer S2a than during the main occupation phase of Layer S2b.

A probe was excavated to the northeast of the structure, in Square BBB43. The probe was later extended to the east and west, in order to relate the walls (W288 and W276) with the layers between. L304, L319, and L277 represented the upper layer within Layer S2a. Comparatively low amounts of finds were collected from there, and all three loci consisted of a darker brown fill with possible clay contents. The lower layer in the probe area was represented by L307, L320, and L281, which all consisted of ashy, silty sediment, located above a possible Layer S2b copper production layer, including crushed slag. The Layer S2a wall additions most likely served as dividers of courtyards situated to the east of the structure.[57]

The main entrance of the Layer S2b building was blocked, and excavation was conducted west of the structure to investigate the blockage (L340). The locus contained very few finds, although some worked stones were mixed in the collapse sediment. The blockage may mark the end of the occupation of Layer S2a. Another blocked entrance was noted in the central portion of W288, bounding the structure to the east. This entrance could have blocked at an earlier stage during Layer S2a as it seemed that it was blocked when W357 was added to the structure.

Layer S2b—The Original Construction Phase and Occupation

Layer S2b represents the main building and occupation phase in Area S. The four-room structure was built during the phase. The building style with rooms connected to a courtyard is typical for Iron Age II in the southern Levant in general and Khirbat en-Nahas in particular (Netzer 1992). Activities inside the structure did not seem to change considerably from Layer S2a to S2b. Secondary melting may have been the main activity in the area as well as crushing slag to extract the copper attached to the slag after the first smelting. Limited bead production may have been conducted here as many examples were found made of a wide range of raw materials.

Room 1

The surface was hard packed in places, light brown, and quite even. Very few furnace fragments, tuyère pipe fragments, slag, and copper metal were found here. The number of worked stones below the collapse also decreased. There was no indication of functional changes between Layers S2a and S2b in this room. In fact, the finds in the locus above (Layer S2a, L305) may be closely related to this locus as the occupation layers may have been mixed as the building was filled. It seems likely that the transition period between Layers S2a and S2b may have been continuous, with no abandonment phase. Thus, the function of the building may not have changed between the layers, except that additional activities may have moved to the courtyards east of the building during later phase (S2a; Figure 2.101S).

Room 2 (L338)

Approximately a quarter of the room was excavated with an east–west orientation, reaching between W297 and W291. The surface was uneven, being hard-packed mud brick mixed with loose sediment. More slag was collected from the eastern portion of the locus, possibly originating from the slag layer below. The density of finds was slightly higher in Room 2 than in Room 1. The majority of the finds were metallurgical such as furnace fragments, tuyère pipes, slag with copper, partially processed copper, copper metal, and copper ore.[58]

Room 3 (L339)

This S2b locus covered approximately a third of the room. A small possible furnace was located in the northeast corner of the room with several furnace fragments. Copper metal, partially processed copper, copper ore, and tuyère pipe fragments were also collected from here. This furnace may have served as a small-scale melting installation used in secondary or final copper casting (note the final product casting mold found in this building described above). However, there was no ash mixed in the sediment surrounding the furnace.[59]

Room 4 (L332)

The surface was situated on a thick layer of crumbled slag, which was partly mixed in with the surface. The density of finds was slightly lower in Room 4 compared to Rooms 2 and 3. Metallurgical related finds from the surface included copper metal, copper ore, slag with copper, prills, slag with copper, tuyère pipe fragments, and furnace fragments. Although Room 4 is separated

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from the extramural production area south of the Area S building by W315, melting activities seem to have taken place inside Room 4.[60]

Copper Production in Layer S2b

The loci associated with copper production in Layer S2b include L285, L321, L323, L318*, L284*, L324, L354*, and L355*. There were two main copper production areas in Area S. A furnace (L324) was situated south of the structure on a surface (L355) with indications of slag-crushing activities. A second surface (L354) with signs of crushing activities was located to the southeast of the structure (Figure 2.106S). The surfaces of L355 and L354 were partially exposed. Both included patches of hard-packed crushed slag that extended below W329 (Layer S2a). Crushing activity took place here that may have related to the furnace.

A second primary copper production area was found north of the structure. A distinct surface was found that extended over approximately 25 m^2 (L284 and L318; Figure 2.107). The surface was hard packed and consisted of very finely crushed slag approximately 15 cm thick, with interfingered thin layers of mud brick–like sediment (Figure 2.108).[61]

Other indications of S2b copper production activity were traced in the probe (L285) and in its extensions to the east (L321) and west (L323). A thick (ca. 15 cm) ash layer with large amounts of crushed slag was found (L285). It was situated slightly lower than L318 north of the structure. Large amounts of animal bones were collected here that may indicate a rubbish dump. Small pieces of slag, fragmentary pottery sherds, and tuyère pipe and furnace fragments indicate metallurgical waste. The layer was very distinct from the crushed slag layers noted above. The surface was very dense and hard, whereas the sediment in the probe was loose and ashy. The northern portion of L323 contained several worked stones of various types that were probably discarded. Below the ash sediment, a layer of silty ashy sediment was found (L295 in the probe, L325 east of probe). A second layer with ash and slag appeared below that (Layer S3, L303 and L326). Thus, L295 and L325 may have been fill between the two (Figure 2.109).

The central part of the courtyards to the east of the structure was sampled (L336). The sediment was slightly darker than on the inside of the structure. The variety of metallurgical finds was collected from this locus, points to melting and possible final product production. Very large amounts of worked stones of various kinds were collected from L336. Hammer stones, dimpled hammer stones, pestles, polishing stones, and grinding slabs were found here, as well as a carnelian flake and worked quartz. Tuyère pipe



Figure 2.107 Slag-crushing area, L318, outside the Area S building. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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Figure 2.108 Detail view of the superimposed crushed slag layers, L318. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

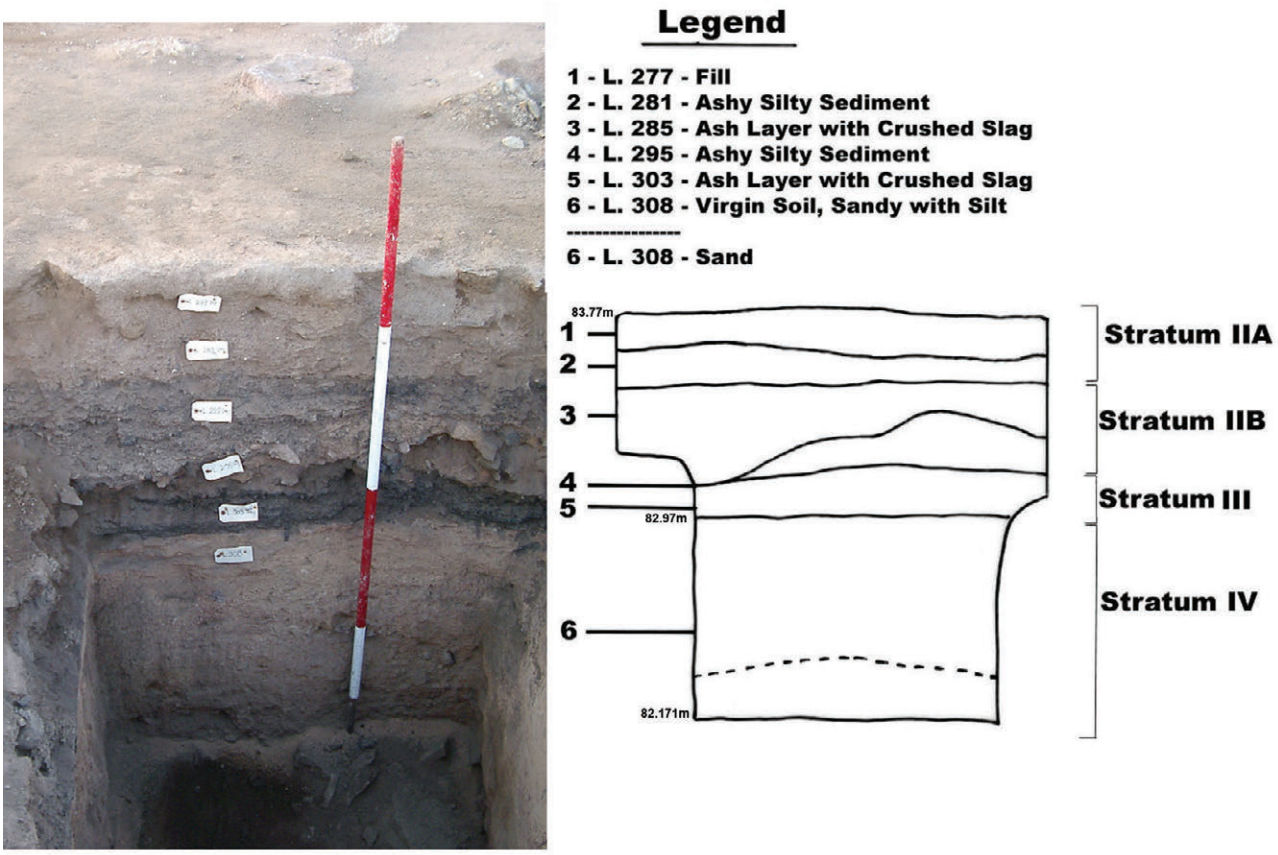

Figure 2.109 Photo and section drawing of Area S stratigraphic probe. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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fragments, partially processed copper, copper ore, slag with copper, and copper metal were represented among the pyrotechnology finds. Thus, casting and some limited bead production took place in these extramural courtyards (Figure 2.110S).

Layer S3—Slag Horizon

Layer S3 consisted of evenly crumbled slag situated below the foundations of the Layer S2B building. The slag was used for leveling the surface prior to building the semi-subterranean S2b structure. The lower line of the wall foundations was remarkably straight to facilitate the construction of the four-room building. The common feature for all the loci below the structure was paucity of artifacts from this layer.

The S3 slag layer appeared as the surfaces from Layer S2b were excavated and removed to expose the foundations of the building. Small probes were made through each floor so the slag layer was not exposed to its full extent. The layer was the thickest below Room 2 (L345) (Figure 2.114S) extending below W298 into Room 1 (L342) (Figure 2.112). Below Room 3, the slag layer (L344) appeared unevenly with a concentration to the northeast. A copper arrowhead was collected from here and recorded with the EDM (B7559, EDM 71533) but most likely belonged to Layer S2b (L339; Figure 2.111). The uneven surface above the slag as well as the irregular distribution of slag below Room 3 could explain why the arrowhead was recorded as part of Layer S3 (Figure 2.116S).

Layer S4

Although Layer S4 runs below the foundations of the Area S building, like Layer S3, it was reached by making probes in the different rooms. Thus, orientation is maintained by making reference to these layers in reference to rooms where the probes were made. The S2b architecture was not to be removed, so the layers below were bounded by the different rooms. As only small probes were made, the function of the lower levels (S3–S4) is difficult to explicate.

Below Room 1 (L353)

Approximately half of the floor in Room 1 was probed to Layer S4. The top of Layer S4 sloped to the south (Figure 2.113S). The S3 slag layer above it was quite thick, especially toward the south (below W298), which may have helped level out the topography of Layer S4 prior to when the S2b structure was constructed. Very few artifacts were found on this surface; however, two large pharyngeal fish teeth were collected (see Chapter 8, this volume). The surface may have been disturbed when the slag fill was distributed over it. As the surface was removed, virgin soil appeared below as yellowish sandy sediment mixed with gravel (Figure 2.112).

Below Room 2 (L353)

The southern quarter of Room 2 was probed near the corner of S2b W297 and W291. The S4 surface appeared as a hard-packed mud brick, light in color. Some pottery sherds and partially processed copper were found. A cup mark, possibly to retain a ceramic vessel, was found in the southwest corner of the locus (EDM 71637). Virgin soil appeared as yellowish sandy sediment mixed with gravel (Figures 2.114S, 2.115).

Below Room 3 (Upper Level Layer S4, L347)

The Layer S3 slag partially covered the top of this fill that rests above the S4 surface. A number of finds were collected from this probe, including a hammer stone and some copper ore. L351 was opened below this



Figure 2.111 Copper arrowhead found below Room 3 (EDM 71533, L344, B7559).
Photo: UC San Diego Levantine Archaeology Laboratory.

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Figure 2.112 Below Room 1, L353, with Layer S3 slag deposit; probe near W297, L353.



Figure 2.115 Layer S4 surface below Layer S4 slag, Room 2. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

locus to reveal the S4 surface. This is one of the few places in the excavations at Khirbat en-Nahas where Early Bronze Age sherds were found. Unfortunately, these are not diagnostic sherds, so it is not possible to pinpoint which EB phase they belong to.[62]

Below Room 4—Upper Level Layer S4, L346

The makeup of this locus below Room 4 was similar to neighboring Room 3 (L347), but larger amounts of animal bones and some IA pottery sherds were found. A possible stone mold was recovered here, broken

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in two pieces, with a single groove on both sides. An installation (L356) was found in the northwest corner of the locus, related to the Layer S4 surface below (L350; Figure 2.118). Some Early Bronze Age sherds were found here.

Lower Level Layer S4, L350, Room 4

Approximately half of room was probed. The surface appeared below the fill layer above (L346). A rectangular installation was found in the northwest corner of the locus and excavated separately as L356. A sample of mud brick material that may have been part of the installation was recovered along with some ceramics and other finds. As the surface was removed, virgin soil appeared below as yellowish sandy sediment mixed with gravel (Figure 2.118S).[63] A small number of sherds, hammer stone, dimpled hammer stone, and a reddish stone were collected from inside the installation (Figure 2.119S).

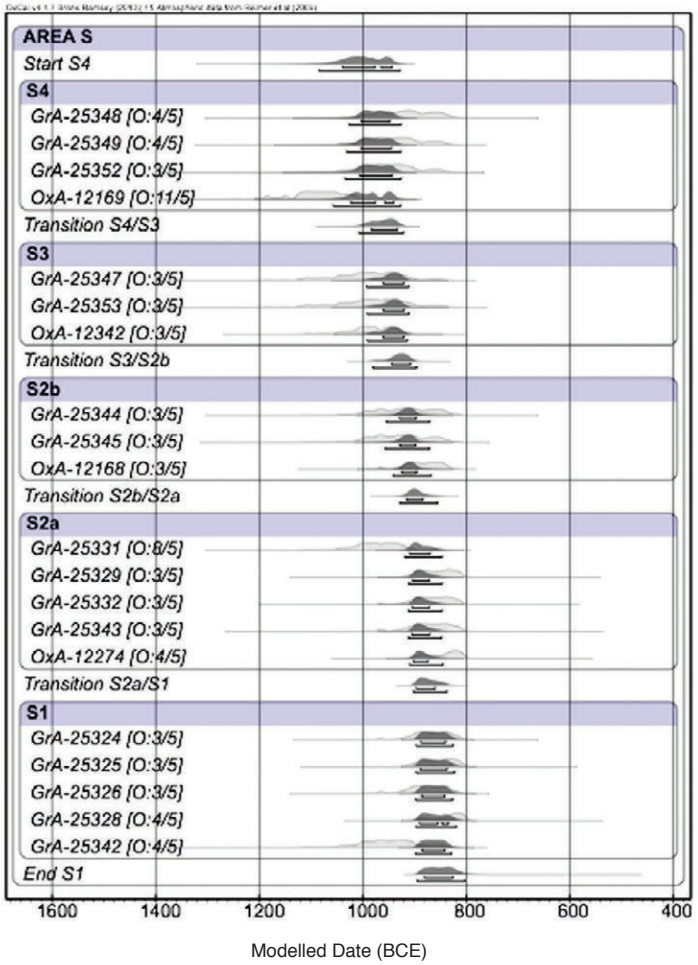

Figure 2.120 Bayesian model for Area S. Radiocarbon determinations are grouped by phase, from earlier at the top. The likelihoods (single calibrated ages) are shown in light gray, while the posterior distributions (in black) show the results after Bayesian modeling.

Layer S5

Below Layer S4, "virgin soil" is represented by Layer S throughout Area S. It was first reached in the probe (L308) northeast of the building, where it appeared as a yellowish sandy sediment mixed with gravel. After approximately 1 m of virgin sediment was excavated, the probe was abandoned. The lower portion of the locus consisted of coarse sand. No artifacts were found here.

Radiocarbon Dating of Area S

A total of 20 radiocarbon dating samples were processed for Area S. Four of these dates were from the Oxford Radiocarbon Accelerator Unit and 16 from the Centre for Isotope Research, University of Groningen, the Netherlands (Higham et al. 2005; Levy, Najjar, van der Plicht, et al. 2005). The reason so many dates were produced for such a modest excavation area at KEN is because they were made early on in the ELRAP research project when we were attempting to clarify exactly where this lowland site fit in the Iron Age sequence of southern Jordan. The fact that these dates fell very early in the Iron Age dating sequence of Edom led to the scholarly debates concerning the chronology of Edom noted above. Here we calibrate the dates with the latest version of OxCal (4.1; Bronk Ramsey 2009a) and present new Bayesian analyses of the suite of dates from Area S.

The age model is shown in Figure 2.120. It is based on the archaeological sequence identified in the field and outlined above. Put simply, this consists of a sequence of five archaeological superimposed levels, from S4, the basal occupation layer comprising small-scale metallurgical activity, through S2a, the main architectural and occupation phase, to S1, the latest level, representing the structural collapse and potential reuse of the site as a pen. The radiocarbon ages, or likelihoods, are placed in their phases within the model. We used an outlier detection analysis to determine whether there were any significant statistical outliers in the group. This is based on the method outlined by Bronk Ramsey (2009).

The model shows no significant outliers (one determination, OxA-12169, is approximately two times more likely to be an outlier than the prior outlier setting of 0.05 probability but is still not significant). The other determinations are less than 0.05 probability, likely to be an outlier, again with one exception that is

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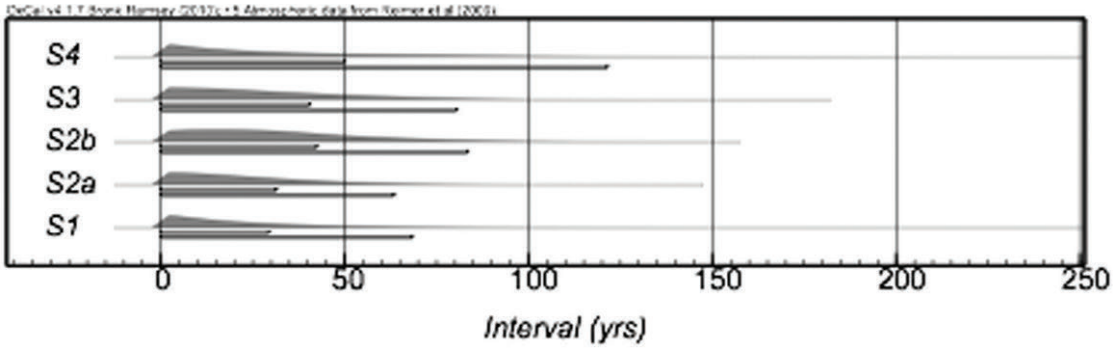

Figure 2.121 Spans for each of the principal phases in the Area S excavation.

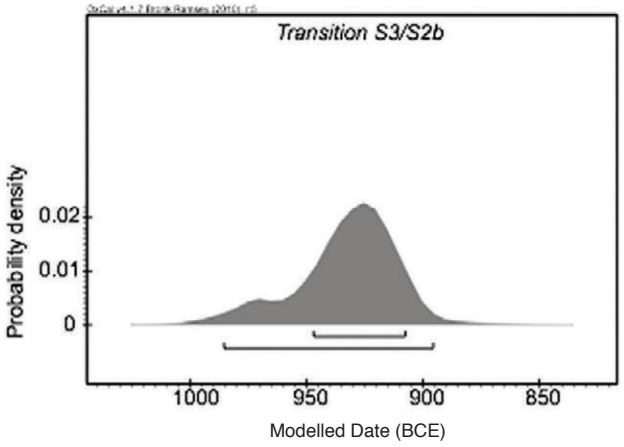

Figure 2.122 Start boundary for the transition from Layer S3 to Layer S2b. This effectively marks the start date for the main architectural construction and occupation in Area S.

marginally higher at 0.08 probability. Taken together, the model is therefore very consistent and outliers are not apparent. We ran the model four times to check convergence, and in each case convergence was more than 99.4 to 99.9 percent. This shows that the MCMC algorithms are finding solutions relatively fast and are therefore not slow to converge. Again, this is an encouraging sign and shows that the model is robust.

The model shows that the basal occupation started between 1035 and 944 BCE (68.2 percent probability) and that this phase (Layer S4) lasted for 0 to 50 years (Figure 2.121). The foundation deposit of crushed slag, which represents Layer S3, began between 984 and 933 BCE (68.2 percent probability) and the main architectural and occupation phase of the building (Layer S2b) began slightly later, between 944 and 908 BCE (Figure 2.122), although there is obvious overlap in the posterior distributions. This seems consistent with the archaeological interpretations above. Our analysis shows that this phase of building and occupation lasted for 0 to 43 years (68.2 percent probability) and could therefore have potentially been of a few years in duration, but we cannot know this at this level of precision (Figure 2.121). It was not longer than a century, though. The total time span represented by the main phase and the subsequent phase of additions to the Layer S2b architecture (ie the span of time from the start of S2b to the end of S2a) ranges from 28 to 88 years (at 68.2 percent probability) and 10 to 123 years (at 95.4 percent). The results show that the building use and activity probably lasted until the end of the ninth century BCE at the very latest.

Elite Residence: Area T—Introduction

Excavations in Area T, which appeared as a large mound of rock rubble identified by Glueck (1935), revealed a large Iron Age building constructed with thick exterior walls encompassing five rooms, one tower, and an interior courtyard. The structure was designed with two occupation floors. Although minute traces of metal production were found inside the structure, the artifacts, numerous samples of carbonized wood, and seeds recovered from the various layers indicate the function of the structure in the different occupation phases. Area T is centrally located on the eastern side of Khirbat en-Nahas (Figure 2.123), situated around 35 m east from Area R, 20 m northeast of Area S, and approximately 17 m north of the DBM probe. The numerous mounds of slag and stone debris in this area led Glueck (1935) to hypothesize this was one of a series of towers along the eastern side of the site. The excavations described here were aimed to test this hypothesis as well as the relationship between this structure, the fortress, and the nearby building in Area R.

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Table 2.11 Radiocarbon dates from Khirbat en-Nahas, Area S.

Lab Number	EDM	Season	Locus	Sample Material	Species	Layer	Stratum	Date BP	Cal Date BC (68.2 and 95.4 percent probability)	Bibliography
GrA-25331	70708	2002	301	Charcoal	*Phoenix dactylifera*	S2A	II	2820 ± 35	1009–919 1112–894	Levy, Najjar, van der Plicht, et al. 2005 :Table 10.1
GrA-25324	70477	2002	263	Charcoal		S1	I	2720 ± 35	897–929 927–805	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
GrA-25325	71109	2002	312	Charcoal	Indeterminate	S1	I	2700 ± 35	893–810 910–801	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
GrA-25326	70920	2002	317	Charcoal		S1	I	2735 ± 35	904–834 971–809	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
GrA-25328	70914	2002	317	Charcoal		S1	I	2670 ± 35	886–798 897–794	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
GrA-25329	70661	2002	301	Charcoal		S2A	II	2705 ± 40	894–814 923–798	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
GrA-25332	71220	2002	322	Charcoal	*Tamarix* sp.	S2A	II	2715 ± 40	897–823 968–800	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
GrA-25342	70984	2002	317	Charcoal		S1	I	2795 ± 45	1008–896 1054–827	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
GrA-25343	71552	2002	340	Charcoal	*Tamarix* sp.	S2A	II	2720 ± 45	902–821 973–799	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
GrA-25344	71507	2002	336	Charcoal	*Tamarix* sp.	S2B	III	2770 ± 45	973–841 1015–815	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
GrA-25345	71448	2002	338	Charcoal	*Tamarix* sp.	S2B	III	2780 ± 45	995–854 1039–825	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
GrA-25347	71559	2002	344	Charcoal	*Tamarix* sp.	S3	V	2830 ± 45	1043–919 1125–848	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
GrA-25348	71571	2002	346	Charcoal	*Tamarix* sp.	S4	VI	2770 ± 45	973–841 1015–815	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
GrA-25349	71569	2002	347	Charcoal	*Tamarix* sp.	S4	VI	2790 ± 45	1005–894 1049–827	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
GrA-25352	70609	2002	353	Charcoal	*Tamarix* sp.	S4	VI	2800 ± 45	1008–899 1108–831	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
GrA-25353	71570	2002	342	Charcoal	*Tamarix* sp.	S3	V	2820 ± 50	1039–908 1121–841	Levy, Najjar, van der Plicht, et al. 2005:Table 10.1
OxA-12168	71475	2002	336	Charcoal		S2B	III	2747 ± 26	911–841 970–825	Levy et al. 2004:Table 1; Higham et al. 2005:Table 11.2
OxA-12169	71667	2002	356	Charcoal		S4	VI	2899 ± 27	1124–1024 1206–1002	Levy et al. 2004: Table 1; Higham et al. 2005:Table 11.2
OxA-12274	71268	2002	331	Charcoal		S2A	II	2682 ± 34	891–802 898–798	Levy et al. 2004:Table 1; Higham et al. 2005:Table 11.2
OxA-12342	70597	2002	341	Charcoal		S3	V	2830 ± 27	1012–929 1068–904	Levy et al. 2004:Table 1; Higham et al. 2005:Table 11.2

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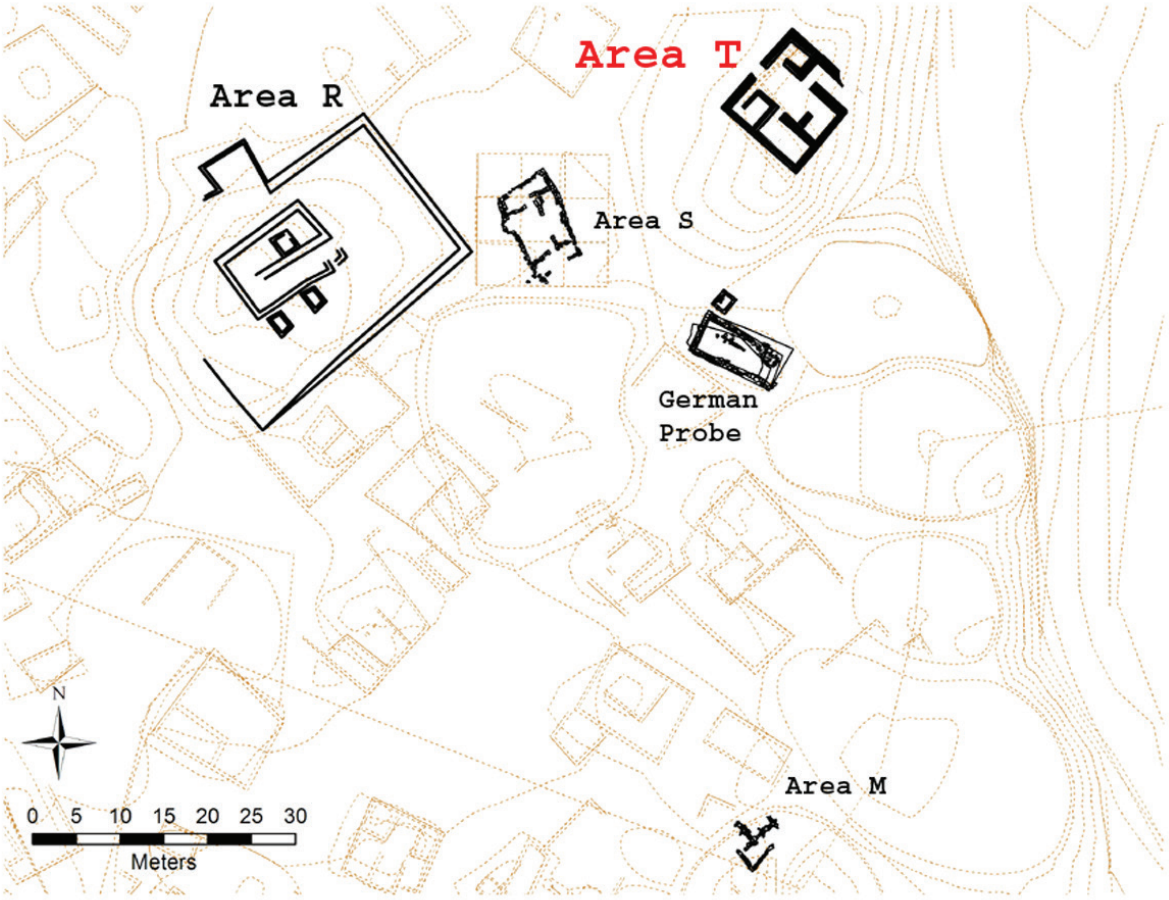

Figure 2.123 Map of excavations adjacent to Area T.

After removal of stone collapse, the basic outline of the rooms in this structure was revealed. What started as a probe became a full-scale excavation. Rock removal of wall collapse and fill from the exterior and interior of the structure revealed a well-designed building with four rooms, a tower, and an interior courtyard that served as a public space (Figures 2.124, 2.125).

The dimensions of the walls and rooms of the main structure are listed in Appendix 2.T.2—Room measurements). The walls of the main structure have been constructed in two courses of large stones and are filled with medium to small stone debris. The height of the exterior walls varies across the site but is the lowest in the southwest corner of the structure. The walls in the interior rooms share similar construction attributes; although the height preservation of the walls varies across the structure, they are best in the central and northern areas. With the exception of Room 4, all rooms in the structure are well defined and have entrances with thresholds or stairs, suggesting the final excavated building may represent the original building design. A discussion of each room and the associated features is presented following a brief discussion on the occupation phases at the structure.

Occupation Phases and Associated Loci

Excavations at Area T identified two surfaces of occupation, respectively identified as Phase 2 (the final surface of occupation) and Phase 1 (the original surface). Figure 2.126 depicts the surfaces excavated in the interior of the courtyard. With the exception of Room 5, no surfaces were found within any of the other rooms in the structure. Traces of surfaces were, however, located in forms of small patches of compact mud associated with the final occupation phase. Similarly, evidence for activity areas in the exterior of the main structure was lacking. Given the slope of the foundation mound and the adjacent drainage, natural processes would have eroded and destroyed such features.

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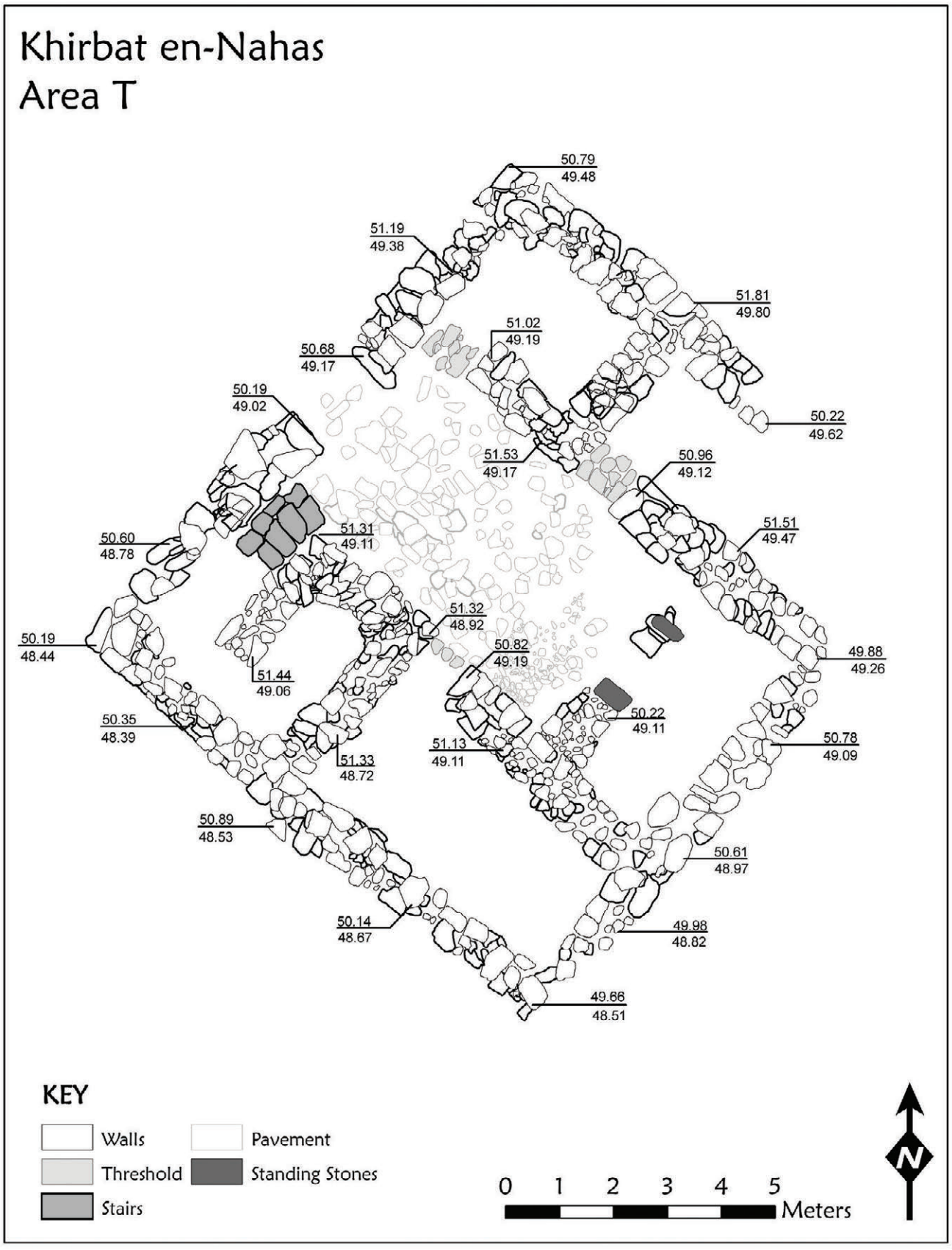

Figure 2.124 Map of the Area T structure and the associated rooms.

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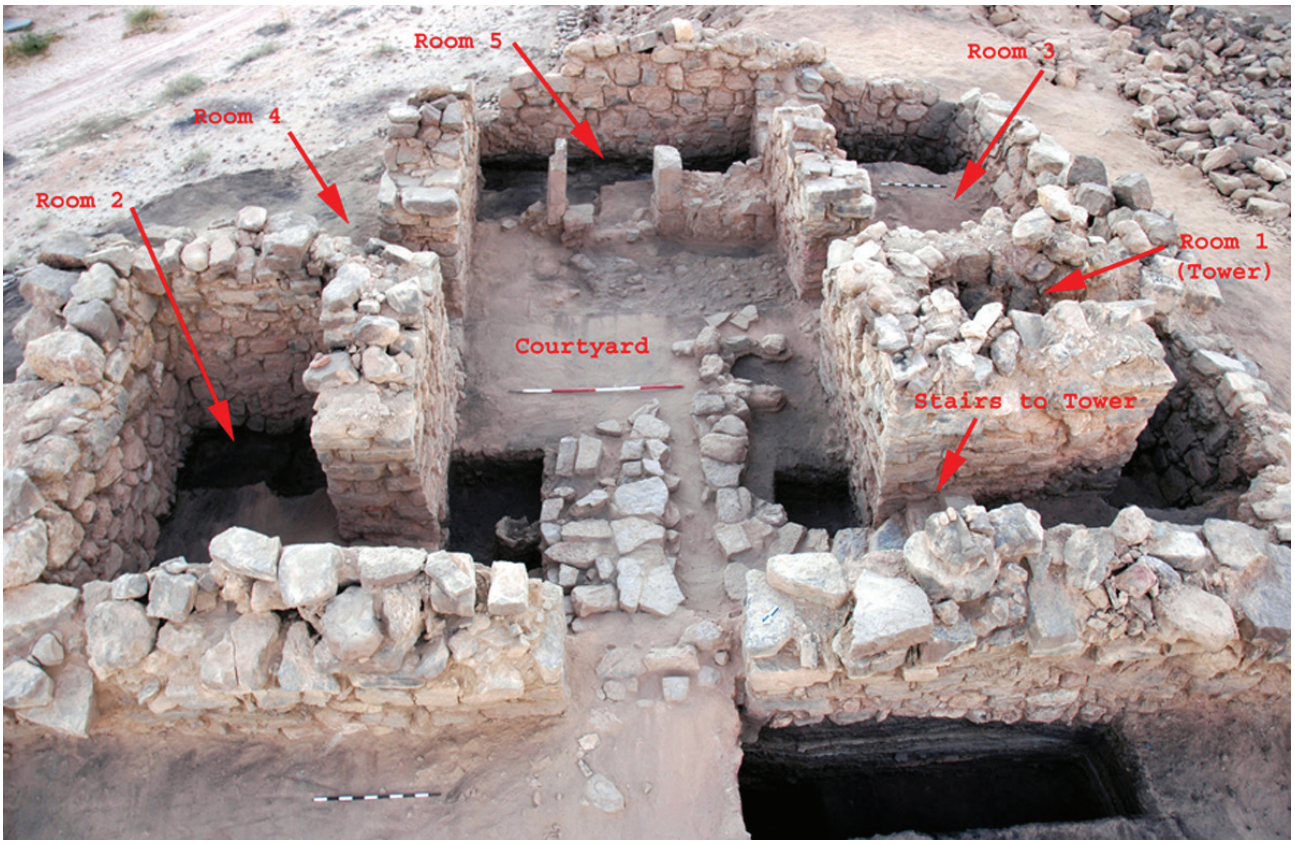

Figure 2.125 Photo of the Area T structure and the associated rooms.
Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.

Overall, 106 loci (Appendix 2.T.1) were assigned to six layers: T1a, T1b, T2a, T2ab, T2b, and T3. The Harris matrix for Area T depicting the four layers and their assigned loci is listed in Appendix 2.T.5. Loci in Layer T1a represent the mound of wall collapse. The loci assigned to Layer T1b consist of the fill and wall collapse. This layer includes sediments removed from the interior and exterior of the main structure to floor level. Loci associated the final occupation phase have been assigned to Layer 2a. This includes any ash layers associated with activity areas. Layer T2ab is associated with both occupation phases. These include the thresholds to all the rooms and the stairs leading to the tower. Finally, loci associated with sediments excavated beneath the crushed slag layer, the foundation of the main structure, have been assigned to Layer T3. Figure 2.127 presents a visual summary of the layers and some of the key features that they represent. The individual layers are further discussed here and are then associated as they were excavated in each room (Section IV). The Harris matrix for Area T is presented in Appendix 2.T.4.

Layer T1a

Loci identified as part of Layer T1a were assigned to the collapse of rocks from the structure. The collapse consisted of a large mound of stones surrounding an area of fill and wall collapse (Figure 2.128S). The wind-blown sands had accumulated over time and formed a semi-compact layer of sediment underneath the stones. The layer of wall collapse extended from the mound that made up the main structure and east along the drainage wall. The wall collapse consisted of medium, large, and very large rocks—many of them contained traces of chipping from shaping the wall stones.

Layer T1b

Fill and wall collapse removal associated with the interior and exterior of the main structure was assigned to Layer T1b. Once the upper layer stones from the wall collapse were removed, loose accumulated wind-blown sands mixed with stone debitage and structural collapse from the main structure were found underneath (Figure 2.129S).

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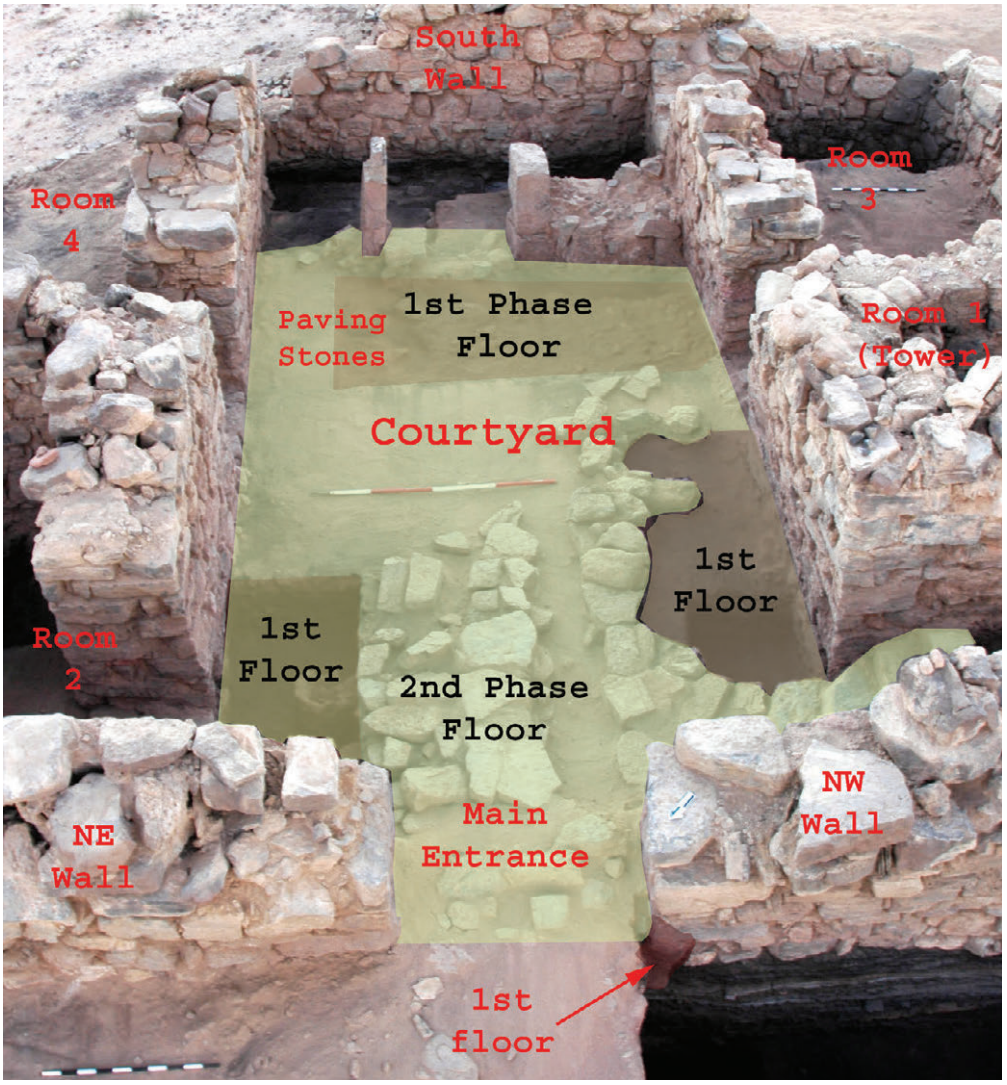

Figure 2.126 Photo depicting two phases of occupation within the main structure.

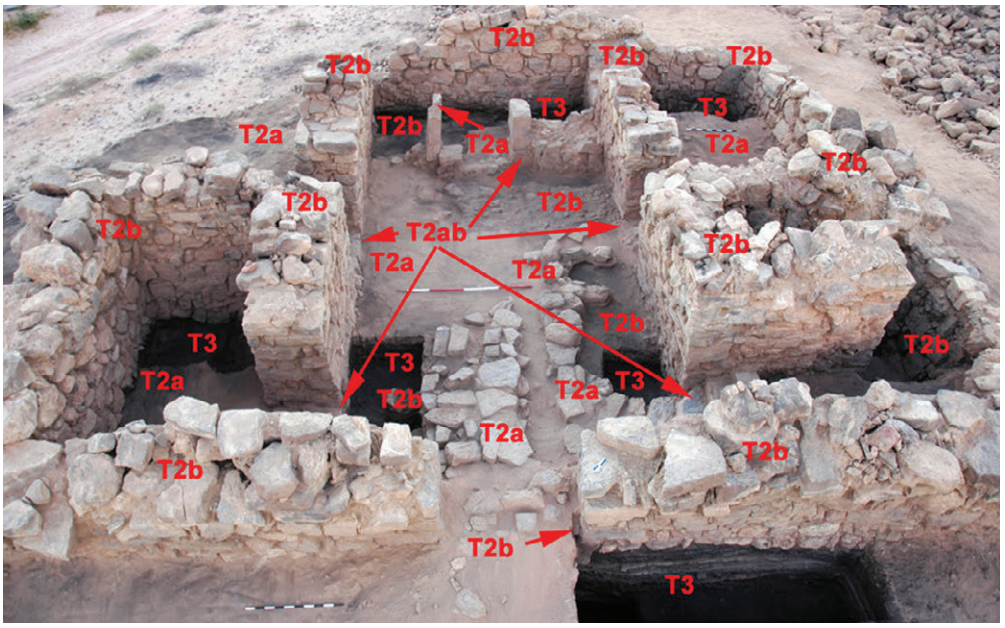

Figure 2.127 Area T main structure depicting features and their associated layers. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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Layer T2a

Layer T2a represents the final occupation level of the structure of Area T. There are several areas associated with this phase of occupation (Figures 2.126, 2.128S). Layer T2a sediments and surfaces include the ash layers mixed with patches of compact mud located inside Rooms 1, 2, 3, 4, and 5. However, the main surface from this layer comes from the courtyard. A layer of paving stones (Figure 2.130) beginning at the entrance (L1557) to the structure, extending to the stairs (L1555) to Room 1 (tower) and the central courtyard (Room 5), was embedded in a layer of compact mud. Similarly, the compact mud mixed with ash was found throughout the various rooms. Thus, any possible activity areas located inside and outside the structure have been assigned to this layer.

Room 5, situated in the southern section of the structure, was the only room where the true Layer T2a surface was located. The surface in this room was a reddish compact mud plaster mixed with patches of dark gray fill. The surface was particularly prevalent in the vicinity of the standing stones (L1532 and L1533) and the adjacent small paving stones. Only the eastern paving stone (L1533) appears to have been added during this phase of occupation. The stone sits on a flat rock that doubles as a platform and part of the surface. Beneath the platform is a layer of fill that reaches the first occupation phase.

Layer T2b

The evidence for Layer T2b, the original occupation phase of the structure, comes from three main sources: the courtyard, the walls of the structure, and Room 5. The areas are depicted in Figures 2.126 and Figure 2.128S. In the courtyard, a layer of paving stones underneath a compact mud layer mixed with ash was unearthed (Figure 2.131). This layer was found beneath the first layer of paving stones discussed above in Layer T2a. Similarly, at the entrance to the structure, a layer of paving stones was found underneath a layer of compact fill beneath the final occupation entrance. Two probes initiated at opposite ends of the courtyard revealed similar results. Both probes revealed a compact mud surface containing artifacts in situ. These are further discussed in the following section.

Associated with Layer T2b are the walls of the rooms and the main structure. The evidence is derived from the foundation of the structure—the layer of crushed slag found beneath all the walls. Other than the standing stone (L1533), no other additions are evident.



Figure 2.130 Layer T2a paving stones in the courtyard and in the area behind the standing stones located in Room 5. L1533 is the stone on the left. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

In Room 5, a hard compact mud surface covered in a dark gray ash layer was found beneath the first surface. A fire installation was found in the western section of the room at the surface level. Underneath the floor, many fragments of a metallurgical nature were recovered. It does not appear that these fragments are related to a production activity but were used as part of mixed sediment to raise the floor in this sloping section of the structure.

Layer T2ab

Layer T2ab encompasses several features and installations that appear to have been used throughout both occupation periods. These include standing stone (L1532) and the three thresholds associated with the three rooms, as well as the stairs leading to Room 1 (the tower). These areas are associated with both surfaces, as indicated by the foundations of the wall in Layer T2b and the paving stones located in Layer 2a.

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Figure 2.131 Layer T2b surface uncovered in the southern section of the courtyard.

Layer T3

The crushed slag layer found beneath the first occupation surface defines the boundary of Layer 3. The associated stratigraphy below the slag layer was excavated without reaching bedrock. Dark brown sediment with a layer consisting of light brown wind-blown sand was encountered. With the exception of the eastern probe, excavations below Layer 3 failed to reach sterile deposits.

The Rooms of Structure T

Room 1: The Tower

Room 1 (Figure 2.132), known as the tower, is the room situated in the northwest corner of Structure T. No other part of the Area T building had evidence of a second floor, so we have identified Room 1 as the basal portion of a tower. The main north wall (W1539) defines the entrance to the room and the northern interior wall of the room (W1543). Four steps (Figure 2.132),

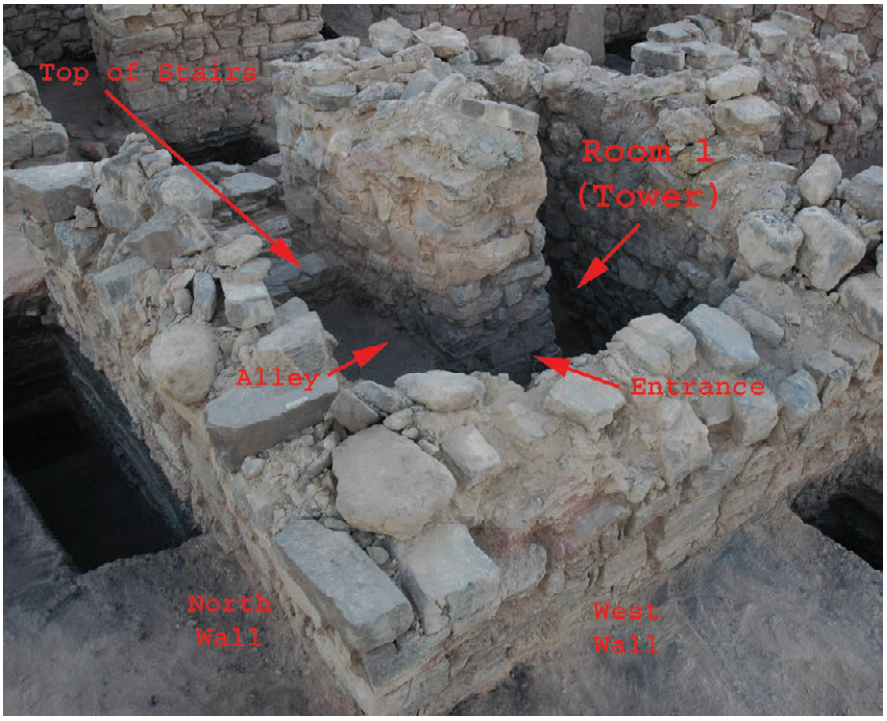

Figure 2.132 Room (tower), affiliated entrance, and stairs. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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each constructed with flat stones, pave the way into a small alley that leads to the entrance of the main room. Although no more stairs were unearthed, in situ, similar flat stones were recovered from the collapse in this area.

The dimensions of this small room (Room 1) are listed in Appendix 2.T.2. The entrance to Room 1 is situated between W1543 and the western wall of Structure T (W1541). The room was probed to a depth just below 4 m. The bases and the foundations of all three walls were revealed. The north wall, the shallowest of the three, was constructed on a layer of fill. This type of foundation varies from the east and south wall as their foundation consists of a layer of densely packed crushed slag.

Room 1 Stratigraphy

The Harris matrix for the stratigraphy identified in Room 1 is listed in Appendix 2.T.4. The associated loci with Room 1 are divided into two excavation areas: the main room and its associated entrance. The loci for Room 1 are L1503, L1511, L1516, L1524, L1560, L1587, L1589, and L1599. The loci are distributed within four different layers. Layer T1a is identified by the numerous amounts of wall collapse found on the surface of the area. The stones varied in size, and in many cases, several individuals were required to move them. Beneath the wall collapse, a sediment layer consisting of wind-blown sands had accumulated in the wall collapse. The layer at this level is identified as T2b. Layer T2b encompasses the final occupation phase at Structure T and includes all the walls and the associated collapse. The removal of the wall collapse and fill in the interior of Room 1 revealed a sediment layer of ash mixed with large amounts of slag and other artifacts. Approximately 2,046 kg of slag were recovered from L1524. Also recorded were 47 partially complete tuyère pipes, 2 large furnace fragments, 8 samples of carbon, 7 samples of slag containing carbon, worked stones, grinding stones, hammer stones, and 1 fragment of Cypro-Phoenician pottery. The locus continued for approximately 2 to 2.5 m.[64] The second area excavated

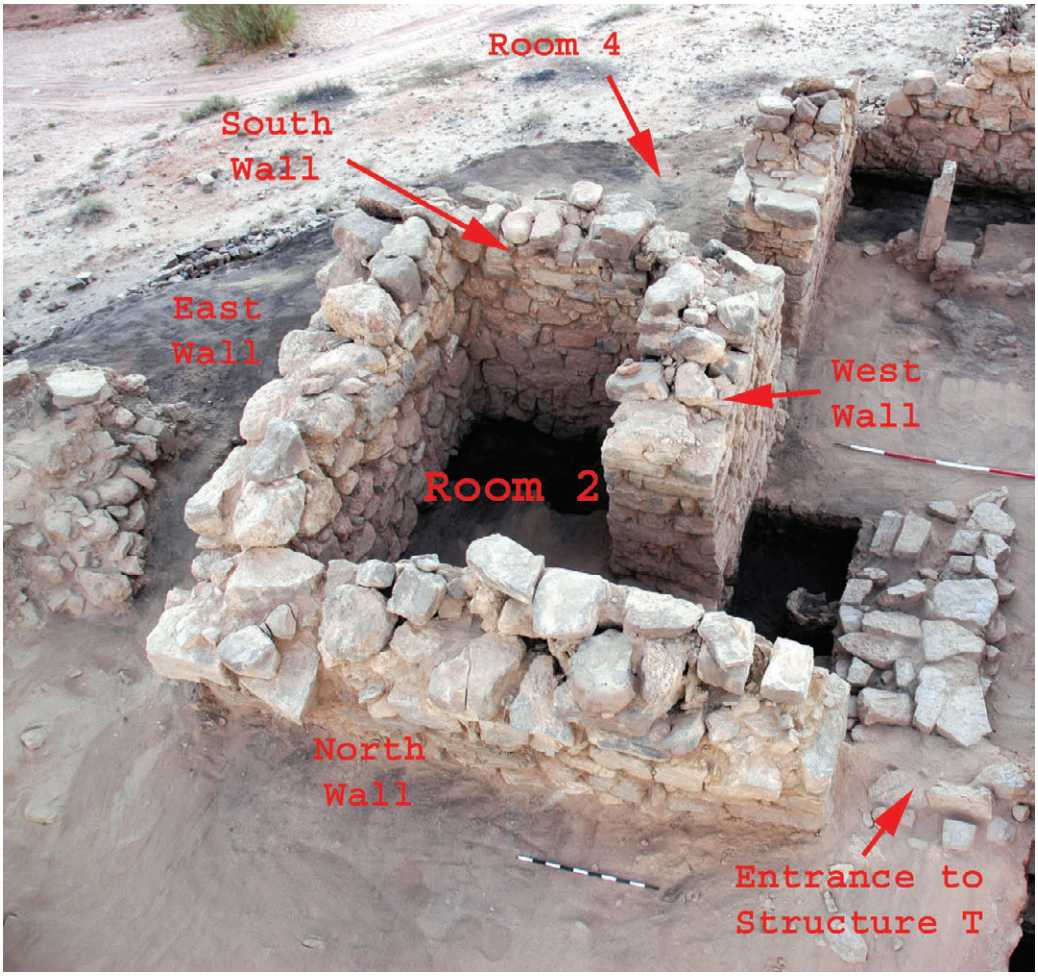

Figure 2.133 Room 2 and affiliated features. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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in Room 1 was the area to the north. With the removal of the fill and wall collapse, L1503 and L1513 revealed a fill composed of sand sediments mixed with ash. Excavation of the ash layer ceased when the top stair (L1555) was uncovered. However, excavation in the adjacent area of the courtyard (see below) revealed a total of four stairs.[65]

Room 2

Room 2 (Figure 2.133), situated in the northeast corner of Structure T, is defined by four walls. The dimensions of the room and Harris matrix are found in Appendix 2.T.4. The room is defined in the north and east by the interior of the north (L1505) and east (L1534) walls of the main structure. Wall (L1535) defines the south wall, and Wall (L1536) defines the west wall. A threshold composed of two courses wide by one course high was uncovered at the entrance between this room and the interior courtyard.

Room 2 Stratigraphy

The room itself was excavated to an ash layer containing small patches of compact mud just below the threshold level. However, no significant surfaces were located within these excavations. Similarly, a probe in the southern part of the room was excavated well below the base of the east, south, and west walls (Appendix 2.T.4). While the probe failed to identify any surfaces, it did reveal a large layer of crushed slag immediately beneath all three walls. The function of Room 2 is not entirely known. However, the artifacts recovered from this room include several large grinding slabs. Following the types of artifacts recovered, the most logical conclusion is that the function of this room was domestic in nature or served as a storage area.

Room 3

Room 3 (Figures 2.134S, 2.135S), situated in the southwest section of Structure T, is the largest of the five rooms found within the main building. The room measurements are presented in Appendix 2.T.2. The north wall (W1545) is the dividing wall between this room and Room 1. The west (L1540) and south (L1506) walls of the main structure define the southwest corner. This corner is also the lowest point of the mound on which the structure was constructed. The walls at this corner are also the lowest in height. The east wall (L1546) separates this room from the courtyard. A small threshold (L1605) composed of a single row of stones separates the entrance from Room 3 into the courtyard. The stratigraphy in Room 3 is similar to Room 2, in that there were no surfaces found in this room.[66] The function of the room is difficult to define, and given it is the largest room in Structure T, it may have served as an administrative room or living quarters.

Room 4

Room 4 (Figure 2.136S), located in the southeast section of Structure T, is incomplete and missing the south wall. The room is defined by W1535 in the north, a small section of W1534 in the east, and W1538 in the west. The majority of the east wall, including the southeast corner, is absent, and its remnants were evident in the drainage cliff below. Given that the missing section of the room opened toward the drainage, the fill and wall collapse deposited in this area created a terrace in the southern opening.

Room 4 Stratigraphy

The stratigraphic makeup of Room 4 is presented in the Harris matrix (Appendix 2.T.4). Fill and wall collapse removal in this room revealed a possible installation along the north wall (Figure 2.136S, left). The installation was composed of several stones and contained pottery sherds and a large piece of tap slag. Along the western wall in an ash layer above a layer of crushed slag (foundation), several sherds of Cypro-Phoenician pottery (Figure 2.137), dating to the mid-ninth century, were recovered. The best-preserved threshold (Figure 2.138) in Structure T was unearthed in this room, consisting of four courses wide and one course high installation that led into the eastern sector of the courtyard into the first occupation phase.

Excavations in Room 4 were conducted without reaching any definitive surfaces. In the interior of this Room 4, the threshold contained the best evidence of a possible surface. Traces of compact mud-plaster were unearthed on small stones adjacent to the threshold (L1600). A probe initiated in the north section of the room failed to find further evidence of any possible surfaces. The function of Room 4 is difficult to discern due to the loss of the wall and the erosion processes that occurred within the structure. However, given the size and layout present, it follows that the function of this room is similar to Room 3 and may have served as an administrative area or living quarters during both occupation phases.

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Figure 2.137 Cypro-Phoenician ceramics recovered from Room 4. Similar pieces, probably belonging to juglets, were recovered in Rooms 1 and 5. *Photo: UC San Diego Levantine Archaeology Laboratory.*

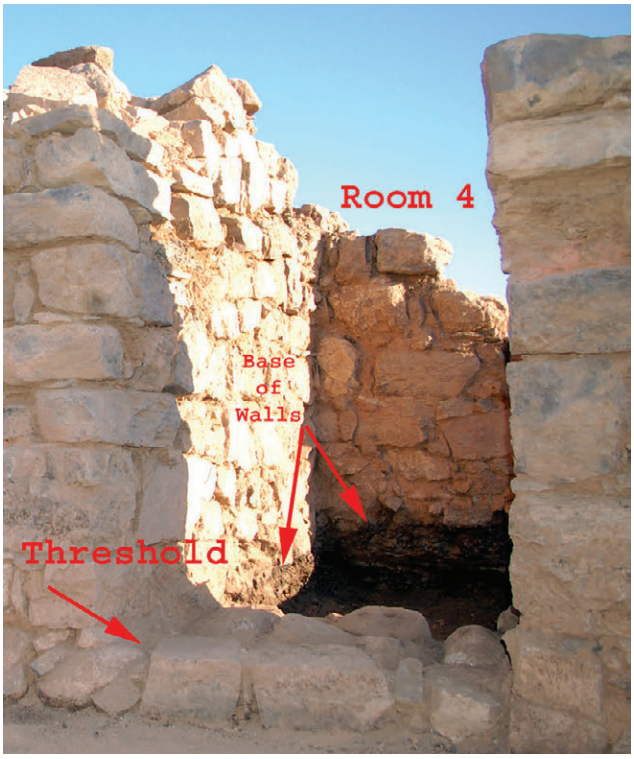

Figure 2.138 Threshold at the base of entrance to Room 4. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

Room 5

Room 5 (Figure 2.139) is situated in the southern portion of Structure T. Originally believed to be part of the courtyard, the room is defined in the north by two standing stones, L1533 and L1532, and is part of a small wall/platform (L1537). W1546 in the west, the main south wall (W1506) in the south, and W1538 in the east complete the room. The northern boundary of the room, based on standing stone 1 (L1533), is, at best, questionable. The standing stone is resting on a flat stone that is level with a compact mud floor in the interior of the room. Therefore, it follows that this stone did at one time delineate the boundary of this room. Standing stone 2 is situated on a large square stone that is part of the western wall or platform that is shared with both Room 5 and the courtyard.

Room 5 Stratigraphy

Excavations in the interior of Room 5 revealed two occupation surfaces (discussed below). The final occupation surface was composed of a dark ash layer with patches of compact mud and scattered paving stones. Underneath the first surface, a second surface containing a fire installation (L1542; Figure 2.140S) was unearthed. Adjacent and beneath the surface, numerous amounts of furnace, tuyère pipe, and bellow pipe fragments were recovered. Whether these artifacts were part of the installation or part of the fill used to level the surface is open for debate. However, if metal production did occur inside this structure, Room 5 contains the most evidence.

A trench was initiated at the southwest corner of the room. Below the base of the walls and well into the slag layer that served as the foundation of the structure, a door socket adjacent to a fire installation was uncovered (Figure 2.141). In the west area adjacent to the slag layer that contained the artifacts, the contour of the landscape turned downward and had been leveled to the slag layer.

Courtyard

The courtyard (Figure 2.142) begins north of Room 5 to the north main wall beyond the entrance to Structure T. Two surfaces were uncovered in this area. The first surface (L1557, second occupation phase) was identified at the base of the stairs and encompasses the series of paving stones throughout the courtyard. In the southern section of the courtyard, along W1537 and the two standing stones, a second surface (L1602, first occupation phase) was identified (Figures 2.126, 2.142). The stratigraphy excavated is presented in Figure 2.143S.

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Figure 2.139 Room 5 and affiliated features.



Figure 2.141 Artifacts found below the first occupation surface. The large stone with a depression is a door socket. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

Courtyard Stratigraphy

As previously stated, the thresholds from Rooms 2, 3, and 4 were used throughout the occupation of the structure, as they are clearly part of both surfaces. A probe (Figure 2.144) initiated adjacent to the stairs indicates both surfaces are clearly present. The second occupation surface is defined by the bottom of the large paving stones that begin at the entrance. As they progress south toward the center of the courtyard, they are elevated from the first surface by additional paving stones indicating the stairs and the tower were used throughout both occupation phases. In the original surface (first occupation phase), a tabun (Figure 2.145) was recovered in situ against W1544. Following this discovery, a probe (Figure 2.146S) was launched in the eastern section of the courtyard

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Figure 2.142 Courtyard and affiliated features in Area T.

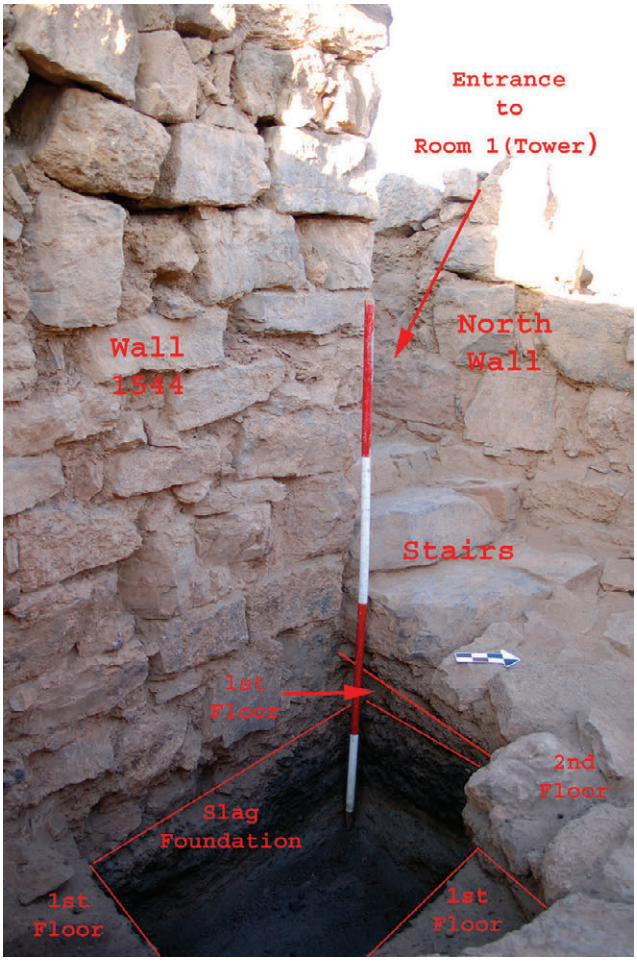

Figure 2.144 Probe adjacent to stairs highlighting the two occupation phases. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

to investigate the surfaces and the function of the courtyard. On the first occupation surface, the probe revealed a conical-shaped installation in situ (Figure 2.147) containing two hammer stones and a pestle. The artifact was originally believed to be a mortar with two pestles. However, following the removal and analysis of the contents, the installation was not a mortar, but these objects were part of a secondary use feature that may have been used as a base for storage jars or similar.

In the southern section of the courtyard, the first occupation surface was found intact. The surface is composed of a layer of compact mud-plaster and contains large traces of ash. Beneath this layer, paving stones in situ were exposed (Figure 2.148). The paving can found throughout the southern section and into the center of the courtyard up to the large flat stones found in the north.

Radiocarbon Dating for Area T

We obtained eight radiocarbon dates from the Area T excavation (Table 2.12). The determinations come from four levels in the site. We built a simple four-phase Bayesian model to analyze more effectively the radiocarbon dates with respect to their stratigraphic sequence (Figure 2.149). An outlier detection method was used (Bronk Ramsey 2009) to determine whether any of the results were outliers with respect to the archaeological phasing imposed. This showed that there were none.

The crushed slag-dominated Layer 3 is found beneath the first occupation surface, and our modeling shows that it formed after 1021 to 945 BCE (at 68.2 percent probability) and fits within the tenth century BCE. Precision is poor due to the calibration curve wiggle through this period. The most important level in Area T is the original occupation phase

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Figure 2.145 Tabun (oven) resting on original occupation surface.



Figure 2.147 Installation with hammer stones and pestle found in situ on the main occupation surface, Area T.



Figure 2.148 Main occupation surface and paving foundation excavated in the southern section of the courtyard, Area T. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

relating to the structural remains (i.e., Layer T2b) and from the courtyard, walls, and Room 5. Based on our model, the start of this T2b phase ranges from 993 to 969 BCE (31.6 percent probability) and 959 to 935 BCE (36.6 percent probability) at 68.2 percent probability, a bimodal distribution. The length of occupation we calculate spans 0 to 80 years (95.4 percent probability) (see Figure 2.150). The final occupation level of Area T is Layer T2a, and this begins from 952 to 909 BCE (68.2 percent probability). We calculate this occupation lasts for 0 to 85 years (at 95.4 percent probability). Between 931 and 881 BCE, T1b, the final modeled phase, begins. This level represents the fill and wall collapse and infill of the structures. There is only one determination from this level, and our modeling suggests a terminal boundary at 909 to 845 BCE. Taken together, the total time span calculated for Area T from the start of phase T3 to the end of T1b is 64 to 174 years (at 68.2 percent probability) and 21.5 to 240 years (at 95.4 percent).

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Table 2.12 Radiocarbon dates from Khirbat en-Nahas, Area T.

Lab Number	EDM	Season	Locus	Sample Material	Species	Layer	Stratum	Date BP	Cal Date BCE (68.2 and 95.4 percent probability)	Bibliography
OxA-18947	41144	2006	1566	Charcoal	*Acacia* sp.	T3	V	2833 ± 30	1005–926 1050–899	This volume
OxA-18948	41071	2006	1580	Charcoal	*Phoenix dactylifera*	T3	V	2819 ± 29	891–806 896–904	This volume
OxA-18980	40290	2006	1517	Charcoal	Indeterminate	T1B	III	2701 ± 26	994–909 1013–847	This volume
OxA-18981	40686	2006	1526	Charcoal	*Tamarix* sp.	T1B	III	2797 ± 27	994–909 1013–847	This volume
OxA-18982	40488	2006	1541	Charcoal	*Tamarix* sp.	T2A	III	2755 ± 26	995–919 1041–984	This volume
OxA-18983	40989	2006	1578	Charcoal	*Phoenix dactylifera*	T2B	IV	2805 ± 28	1041–939 1110–920	This volume
OxA-18984	40908	2006	1561	Charcoal	*Tamarix* sp.	T2B	IV	2844 ± 25	1039–935 1109–916	This volume
OxA-18985	41107	2006	1599	Charcoal	*Retama raetam*	T3	V	2840 ± 26	893–822 904–809	This volume

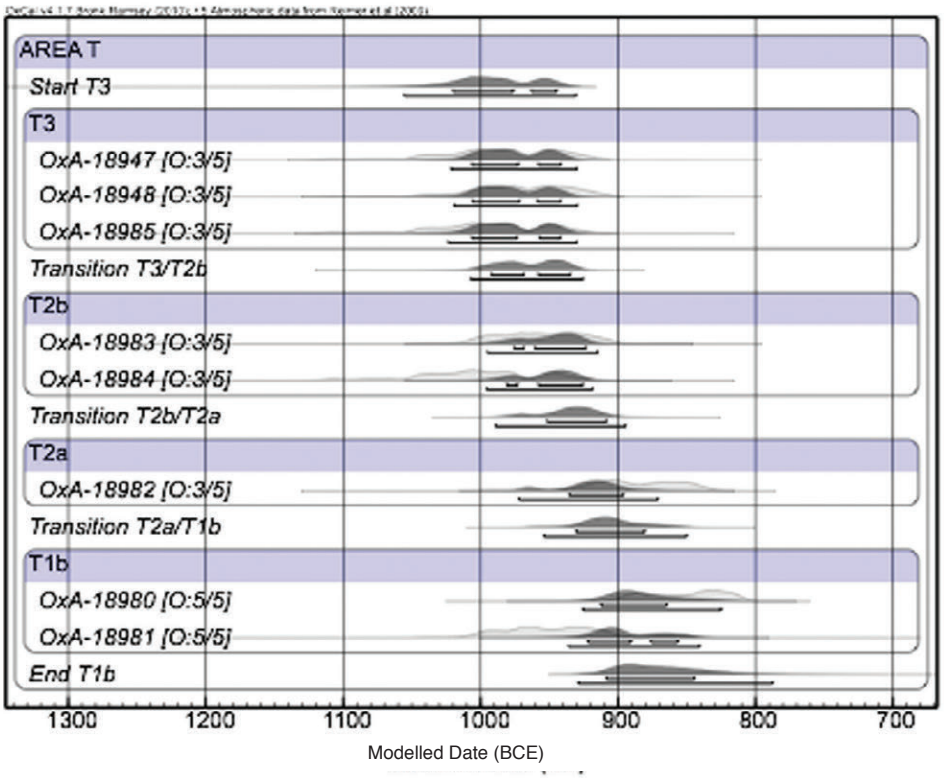

Figure 2.149 Area T Bayesian model. The model reflects the archaeological phases described in this chapter. The figures in brackets are the results of the outlier detection analysis; prior and posterior probabilities are given in brackets (O = posterior outlier probability/prior outlier).

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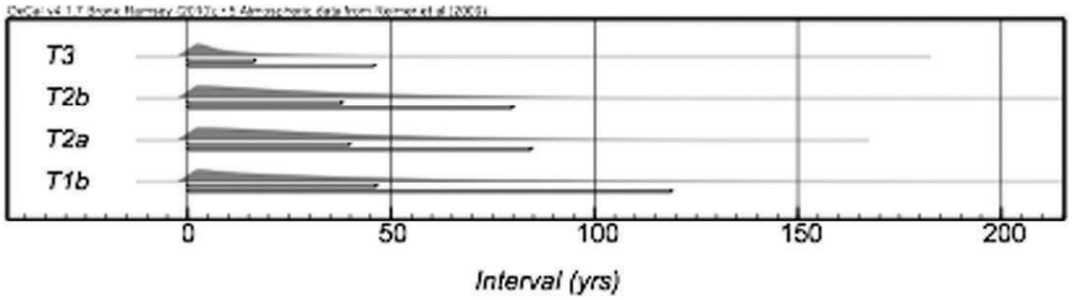

Figure 2.150 Time intervals for the successive phases modeled in the Area T excavations. This shows that most of the phases at the site are most likely to be brief periods, with less than a century spanning each one.

Summary—Area T

The excavations at Area T exposed one of the largest buildings at Khirbat en-Nahas with five rooms constructed around a large interior courtyard. Probes were made within each of these rooms. The excavations and the probes uncovered two occupation phases associate with Iron Age building. The earliest phase indicates the structure was designed and constructed on a layer of crushed slag over an area that had previously been used for metallurgical activities in earlier Iron Age phases. This surface was constructed immediately above the layer of crushed slag throughout the courtyard. Above the first surface, a second occupation phase was found. The paving stones were filled and covered with compact mud and had been laid throughout the courtyard to raise the floor toward the main entrance. A section profile at the main entrance provides the evidence for both occupation layers. Other than small additions, such as paving stones and a standing stone, no main construction phases are evident during the final occupation phase. It follows that the structure was planned and constructed for a particular function. Room 1, the tower, overlooks the interior of the site of Khirbat en-Nahas and may have served as a lookout. Room 2, with its small area, appears to have been a storage area; Rooms 3 and 4 are much larger and might have been living or administrative quarters. The mystery in the construction of the structure lies in Room 5. The function of this area with the layers of dark gray ash and a pyrotechnology installation presents some of the only evidence for an activity area in the Area T building. Whether it was industrial or domestic in function will require further analysis of the soil samples collected.[67] This administrative building was constructed (Layer T2b) around the same time as the early tenth-century BCE gatehouse associated with the KEN fortress (see Area A discussion above). The later occupation (Layer T2a) continued after the early tenth-century BCE disruption in copper production seen in the Area M slag mound (see Area M above).

Residential and Storage Complex—Area W

Introduction

Area W is located in the southern section of the site of Khirbat en-Nahas (Figure 2.151). The excavated area is part of a larger cluster of structures and courtyards that are situated south of Area R and southwest of Area M, the well-known and defined slag mound excavated during previous seasons. The most obvious characteristic of Area W is the lack of the large traces of slag heaps evident in other structures found at KEN. In this section of the site, the slag mounds are mostly confined to the structures situated immediately to the south of the site. The eastern section of the site is located atop a small mound. A probe initiated within one of the structure indicates this mound is constructed of crushed slag overlaying a mixture of finely sorted fills. This matrix was not present in the western section of the site. Soundings in this section of the site revealed deeply homogeneous sediments resting atop a compact mud floor. Time constraints did not allow further probing in the western section of the site. Eighteen rooms were revealed in Area W. These functioned as living areas, storage, and possibly cultic activities.

The large amounts of large, medium, and small stones once belonging to a series of structures marked the boundaries of the site (Figures 2.152, 2.153S). The remains of few walls were detectable amid the collapse. These walls belonged to a series of three structures separated by a north–south alley. To the northern and western sections of the site, several archaeological features were also observed, indicating that Area W is in fact part of a larger complex structure that might be representative of a "neighborhood."

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Figure 2.151 Aerial view of Khirbat en-Nahas. The site of Area W can be seen on the left side of the photo.



Figure 2.152 The stone collapse and walls of the site of Area W previous to the 2009 excavations. Note the two main structures separated by a north–south alley. *Photos: UC San Diego Levantine Archaeology Laboratory.*

Taphonomically, natural processes, including flora, fauna, and erosion, have affected the formation processes at this site. Different varieties of brushes, shrubs, and trees can be found on and around the site (Figure 2.153S). Roots were frequently encountered in the upper levels of the site, including the courtyards. Similarly, burrowing animals have made their home on and around the site. Their burrows and tracks were frequently encountered. Other than flora and fauna, erosion has significantly affected the site and the adjacent landscape. To the southwestern area of the site, recurring flooding has carved a trench through a section of one of the adjacent complexes. The Appendices 2.W.1 to 4 contain the complete master locus list, structure and room measurements, and Harris matrix for the Area W excavations.

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Figure 2.154 Aerial view of the walls, rooms, and floors of the structures unearthed at Area W. Note the alley separating the two structures. *Photo: UC San Diego Levantine Archaeology Laboratory.*

Layout

Removal of the vast amount of rock collapse and different stratigraphic layers (Appendix 2.W.2) revealed that the structures and courtyard (Figure 2.154) located at Area W are not similar in design and function to any other structures currently found at the other excavations at Khirbat en-Nahas. Large two-course-wide walls form an eastern compound of storage rooms. These rooms buttress a single-course wall that serves as the eastern wall of a large structure composed of an interior courtyard surrounded by smaller structures. This second structure appears to have gone through several occupation phases, including a construction phase. Across a small alleyway on the western section, a third structure with large raised rooms and a sunken courtyard was identified. These rooms represent the remains of a small community where the local population lived and practiced their craft.[68]

Entrances were located in Structures 1 and 3. However, the entrance to Structure 2 was sealed in antiquity, probably when the structure went out of use. An important attribute shared in many of the rooms consisted of the addition of thresholds or other similar installations following a later phase. Similarly, floors were in a continuous state of repair. Fill and crushed slag appear to have been used to level floors throughout the structures. In two rooms, stairs leading to a roof or upper level were constructed. These architectural features found in the various occupation phases reflect a sense of communal agential action in the maintaining of living and working space. A discussion of each room and the associated features is presented below following a brief discussion on the occupation phases at the structure.

Occupation Phases

Layers were assigned on the basis of architectural phases, sediments, and floors. Three main occupation phases have been identified at Area W and have been further subdivided into related phases. Any fills and sediments removed from a corresponding architectural feature have been assigned to its related layers (Table 2.13).

Table 2.13 Area W stratigraphic layers.

Layer	Description
W1A	Topsoil and wall collapse
W1B	Postabandonment
W2AI	Architectural expansion phase
W2AII	Floor 1
W2BI	Original architectural phase
W2BII	Floor 1 and Floor 2
W3	Occupation phase below structures

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Overall, 299 loci were assigned to the seven layers identified in Area W (see Appendix 2.W.1). The Harris matrix for Area W depicting the main layers and their affiliated loci is listed in Appendix 2.W.4. The corresponding loci for each room are also included in the next section. Briefly, loci in Layer W1A represent the mound of wall collapse. Any loci assigned to Layer W1B are related to the fill and wall collapse associated with the late postabandonment phase (i.e., Nabatean, Roman, Byzantine, Islamic, etc.). This layer includes sediments removed from the interior and exterior of the main structures to the first evident architectural shift. Loci associated with the second main occupation and architectural expansion phase have been assigned to Layer W2AI. This includes any fills and sediment ash layers associated with walls and installations. Activity areas, such as floors affiliated with this occupation phase, are assigned to Layer W2AII. The main occupation and building phase at Area W, Layer W2B is subdivided into W2BI, which includes all main architecture, and W2BII, which includes any affiliated floors. Any traces of occupation below the floors have been assigned to Layer W3. The individual layers are further discussed below and are then associated as they were excavated in each room.

Layer W1A

Loci identified as part of Layer W1A include the wall collapse from the structure. The collapse consisted of a large mound of stones surrounding an area of fill and wall collapse (Figure 2.155). The wind-blown sands had accumulated over time and formed a semi-compact layer of sediment underneath the stones. The layer of wall collapse extended from the mound that made up the main structure and continued past the alleyway west to a series of large structures. The wall collapse consisted of large stones—many of them contained traces of chipping from shaping the wall stones.

Layer W1B

Fill and wall collapse removal associated with the interior and exterior of the main structure has been assigned to Layer W1B. Once the W1A upper layer stones were removed, loose accumulated wind-blown sands mixed with stone debris and structural collapse from the main structure construction phases were found underneath (Figure 2.156S). The walls assigned to this locus are poorly preserved and quite distinct from the previous construction phase. These are best seen in W25 of Structure 1. This style of construction was restricted to Structure 1 and Rooms 4 and 5 of Structure 2, as well as in the unexcavated area situated east of the excavation area. No floors were detected corresponding to these later phases of occupation.

Layer W2AI

The construction and occupation phase relating to Layer W2AI represents a secondary occupation and expansion phase of the structures found at Area W. These consist



Figure 2.155 Aerial view of Layer 1a at Area W. The layer is composed of various size stones of wall collapse.
Photo: UC San Diego Levantine Archaeology Laboratory.

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of a small double-course wall similar to the one found in Rooms 2 and 5. These types of add-ons serve in the further division of space within these structures. Other installations range from thresholds to a poorly constructed wall used in the division of space in courtyards, as can be seen Figure 2.157S and Figure 2.158.

Layer W2II (Floor)

Layer W2II sediments and surfaces include the ash layers mixed with patches of compact mud located inside Structures 1 and 2. However, the main evidence for a surface from this occupation phase is most evident in the courtyard. A layer of compact mud was laid over layers of paving stones, fill, and crushed slag. Similarly, the compact mud mixed with ash was found throughout the various rooms from the same structures. Courtyard 1, situated centrally in Structure 2, is the only room where extensive W2AII surface was located. The surface in this room was a reddish compact mud-plaster mixed with patches of dark gray fill. The surface was particularly prevalent at the base of standing stones and pillar installations. The bases of both eastern and western installations appear to have stabilized during this subsequent phase of construction. The stone installations are encompassed inside a ring of very large flat stones that has been filled with compact mud and stones. Beneath the platform are layers of compact mud and fill that reach the first main occupation phase.

Layer W2BI

The majority of architecture found at this site and at Khirbat en-Nahas in general is from Layer W2 (Figure 2.160S). The evidence is derived from the foundation of the structure: the layer of crushed slag found beneath all the walls. The walls for W2BI are of two main construction types. The most evident are those found in Structure 1, Rooms 1, 2, and 3. These are large two-course walls constructed with large flat shale and limestone rocks and filled in the center with large amounts chipped stone and fill. These walls are very robust, and their construction supports higher walls and even possibly second levels. A second type of wall is found in Structures 2 and 3 of Area W. These walls were constructed with large single-course stones constructed against large robust pillars that form the entrances to the structures.[69]

Layer W2BII

Two W2BII floors have been identified at Area W (Figure 2.160S). These are most evident in Courtyard 1, but remnants can be detected throughout the other structures. The first floor encountered was a mixture of compact mud and plaster. The pise floor was constructed over a dark gray fill mixed with crushed slag. This type of pise was found in small quantities in Rooms 6, 7, 9, and Courtyard 1. Beneath these compact layers, the main occupation floor was found. Labeled as W2BII Floor 2, this layer was found throughout the excavated areas of Structures 1, 2, and 3.[70]



Figure 2.158 Example of W2I installation in Room 5, Structure 2. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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Figure 2.159 Examples of Layer W 2AI and W2AII installations found in Courtyard 1 of Structure 2. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

Layer W3

The crushed slag layer found beneath the first occupation surface defines the boundary of Layer 3. The associated stratigraphy below the slag layer was excavated without reaching bedrock. Dark brown sediment with layers of crushed slag mixed with sand was encountered. This layer has been found in the previous excavated areas at Khirbat en-Nahas and represents the earliest levels of industrialized smelting. The degree of construction beneath the structures at Area W is not known. Small installations (Figure 2.161S) associated with an earlier phase of construction were identified below the floor level in Room 2. A small probe carried out in this room failed to reveal the basal layers of this matrix and is a project that might be well worth considering in the future.

Architecture

Overview

The excavators in Area W unearthed three structures quite different in design (Figure 2.162S). The archaeological evidence suggests the function of these structures to be domestic. People lived and organized their lives while practicing their craft within these structures. Structures 1 (Figure 2.163S) and 2 share a main wall (W25). The relationship between these two structures was baffling. However, wall cleanup on W25 in Structure 2 revealed a large blocked area that encompassed the entire area of Room 2 in the courtyard. The logical interpretation is that Room 2 in Structure 1 once represented the only entrance into Structure 2. This building was in use for an extended time until it was abandoned. The main entrance was blocked off and the courtyard area sealed afterward. Following the blockage of the entrance, Structure 1 appears to have been used as a storage area. Evidence ranging from large fragments of ceramics, including large pithoi and other utilitarian vessels, indicates this area was possibly used for storage. The various amounts of rodent bones recovered from the fills and wall collapse lend support to this conclusion.

Although the evidence in Structure 1 directly indicates this area was once used as storage, the evidence, both the architecture and the recovered finds, tells a different story. Seven rooms (Figure 2.162: Rooms 4–10) surrounding a center courtyard were identified. A total of three occupation floors were identified: one Layer W2II floor and two Layer W2BII floors. Of interest in this structure is the design and use of the large pillars. It is quite possible this structure was once a building with two levels. During one of the occupation phases, the structure appears to have been destroyed by fire, as evidenced by the large traces of ash and fire-affected compact mud recorded. In regards to function, it is possible the courtyard was used for cultic activities during one of the occupation phases. A large standing

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stone had been erected in the middle of two large pillars (see section on Room 7 and courtyard below). The latter feature coupled, with a Pataikos figurine, may lend support to this notion. Regardless of the function of the courtyard, the rooms surrounding the courtyard appear to be either storage or domestic in nature. These will be discussed in the following section (see also Chapter 11, this volume).

The excavations in the area west of Structure 2 (Figure 2.162S: Rooms 11–18) unearthed the domestic structures belonging to the inhabitants of the site. Evidence recovered from the fills of this structure revolved around food processing and other domestic activities. The architecture contains various installations extending to this function. It is quite possible these types of activities were occurring on the rooftop of the structure, as evidenced from the large amounts of collapse defined in the central courtyard. This being the case, access to the roof would have been through the step located in Room 14. In the remainder of this section, closer attention is given to the individual rooms.

Structure 1, Area W (Rooms 1, 2, and 3)

Rooms 1, 2, and 3 make up Structure 1 (Figure 2.163S). The three rooms share several common attributes, starting with the large two-course walls in the northern, eastern, and southern sections of the structure. The question as to why such a large wall was necessary for this structure remains a mystery. All three rooms also share the western wall (W25), which was constructed as a one-course wall and separates the spaces between these rooms and those in Structure 2. Similarly, all these rooms share entrances in the northern walls, although a threshold/steps separate the floors between Rooms 2 and 3 (Figure 2.165S). The main entrance to the structure is located in the northern section of the structure.[71]

The breakdown of the archaeological layers of the three rooms is listed in Appendix 2.W.4. Structure 1 is one of the two structures that contain Layer W1B architecture (Figure 2.165S). The architecture consists of a single-course wall built on top of the Layer W2BI wall (W25). While the date for its construction is not currently known, the pottery recovered in association with this level might be Nabatean and Islamic. One artifact—the glass neck of a small juglet or vase (Figure 2.168S)—was recovered from the fills outside the eastern wall in the vicinity of Room 3. While the analysis is still pending, the glass object may be of Roman origin.

The removal of W2I sediments in all rooms of the structure was uneventful. Of particular interest were two deep deposits of chipped shale mixed with reddish sediments located in the eastern section of Room 1 and



Figure 2.164 Close-up views of Room 1. All three layers were identified in this room: (*a*) top), (*b*) lower left, and (*c*) lower right. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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in the doorway belonging to Rooms 2 and 3. These deposits were first believed to be blockages. However, further excavations proved otherwise. The most plausible answer is that these were deposits caused by the broken shale that once formed part of the wall in these sections. Besides the threshold installation in the Room 3 doorway, only one other significant installation belonging to the W2I expansion phase was identified. The feature was a small two-course wall built on the southern wall (Figure 2.165S). The installation sectioned Room 2 into two areas. It is argued that the installation was constructed during the occupation phase when the doorway leading to Structure 2 was in use. It might have served as a divider that allowed individuals to enter into the courtyard or into Room 3.

The same installation in Room 2 correlates the first definitive evidence for surfaces in this structure. The base of the feature can be found just below the W2II floor level but above the main W2BII Floor 2. This surface is also found in the eastern section of Room 1 and along the wall in the western section of Room 2.[72]

At the base of the W2I installation, the foundation for the main occupation is found. Due to the uneven floors caused by the slope of the natural (or constructed) mound that the building was built upon, crushed slag was laid to form the main occupation surface. The layer was then covered with a hard mud surface that contained traces of plaster. This type of floor was found in all three rooms (Figure 2.164, Figure 2.165S, and Figure 2.166S). Small paving installations covered with ash were found immediately on the surface in Room 3 against the northern wall. Whether these installations represent part of a cooking installation is not known.

Stratigraphically, Structure 1 represents the only area where Layer 3 deposits were encountered. The eastern and western sections of Room 2 were probed to determine whether there were any deposits below the W2BII floor. In both cases, layers of crushed slag mixed with fill and ash were encountered.[73]

The archaeological material recovered from Structure 1 indicates the areas were mostly used as domestic or storage areas. Preliminary ceramic analysis indicates that most vessels recovered from the fills associated with floor levels are large handmade wares. A breakdown of these wares is presented in Chapter 5 (this volume). Other artifacts included pieces of copper metal, bone (regular and worked) (Figure 2.167S), and fragments of tuyère pipes.

Structure 2, Area W (Rooms 4, 5, 6, 7, 8, 9, 10, and Courtyard 1)

Structure 2 is situated west of Structure 1 (Figure 2.169). Several tons of wall collapse and sediment revealed a well-designed structure containing a large interior courtyard surrounded by seven smaller rooms. W25, which separates Structure 1 from Structure 2, runs from Room 7 in the north to Room 4 in the south. The large central courtyard contains W2BI architecture. An expansion phase where installations and walls were added to the existing structures occurred during the last occupation phase. The rooms of the structure are defined in the interior by large pillars constructed from large flat shale with smaller chipped stone laid in between. The outer walls of the structure, all single-course walls, were constructed during the original W2B occupation phase. No exterior doors leading into the structure are evident. The only possible entrance to the structure would have been through W25—an entrance that was sealed during the W2AI occupation phase. While three main floors have been detected in the courtyard, not all of the W2AII and the upper W2BII floors were detected. However, the main W2BII floor was reached in all rooms.[74]

Two of the main differences in construction are seen in Rooms 4 (Figure 2.170S) and 5 (Figure 2.171), located in the southern section of the structure adjacent to the main wall. Rooms 4 and 5 were created during the W2BI second occupation phase. The floor plan during the earlier phases most likely consisted of two larger rooms on the southern side of the structure. During the second main occupation phase, the structure was redesigned, most likely following a fire that collapsed the roof. This is most evident by the large amount of ash and fire-affected sediments found beneath the W2BII Floor 1. The shared wall between Rooms 4 and 5 is of the W2BI construction phase, but there is some variation seen in the interior of Room 5 (Figure 2.171).[75] It is proposed that prior to the construction of Room 4, the courtyard section of Room 5 mirrored, on a smaller scale, the design of Room 7 in the northern section of the structure: two pillars with an installation at the base used to support the roof. The remains are not the lintel of a door or window but of one small roof support installation.

The contents of Room 4, the crushed slag and the steps, were deposited and constructed after the original occupation phase when an extensive second level was erected. Access to the roof would have been from this room most likely via a wooden ladder on an elevated platform.

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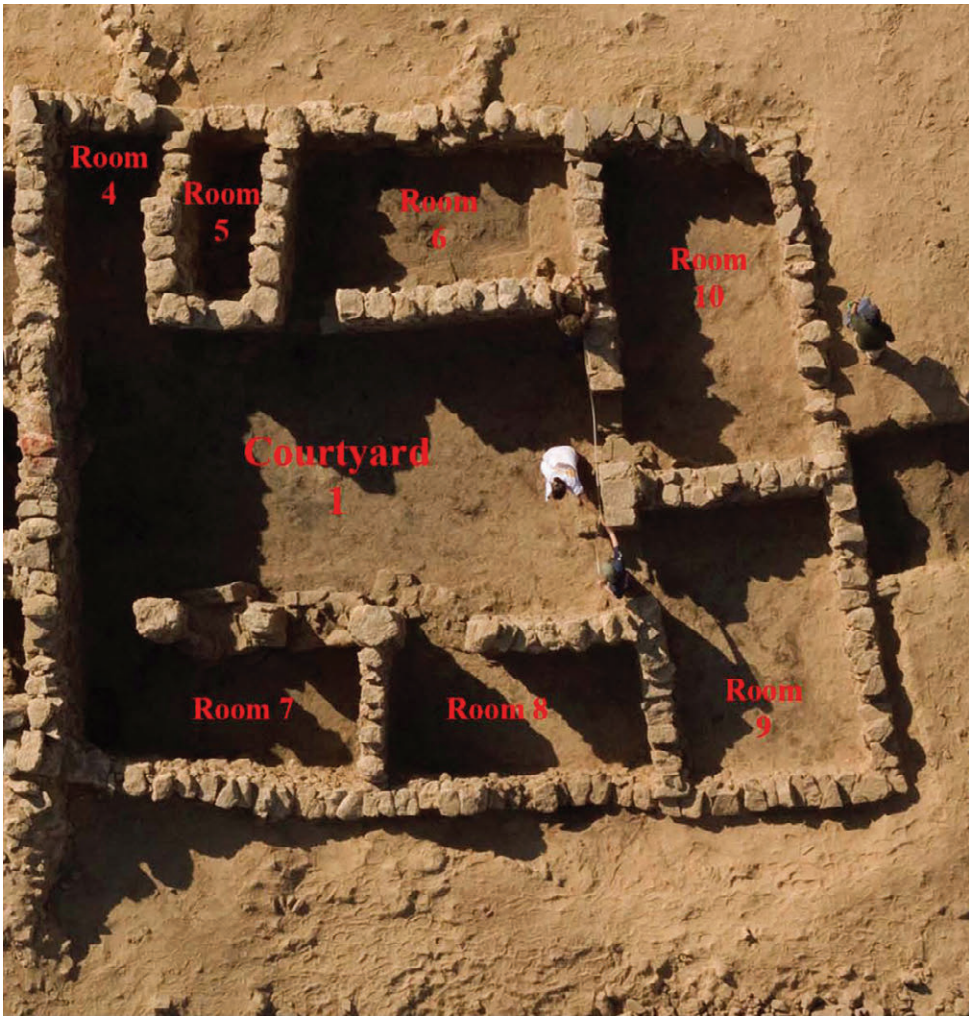

Figure 2.169 An aerial photograph of the rooms and courtyard that make up Structure 2. *Photo: UC San Diego Levantine Archaeology Laboratory.*



Figure 2.171 Room 5 details: the view from the interior courtyard can be seen on the left (*a*) and from the exterior on the right (*b*).*Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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A second access was probably available to the inhabitants from Room 7, where a smaller platform of crushed slag was laid on top of the main occupation floor, probably via a ladder.

This scenario prompts the question of function and use during the original W3BI construction phase (see Appendix 2.W.4). Removing the platforms from the scenario removes the requirements to access a second level. Yet the installations found on the main occupation floor (Figure 2.171) indicate some forms of cultic practices. Installations resembling offering platforms were discovered in areas adjacent to the pillars and a very large monolith or standing stone. Similarly, installations sunken into the main occupation floor were found in Room 6 and Room 7 as well as in the center of the courtyard (see below).

The remaining rooms found on the southern sector of the structure include Rooms 6 and 7 (see Appendix 1.W.5). The room has been excavated to the W2BII floor level (Figure 2.172S). The exterior walls of the structure are poorly preserved and consist mostly of limestone and shale building material. Of these, the construction of Room 6 is the most interesting and supports the claim of possible cultic activity at this structure. First and foremost, the interior walls facing the courtyard have been given special care in their construction and are much more aesthetic than the walls in the interior of the room. It is proposed that these walls were constructed with aesthetics in mind. The mason wanted to preserve the clean and even construction in the courtyard.[76]

Preliminary analysis of the ceramics recovered from the surface of this room includes *1Bowl 26* (possible import) that has incised decoration, red burnished ware (possibly dating to the tenth century BCE), a juglet that has a local fabric, and a Krater 8 bowl also containing white fabric (see Chapter 5, this volume).

Room 7 (Figure 2.173S) is situated on the northern section of the structure. Similar to Room 4, W25 serves as the eastern wall. The exterior walls are low and poorly preserved and are constructed as single-course walls. Perhaps the most interesting feature of this room is a very large standing stone flanked by two large pillars that have walls built to the north. The standing stone is a large monolith of monzogranite. Time and the elements have taken their toll on this feature. All sides of the stone have been eroded.

Installations at the base form the Room 7 southern wall that faces into the courtyard. The interior of the room has been excavated to surface level with two different results. A platform consisting of crushed slag has been laid to elevate the surface of the room in the eastern sector. As stated previously, the platform could have been erected to access the roof or second level of the structure. The western sector of the room has been excavated to a W2BII floor level where traces of a mud-plaster floor were found. Removal of the sediments (Figures 2.173S, 2.181) associated with W2AI levels revealed a very large cache of dimple hammer stones. In total, the excavators collected about 45 of these items that had been discarded here. Few ceramics were also recovered from similar fill. These included jugs, Bowl 13, other miscellaneous decorated sherds, and a pixie small jar.

One of the most significant finds came from the upper levels of Room 8 (Figure 2.174). Situated in the center of the northern section of Structure 2, this room provides the best clues to outside contact. A Pataikos figure (Figure 2.175) was found in the W2AI fills near the entrance of the room. In Egyptian myth, Pataikos refers to a protective god in the form of a dwarf. These figurines are particularly common in the archaeological record from the New Kingdom (see Chapter 11, this volume). Apart from this find, other forms of ornamentation, including beads and Pithos 5 storage jar ceramics, were recovered here.

Rooms 9 and 10 (Figure 2.176Sa and b; see Appendix 2.W.4) are found in the western section of Structure 2. These rooms are larger than the other rooms found on the exterior of the courtyard. The fills in Room 9 were extremely homogeneous. This part of the structure represents the lowest point of the natural mound. Thus, it contained the least preserved exterior walls. While the room was excavated to floor level, the sediments were homogeneous (Figure 2.176S). One sherd of Midianite pottery with a bird motif was recovered from the lower levels of the structure.

In comparison, the sediments removed from Room 10 (Figure 2.169) were similar to the fills from the other excavated rooms. The removal of sediments in this room revealed very large slabs of shale and wall collapse. Artifacts were similar to other areas, ceramics, copper debris, bones, and hammer stones. Recovered from this room was a reconstructable vessel.

The most significant feature of Rooms 9 and 10 are the three large pillars and their affiliated installations (Figure 2.177S) that make up the inner walls of the courtyard. Similar to the other walls that face the

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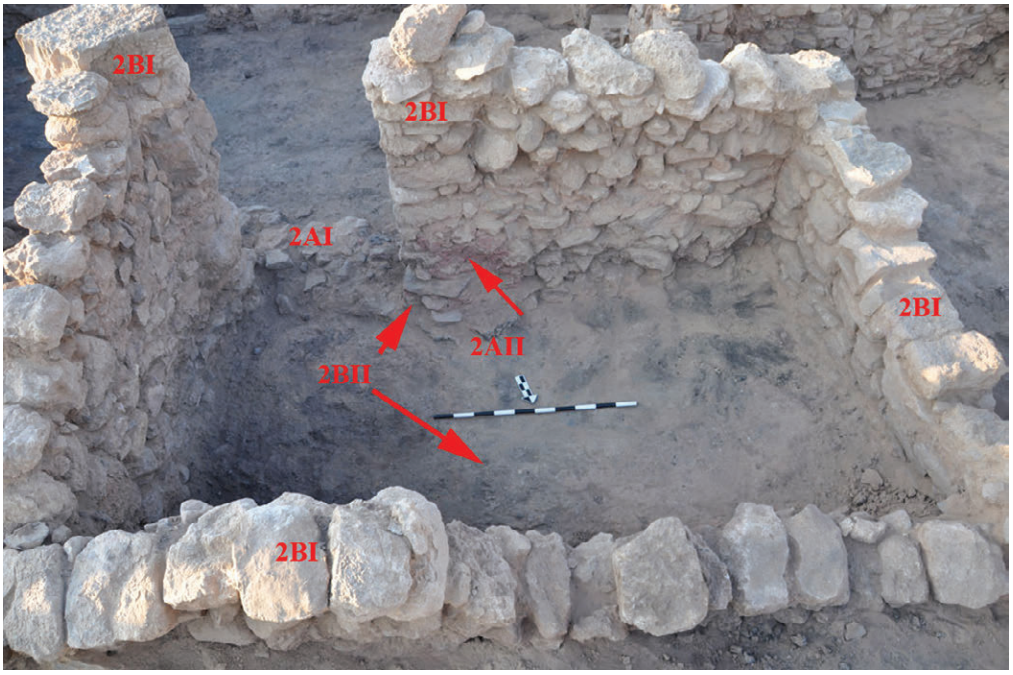

Figure 2.174 Overview of Room 8 looking toward the interior courtyard. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

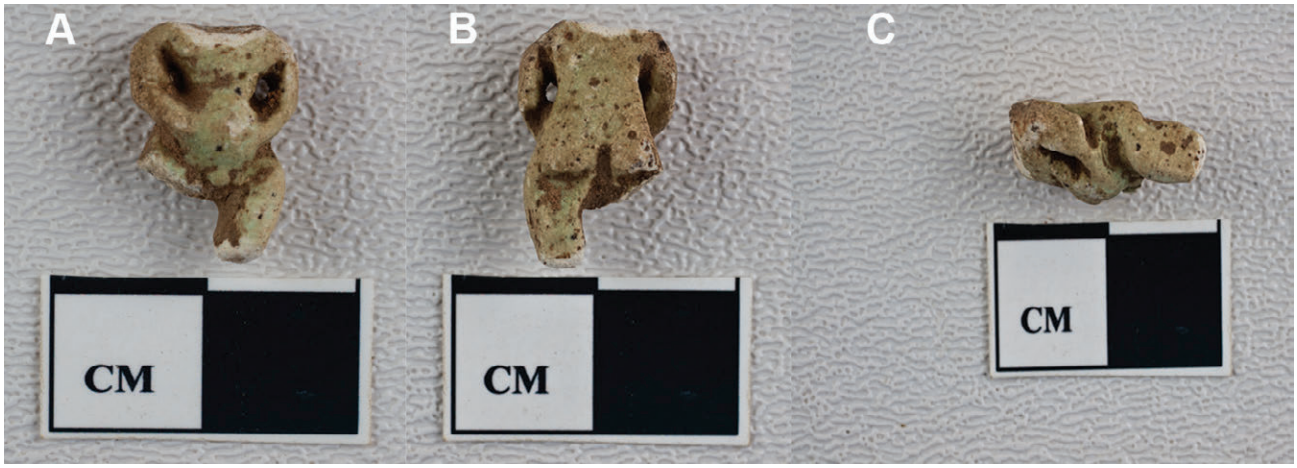

Figure 2.175 Pataikos figurine recovered from the upper sediments of Room 8: (*a*) front, (*b*) rear, and (*c*) side views (see discussion in Chapter 11). *Photo: UC San Diego Levantine Archaeology Laboratory.*

courtyard (Figure 2.178S), these features have their own distinct style and have been aesthetically constructed. As with the other entrances to the courtyard, paving stone installations can be found adjacent to or in the doorways buttressing the pillars.

Courtyard 1 (Structure 2)

Many observations have already been presented with regard to the courtyard. This area in Structure 2 is most significant for its floors that were identified here. Similarly, the numerous installations that are prominent in this area are bold and were probably once used by the inhabitants of this structure to make a statement about their position or role in life. Whether it was cultic or domestic, this was an area of importance. All an individual had to do was to step inside the structure and be greeted with grand pillars, installations, and a large standing stone (Figure 2.181) that most likely commemorated an important figure associated with this structure (see Appendix 2.W.4).

The archaeological evidence reflects that the courtyard was used continuously over long periods. The three floors identified here are separated by large quantities of paving stones, compact mud, and ash layers and crushed slag mixed with fill. Yet, pise mud-plaster floors have been identified here, indicating the importance of this

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structure. The installations and finds (Figures 2.179, 2.181 and Table 2.14S), including scarabs, many different types of ceramics, ornamentation, and finely crafted stoneware found on the floors, attest to this claim.

Eventually, the courtyard went out of favor. The reason is not known, but the large amounts of collapse found in the interior of the courtyard may provide a clue. The collapse was surrounded in the northern and southern areas along the western walls by a deep layer of ash. When the collapse occurred is not known, but it is proposed the building had been abandoned. The entrance from Structure 1 into the courtyard was sealed (Figure 2.180).

Passage (Probe)

A small probe was carried out in the area (a passage or street) between Structures 2 and 3 in an attempt to identify any installations or architectures and further clarify the relationship between the structures (Figure 2.182, 2.183). Excavations here reached the compact mud and crushed slag layers affiliated with W2BII. The probe did not reveal any new features, but it did shed light on the uses of the area between the structures. Very large volumes of slag (almost half a ton) were removed from the small probe. The slag had been discarded along the walls of Structure 3, forming a large buildup against the main wall. Much slag had also been deposited inside the

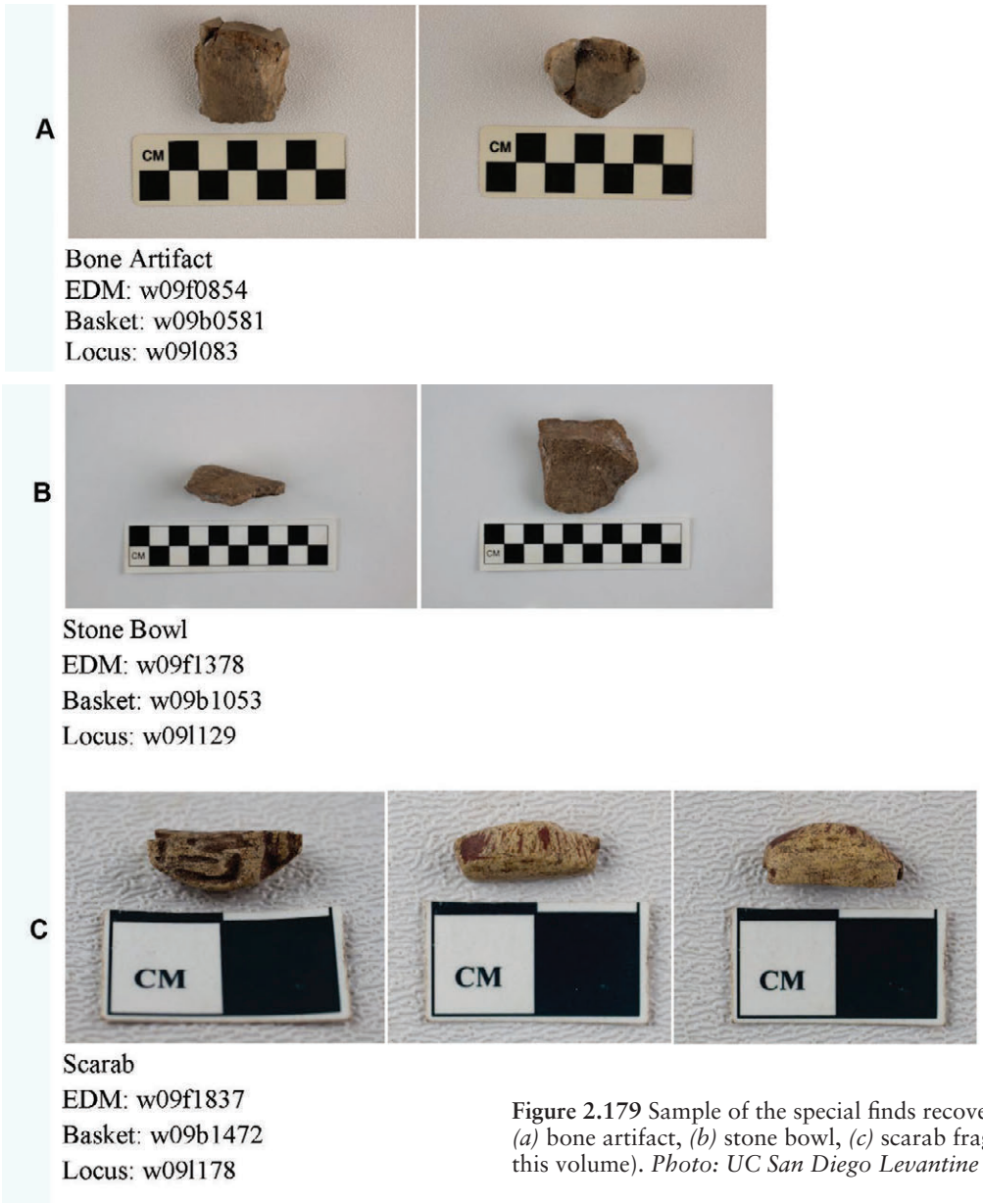

Figure 2.179 Sample of the special finds recovered from the courtyard: *(a)* bone artifact, *(b)* stone bowl, *(c)* scarab fragment (see Chapter 11, this volume). *Photo: UC San Diego Levantine Archaeology Laboratory.*

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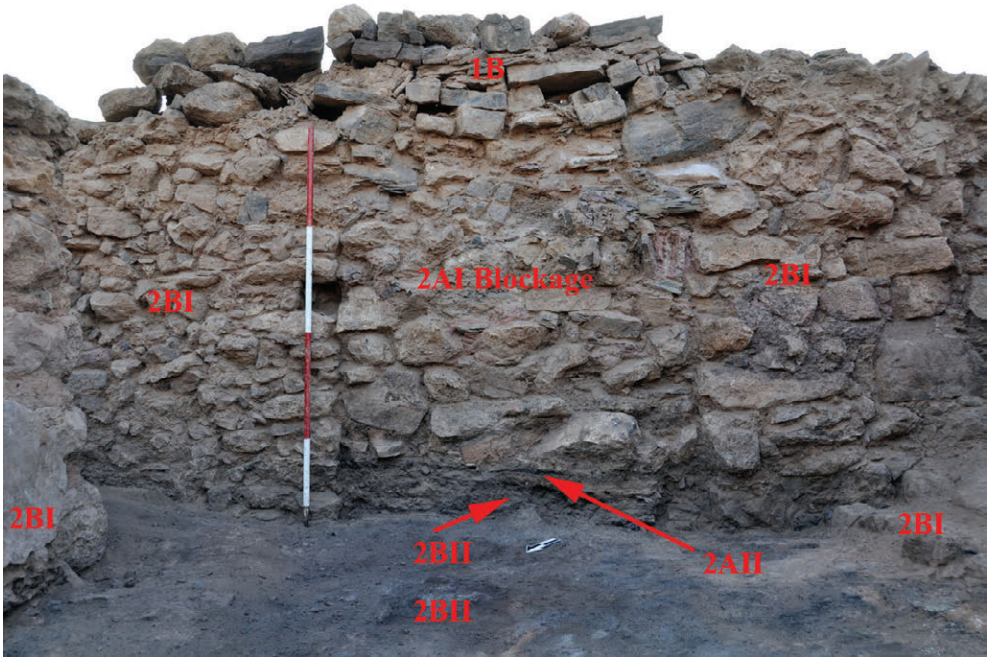

Figure 2.180 The blockage in W25.

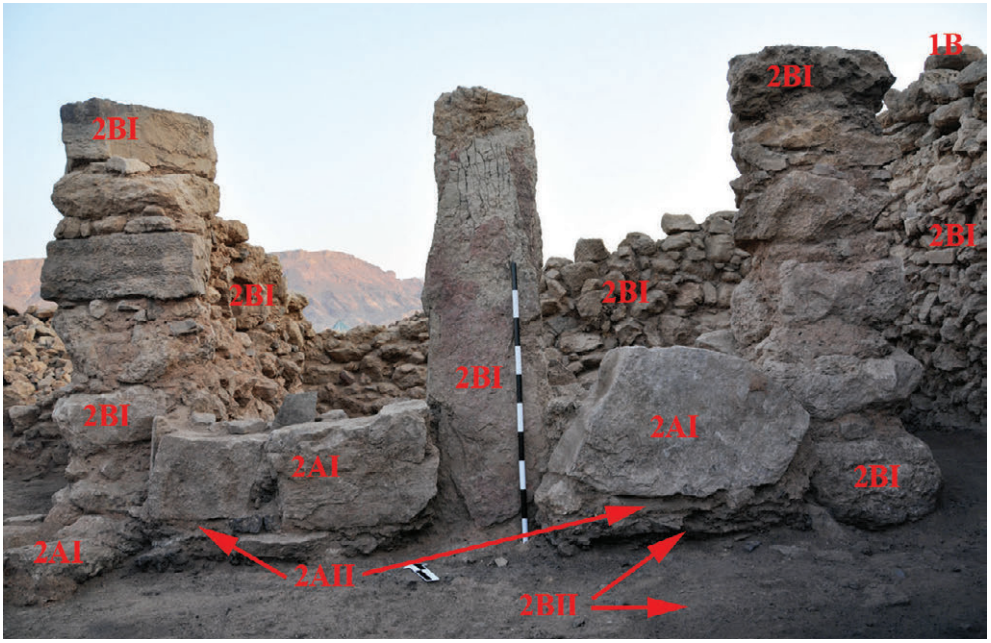

Figure 2.181 The main installations of Room 7 and the courtyard. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

adjacent room of Structure 3. This debris is not found on the eastern section of the probe wall for Structure 2.[77]

Structure 3, Area W (Rooms 11, 12, 13, 14, 15, 16, 17, 18, and Courtyard 2)

Overview

If Structure 2 represents the home of a high-ranked official and his kin, then Structure 3 would represent the homes of the workers or "proletariat." Excavations into the various rooms identified indicate the function of these rooms was domestic. In Structure 3, the courtyard was sunken below the floor levels of the surrounding rooms. Similar to Structure 2, a series of steps was laid next to the entrance of the structure. Where these steps lead is a mystery, but a clue is provided in the sunken courtyard and the vast amounts of mud brick collapse that came from either the roof or a higher level. Unfortunately, a lack of time resulted in limited

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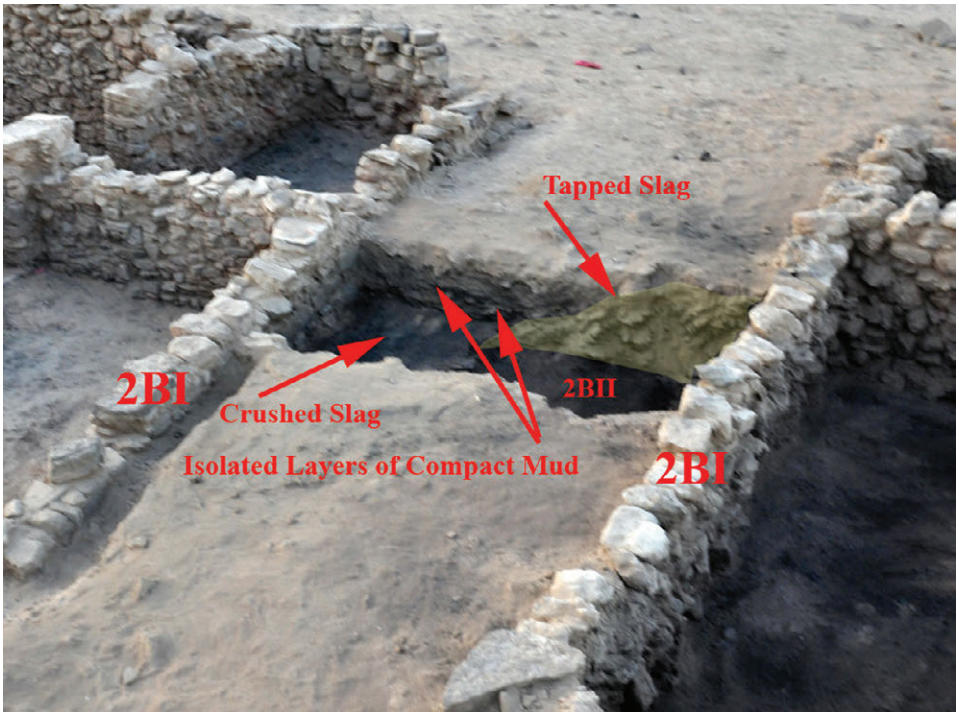

Figure 2.182 The probe carried out between Structures 1 and 2. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

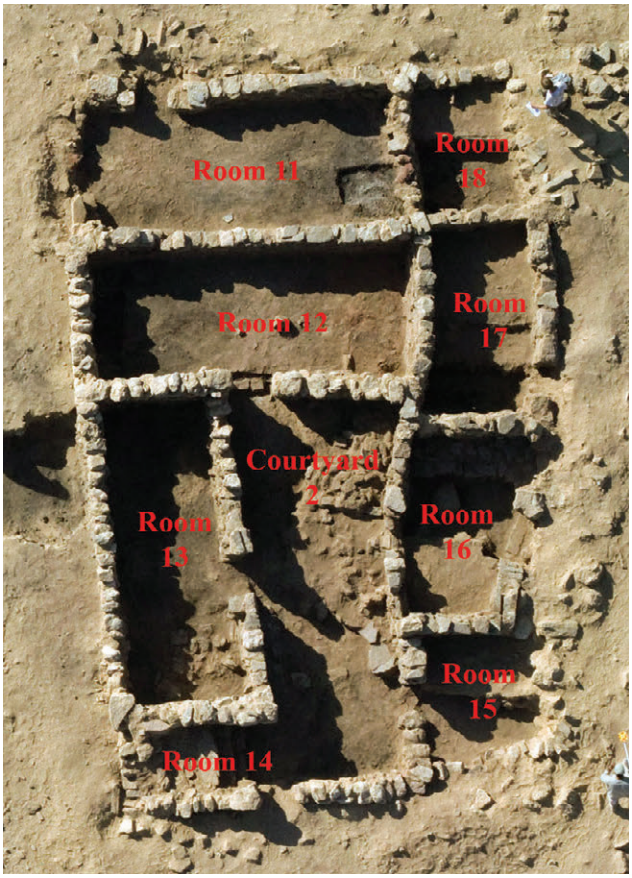

Figure 2.183 Overview of Structure 3 and the different rooms identified. *Photo: UC San Diego Levantine Archaeology Laboratory.*

excavations along the western section of the structure. Probes were carried out and sediments were excavated to floor level. Several installations were found in these rooms, but the information given for the residences provides a launching off point to future projects.

Room 11 is the southernmost feature of Structure 3 (see Appendix 2.W.4). A single-course wall forms the southern wall. No wall was detected in the eastern section of the room, suggesting that it could have been a courtyard. The western wall was poorly constructed, but nevertheless, it is a wall. The room was excavated to floor level (Figure 2.184). The floor here is composed of sediment mixed with compact mud over crushed slag that has been laid to elevate the floor. This is true with the adjacent room (Room 12) too. A small probe in the area continued to yield more crushed slag. There is also excellent evidence that this area was used for processing foods. The remains of large pithoi were common (Table 2.15S). As well, a large tabun was recovered from the floor level.

Similar to Room 11, Room 12 (Figure 2.185S) was elevated from the rest of the rooms. The excavated fills were also pretty homogeneous from the upper layers to the floor level. Door blockage was also detected on the interior of the southern wall leading to Room 11. The reason for this blockage probably had something to do with the use of the adjacent room.[78] Finds recovered in

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Figure 2.184 Overview of Room 11. Note the large tabun in the upper left.
Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.

this room included a complete oil lamp and fragments of ornamentation (Figure 2.186). Other ceramics included jugs, pithoi fragments, and bowls, indicating the room had a domestic function.

Room 13 is located along the north–south wall on the eastern section of Structure 3 (Figure 2.187; see Appendix 2.W.4). Removal of sediments in this room exposed large amounts of tapped slag similar to the ones removed for the probe in the alley on the exterior side of the wall. Other interesting finds revealed the inhabitants of the site were creating objects and construction materials by incorporating mud with finely crushed slag. In Room 13, a large object resembling a basin made from this material was found. Similarly, in the adjacent courtyard, large deposits of collapsed mud bricks made from this material were identified.

The sediments encountered in this room were very similar to other fills around the site. A scarab (Figure 2.188) was recovered from the W2AI deposits in the southern–central section of the room. Other finds included ceramics (Midianite ware, Bowl 8, Jug 4, and krater bowl; Chapter 5, this volume) and items affiliated with the production of copper.[79]

Room 14 proved to be an interesting feature of Structure 3. Removal of sediments (Figure 2.189; Appendix 2.W.4) here gave way to an interesting structure. Three large steps laid between two walls were unearthed. The series of stone steps is located between two walls leading up to a flat area or platform, similar to Room 4. Unlike Room 4, there was no crushed slag layer used to elevate the platform. An entry into the structure and the courtyard is found immediately to the north of the steps. The question is, where do these steps lead?

A clue to answering this question may lie in the collapsed mud brick found in the courtyard. This very large pile of debris could at one time have belonged to either the roof of the structure or a second level. Similar to Room 4, the platform could have served as the entryway to the higher level via a ladder.

Probes (Rooms 15, 16, 17, and 18)

Four rooms along the western section of the structure were opened for excavation (Figure 2.190S). Unfortunately, due to time constraints, the rooms were not completed. However, probes were initiated in all rooms.[80]

Courtyard 2

The final area excavated in Structure 3 is the courtyard (Figure 2.190S), situated in the center of the structure. While dissimilar to Courtyard 2, this structure brings the different rooms together. This area represents the main public space where the various rooms in the

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Figure 2.186 (*a*) Bone ring and (*b*) oil lamp recovered from Room 12, Area W. *Photo: UC San Diego Levantine Archaeology Laboratory.*

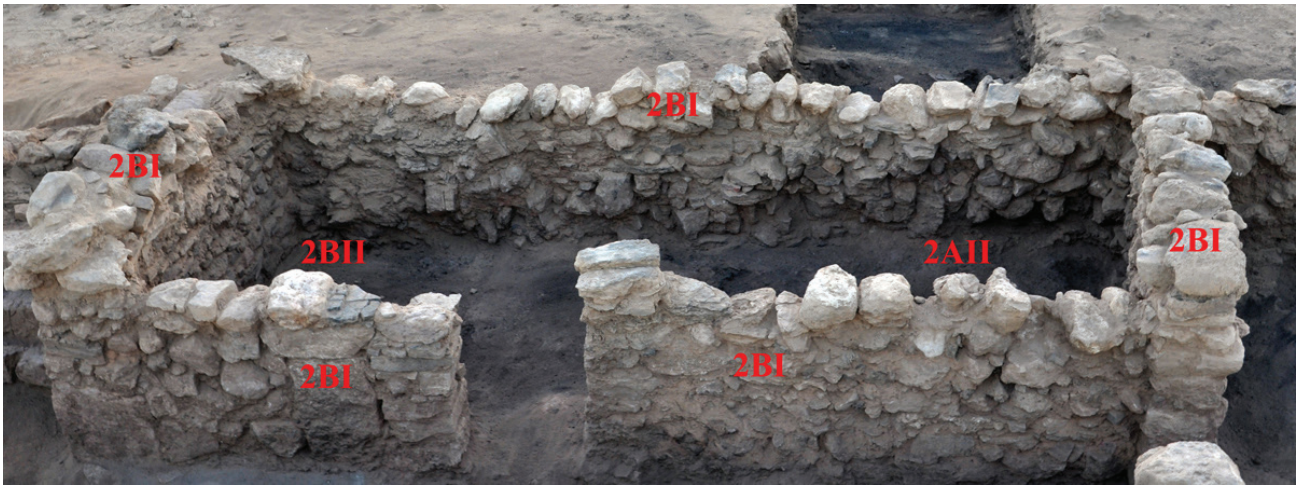

Figure 2.187 Overview of Room 13. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

south, east, and north can be accessed. Numerous numbers of grinding implements have been recovered from this and adjacent areas. As well, large grinding mortars have been found in situ along the base of walls and other installations, including benches and possibly food preparation areas (Figure 2.191). Aside from these implements, ornamentation (Figure 2.192) and ceramics were also recovered from the fills.[81]

Radiocarbon Dating and Area W

Two accelerator mass spectrometry (AMS) determinations of *Tamarix* species charcoal were obtained from Area W, both from Layer W2B. When calibrated, OxA-23240 spans from 996 to 837 BCE, while OxA-23241 runs from 1117 to 933 BCE (at 95.4 percent probability) (Figure 2.193). This imprecision is simply a reflection of the calibration wiggle

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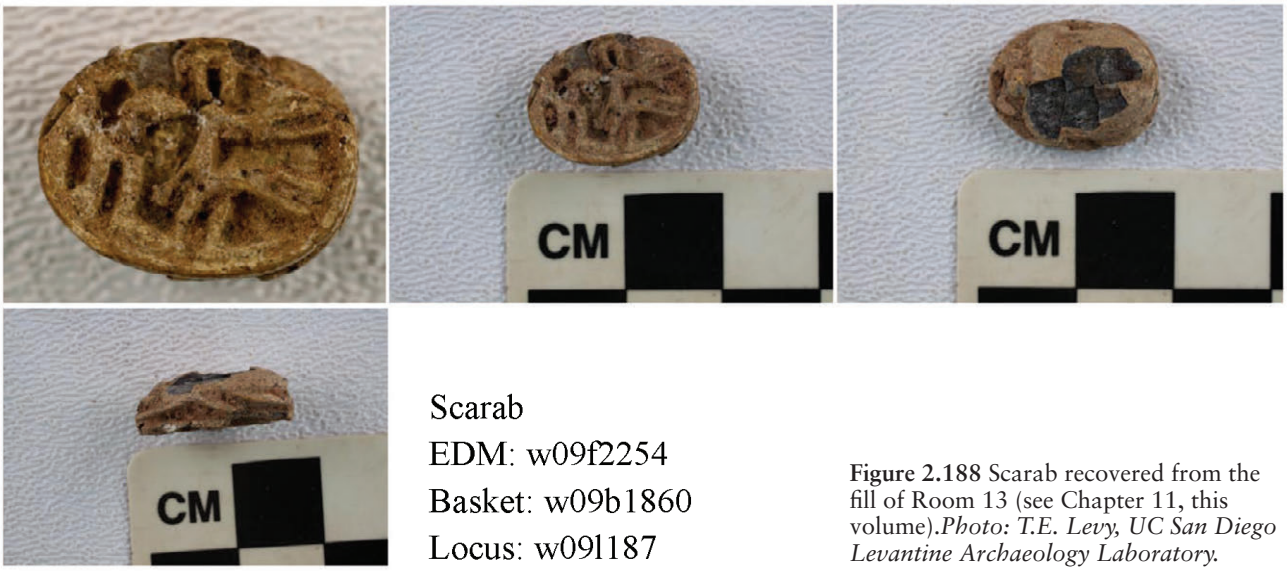

Figure 2.188 Scarab recovered from the fill of Room 13 (see Chapter 11, this volume).*Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*



Figure 2.189 Steps and the entrance to Room 14, a stairwell. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

in the tenth-century BCE, and modeling is not able to improve upon it. All that can be said it is that the results are consistent with the other chronometric data obtained from other areas of the Khirbat-en-Nahas site and probably fit, like them, within the broad range of the late eleventh, tenth, and early ninth centuries BCE.

Summary—Area W

Area W, located near the southern margin of Khirbat en-Nahas, is the southernmost structure excavated to date at the site. It was selected for investigation as a possible administrative complex linked to copper production at KEN. However, the complex turned out to have little to do with administration, which was associated more with the large buildings in Area R, Area T, and, in the early tenth century, the gatehouse complex. The three structures excavated in Area W are unique in design and function. Structure 1, with its massive walls and installations, appears to have been used as storage facilities. The large courtyard and its adjacent rooms may have served as a

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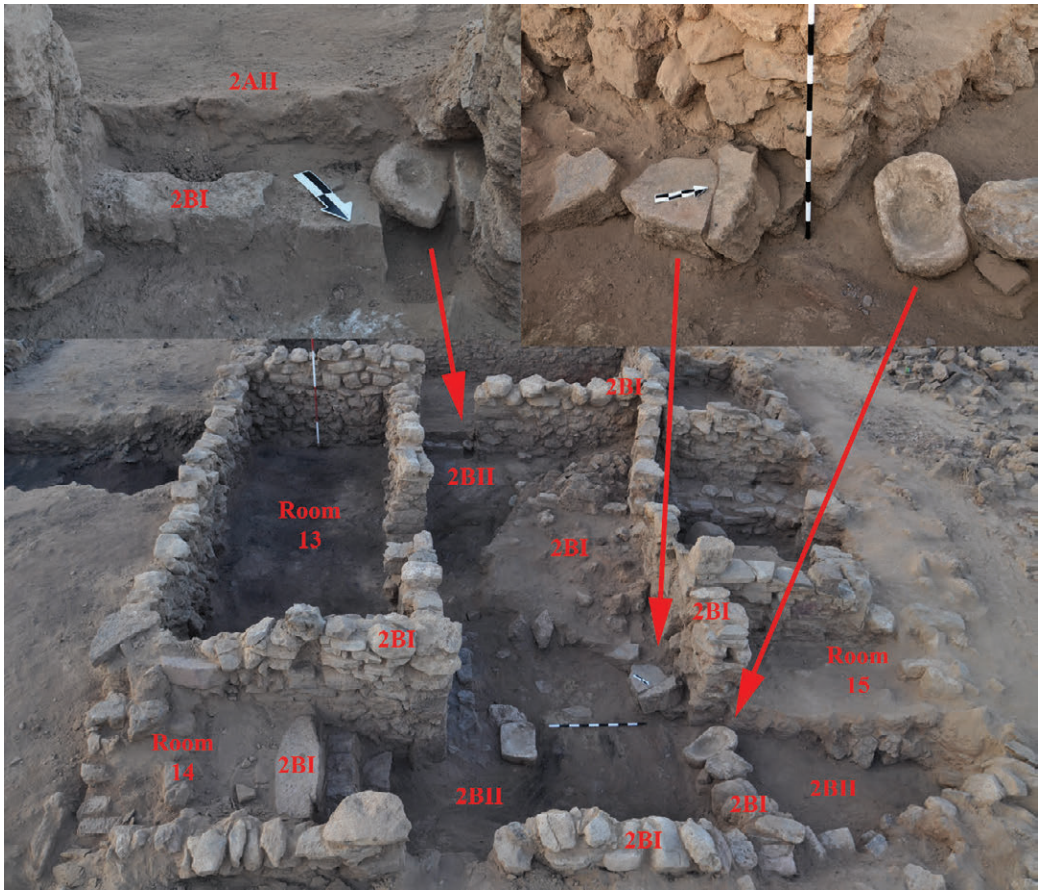

Figure 2.191 Overview of the courtyard and the significant installations placed as inserts above. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*



Ornamentation- Copper Bracelet
EDM: w09f2369
Basket: w09b1968
Locus: w09l227

Figure 2.192 Complete copper bracelet recovered next to the collapsed mud brick. *Photo:UC San Diego Levantine Archaeology Laboratory.*

home for an individual with elite status. The construction techniques used in this structure rely heavily on aesthetics and public display. Individuals lived and worshipped in this structure, as evident from the personal accoutrements recovered in the sediments and floor. At some point, the structure fell out of use and it was abandoned. Whether it was destroyed or abandoned is anyone's guess. What is known is that whatever the reason, the main entrance to the structure was sealed. Structure 3 in the western section of the site represents the domestic households of the population. All artifacts and features indicate individuals lived and worked here. The remains of processing implements coupled with processing installations are widely distributed throughout the site. Unfortunately, only two carbon samples could be successfully dated from this area. As shown above, the radiocarbon dates indicate that the Area W building complex was occupied in the early tenth century. It is possible that copper production took place prior to the construction of the buildings, as early as the twelfth and eleventh centuries BCE.

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Table 2.17 Radiocarbon dates from Khirbat en-Nahas, Area W.

Lab Number	EDM	Season	Locus	Sample Material	Species	Layer	Stratum	Date BP	Cal Date BCE (68.2 and 95.4 percent probability)	Bibliography
OxA-23240	2689	2009	243	Charcoal	*Tamarix* sp.	W2B	IV	2767 ± 25	971–848 996–837	This volume
OxA-23241	2652	2009	244	Charcoal	*Tamarix* sp.	W2B	IV	2856 ± 25	1055–943 1117–933	This volume

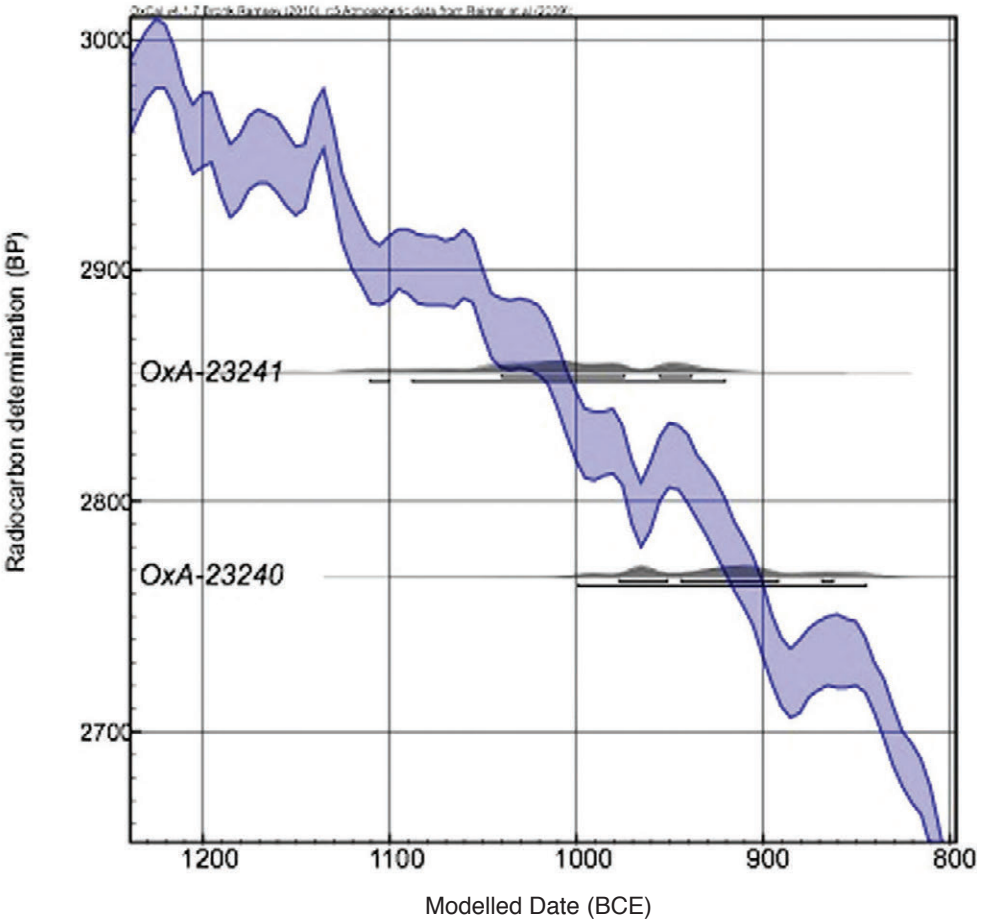

Figure 2.193 Calibrated ages for the two determinations from Area W. The results are plotted against INTCAL09 (Reimer et al. 2009) to illustrate the effects on the precision of the resulting calibrated results as a function of the calibration wiggle in the tenth-century BCE.

Area R—Central Elite Residence, Smelting Area, and Furnace

The largest building complex visible on the site surface and located at its center is called Area R (Figure 2.193). The large pile of rock rubble is delineated by a perimeter wall that is contemporary with and surrounds that structure. The monumental structure appears as a square building on the map published by Nelson Glueck (1935). It is one of the buildings Glueck suggested may have been, but most likely was not, a defensive tower (Glueck 1935:27). In 2006, one room of the massive structure and metallurgical levels in front of and below the structure's exterior were first probed by ELRAP, and in 2009, the ELRAP team fully excavated all but the central courtyard of the monumental building. In addition, the metallurgical deposits in front of the structure were excavated on a larger scale in 2009, when a largely intact smelting furnace was discovered. This installation is especially important for the history of Iron Age copper production in the southern Levant.

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As noted above, Khirbat en-Nahas was visited by Glueck during his 1934 survey of eastern Palestine, and his published a map shows a large square building, which we label as the Area R structure, situated close to the center of the site. Glueck (1935:166) observed, "Overlooking the small wadi on the east side is a whole row of ruined buildings. The outer walls of some of them are still fairly intact. It is possible that some of them may have served as watch-towers, although this is unlikely in view of the general nature of the site, which did not require any protection from the east, and which depended for security against any major attack from the west upon the key fortress of Khirbat Hamra Ifdan (خربة حمرة إفدان)" (Glueck 1935:27). Khirbat Hamra' Ifdan is no longer considered an Iron Age fortress (Adams 1992; Levy et al. 2002; Levy et al. 2004), but significant Iron Age metalworking activities took place there (see Chapter 12, this volume). Glueck is silent on the massive building in Area R in his popular book, *The Other Side of the Jordan* (Glueck 1940a).

Area R is located near several other areas excavated by the Deutsches Bergbau-Museum and the Edom Lowlands Regional Archaeology Project (Figures 2.4a, 2.4b; 2.194). Area T, another monumental structure, is located around 25 m to the northeast. Area S, a metallurgical area and associated building, is adjacent to the Area R northeastern perimeter wall. The Deutsches Bergbau-Museum excavations are located approximately 30 m east of Area R, to the southeast of Area S. A small depression/wadi passes south of Area R. Geophysical investigations in this area indicate the presence of sporadic subsurface architecture in this area (Witten et al. 2003). The Area R structure is especially notable on the site surface for being surrounded by a stone perimeter wall. Metallurgical layers, where copper was smelted and metallurgical debris was deposited, both predate and postdate the structure.

The 2006 excavation in Area R focused on Room 1 that was visible in the rubble surface and a trench toward the southwest area of Room 2 (the "Gallery" of the 2006 report), which both relate to the main Layer R2 construction of the monumental building. These excavations revealed the importance of the monumental building and the relative wealth of its occupants. These excavations also exposed the northwest exterior walls of the building and segments of the structure's perimeter wall. In addition, they sampled the metallurgical levels of Layer R3, below the courtyard. What were believed to be intact furnace structures that were observed but left unexcavated during the 2006 field season were exposed in the 2009 field season. As will be shown below, the stratigraphic relationship between the courtyard area and the monumental building are complex and not intuitive. Accordingly, the stratigraphy in the courtyard of Area R is labeled "Layer R3 court" and so on, and that found associated with the structure is simply listed as "Layer R1, R2, R2a," and so on (Table 2.18).

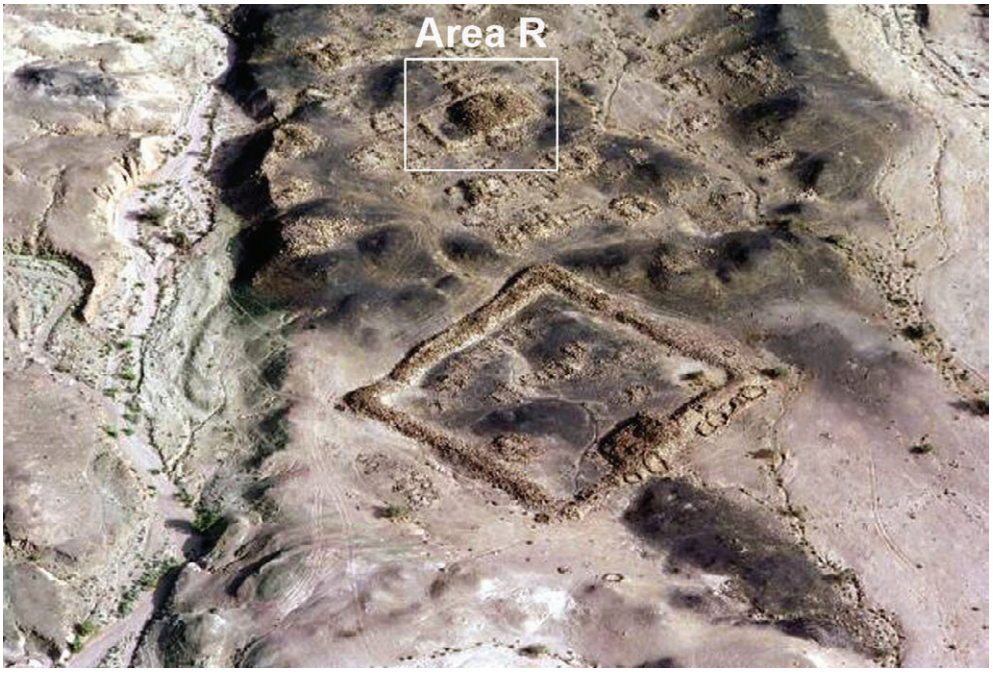

Figure 2.194 Aerial photo of Khirbat en-Nahas, taken in 1999, showing Area R. *Photo source: ROHR Productions.*

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Table 2.18 Area R stratigraphic layers.

Layer	Description	Approximate Period Based on ^{14}C Dates
R1a	Very limited modern reuse associated with some modern materials	? to present
R1b	Nabataean associated with rebuilding some of the tops of the walls. (L.R 09L008, L.R 09019) EDM: R09F0122, R09F0077	Nabataean
R3	Courtyard copper production complex; postdates occupation of monumental building; tap slags, furnaces, single-course walls in front of the main building: L1832–33, 1845, 1847, 1850–52	Late tenth to ninth centuries BCE
R2a	Additional installations related to main structure made shortly after the main R2b construction activities	Early tenth century BCE
R2b	Monumental building and perimeter walls	Early tenth century BCE
R3a	Copper industrial waste accumulation; thick layers	Early tenth century BCE

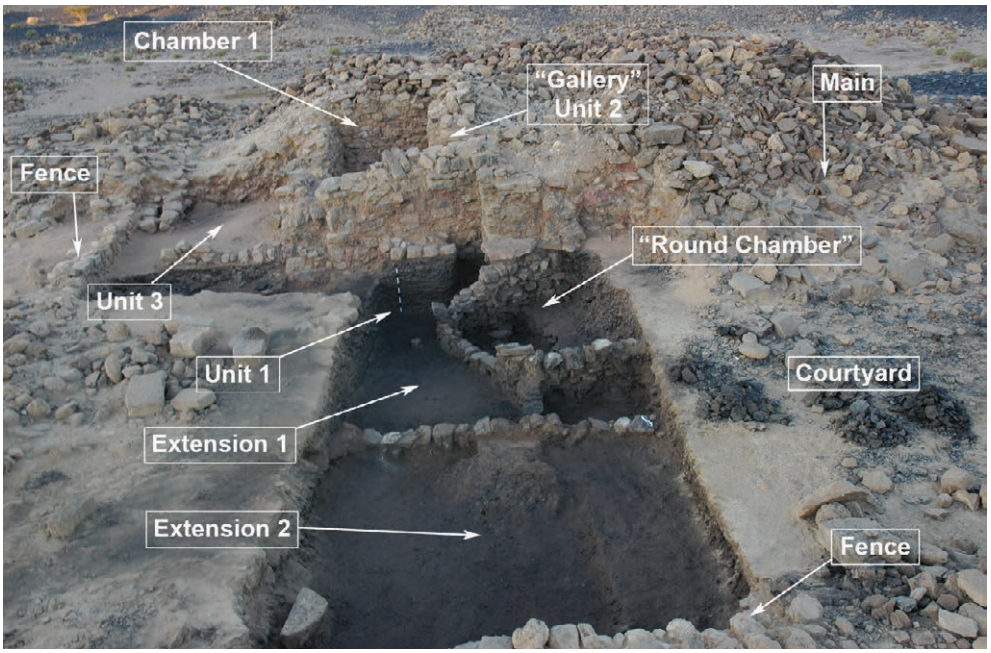

Figure 2.195 Overview of the 2006 excavations in Area R highlighting the different excavation units. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

The aims of the 2009 excavations were twofold: first, to achieve a better understanding of the layout, construction, and activity areas associated with the monumental structure and, second, to clarify the nature of the metallurgical deposits beneath and in front of the structure. These goals were essential for elucidating the nature of control over the site and the role copper production played in the development of society in the region.[82] Following the excavations, five separate phases can be distinguished in the stratigraphic sequence of Area R (Figure 2.195), as designated in Table 2.18.

Layer R1: Abandonment and Ephemeral

The uppermost levels in the structure at Area R testify to abandonment and ephemeral reuse of the monumental structure in late historical times (Figures 2.197S, 2.198S). The distinction between Layers R1a and R1b is arbitrary. Layer R1a lacks sediment between the rock debris. It consists entirely of accumulated large stones fallen from the upper courses of the building. Layer R1b is a yellow-brown Aeolian silt fill that is densely packed with wall collapse, yielding to darker brown silt that is also densely packed with wall collapse. Both Layers R1a and R1b contain many ground stones and hammer stones that

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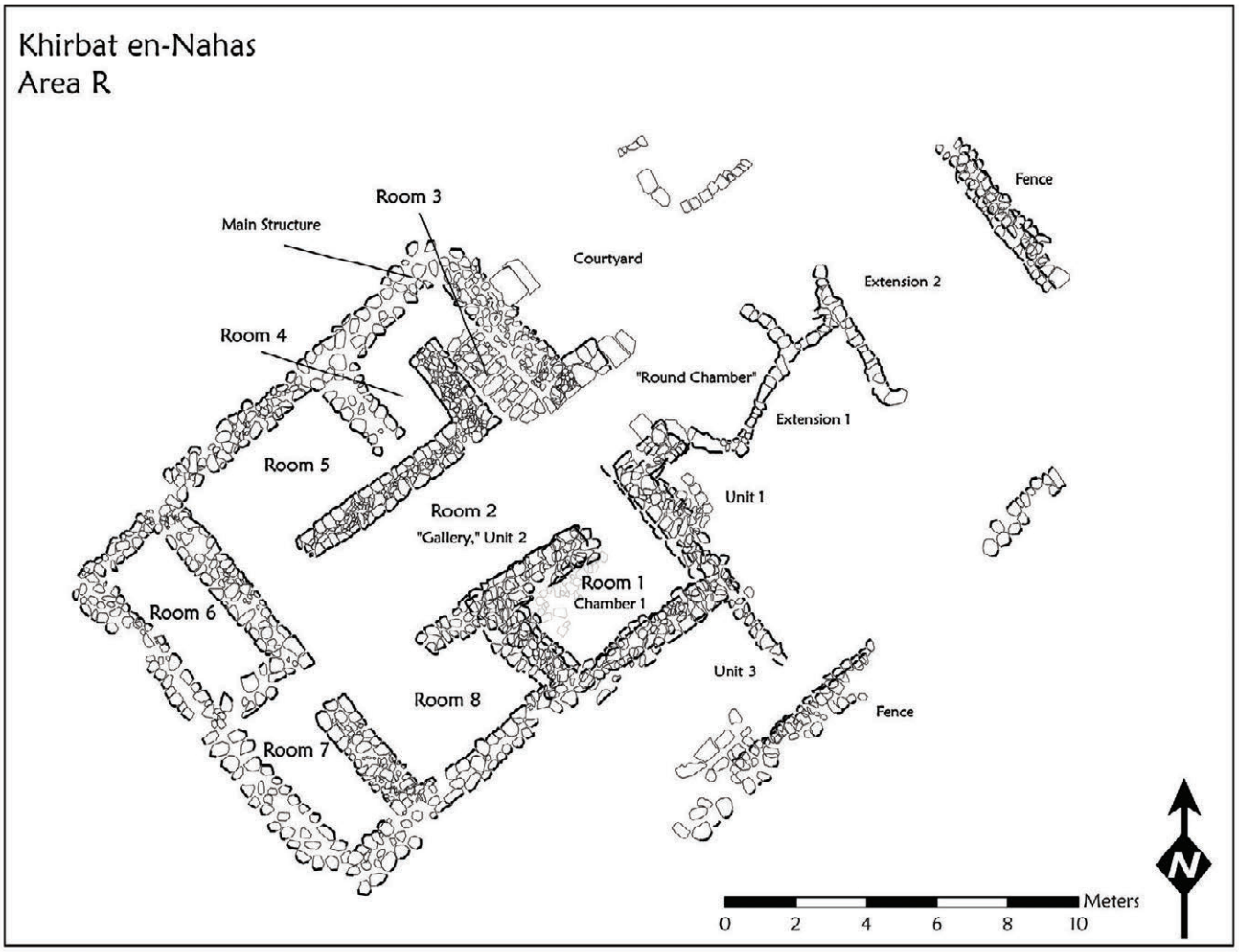

Figure 2.196 Final plan of the monumental building in Area R, Khirbat en-Nahas (2006 and 2009 seasons). Excavated portions of the perimeter wall surrounding the structure can be seen running parallel to main walls of the building. Surface indications of the perimeter walls show the enclosure to be around 22.3 x 32.6 m.

were reused in the construction of the building or may have been stored on the upper floor or roof of the monumental building. Some reuse of the structure and, to a limited extent, rebuilding dates to the Nabatean period, and other reuse is modern Bedouin. It is possible that there was reuse from other periods that cannot be dated.[83]

At an unknown phase, roughly circular structures were built in the collapse over Rooms 1 and 8 in Area R. These may be Iron Age tombs or tumuli were constructed. A complete example was excavated at WF 4, where Iron Age pottery with scarabs was uncovered (see Chapters 9 and 11, this volume). These structures may postdate the tenth-century monumental building and date sometime in the ninth century BCE. The structure over Room 1 was excavated and removed during the 2006 excavation season (L1811 and L1813). No artifacts were recovered.[84]

Like Area R, circular structures were observed on the western side of the fortress gatehouse in Area A (see above). These structures appear in the SGNAS maps of the fortress (SGNAS Site 159; MacDonald 1992). Remains of plastic crates found within one of these features suggest some reuse by modern Bedouin, although their date of construction remains uncertain. Carol Palmer, Helen Smith, and Patrick Daly (Palmer et al. 2007) note the use of 1- to 1.5-m-wide stone circles as pens for very young kids in Wadi Faynan. As noted above, satellite imagery from the 1980s does not show the well-preserved stone circles from Area A demonstrating that they are less than 30 years old. While the animal pen analogy is a likely explanation for the structures near the gatehouse, the placement of the Layer R1a structure atop a mound and away from any similar features, coupled with the unusual thickness of

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Figure 2.201 Deep layers of debris exposed in the excavated trench through the southern part of Room 2 (interior courtyard); the section is visible here in Room 1 (left) prior to its excavation. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

the feature's walls and the effort used to construct it, make it unlikely that the feature was intended as an animal pen.

Recent Bedouin use of Area R is testified to by some modern objects found in the collapse. These include a piece of burlap (R09F0117), a metal strap (R09F0003), and a fire-starting implement identified by the Bedouin workers as an old candle (R09F1004). A spherical red bead, probably made of plastic and found on the surface near Area T (R09F1783), may also be testament to modern pastoral nomadic activity.[85]

Loci assignments in Layer R1b inside the structure were governed by the presence of walls and changing nature of the sediments. Excavated depth was arbitrarily assigned. No significant changes were noted in Layer R1b, except for the fact that in the lowest levels, the sediment lost its beige-white uniformity and gained a pale-reddish appearance. Monzogranite debris crumbled on impact as it fell over the surfaces of the structure and its surroundings. The soft stone eroded under pressure, contributing to these changes. Other changes occurred due to mixing of ashy deposits from the occupation layers.

Finds from Layer R1b are generally as poor as those from Layer R1a. One notable exception is a large restorable pottery vessel (EDM 30069) found among the lower debris (L1807) outside the main structure, near the corner between the northeastern and southeastern (L1800 and L1819; Figures 2.202–2.204). The outer face of the jug is covered with a white slip upon which various geometric motifs have been painted in black. This type of decoration may reflect Midianite ware found as sherds in various parts of the site. This vessel and the three small cups (Layer R2b) found on the occupation floor of Room 1 may be local adaptations of this north Arabian style.

The average depth of Layer R1b is around 1.50 to 1.70 m. Like the gatehouse structure (Area A), the debris fill accumulated directly over the occupation layers of the Area R structure, with little wind-blown sediment in between Layers R2a and R1b. The implication is that a collapse event occurred within a relatively short time after the building became obsolete. However, the lack of artifacts on the occupational surfaces of the structure suggests that this was not the direct cause for abandonment and that it was a rather low process. Thus, the abandonment of the Area R building appears to have been planned and orderly.

Although the accumulation of the Layer R1 sediments date to the building's abandonment phase, many of the artifacts found therein, like the jug mentioned above, probably derive from the building's main construction and use phase (Layer R2a/R2b). The numerous ground stone artifacts recovered were most likely reused as building stones. Many of the portable artifacts are believed to have fallen from the building's upper story or roof and should be interpreted as belonging to the Layer 2 monumental structure.

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Figure 2.202 Reconstructed pottery vessel found in Layer R1b, Area R, Khirbat en-Nahas. *Photos: Gene Barryhill, UC San Diego Levantine Archaeology Laboratory.*



Figure 2.203 Detail of the decoration on the restorable painted jug found among debris by the outer walls of the main structure.

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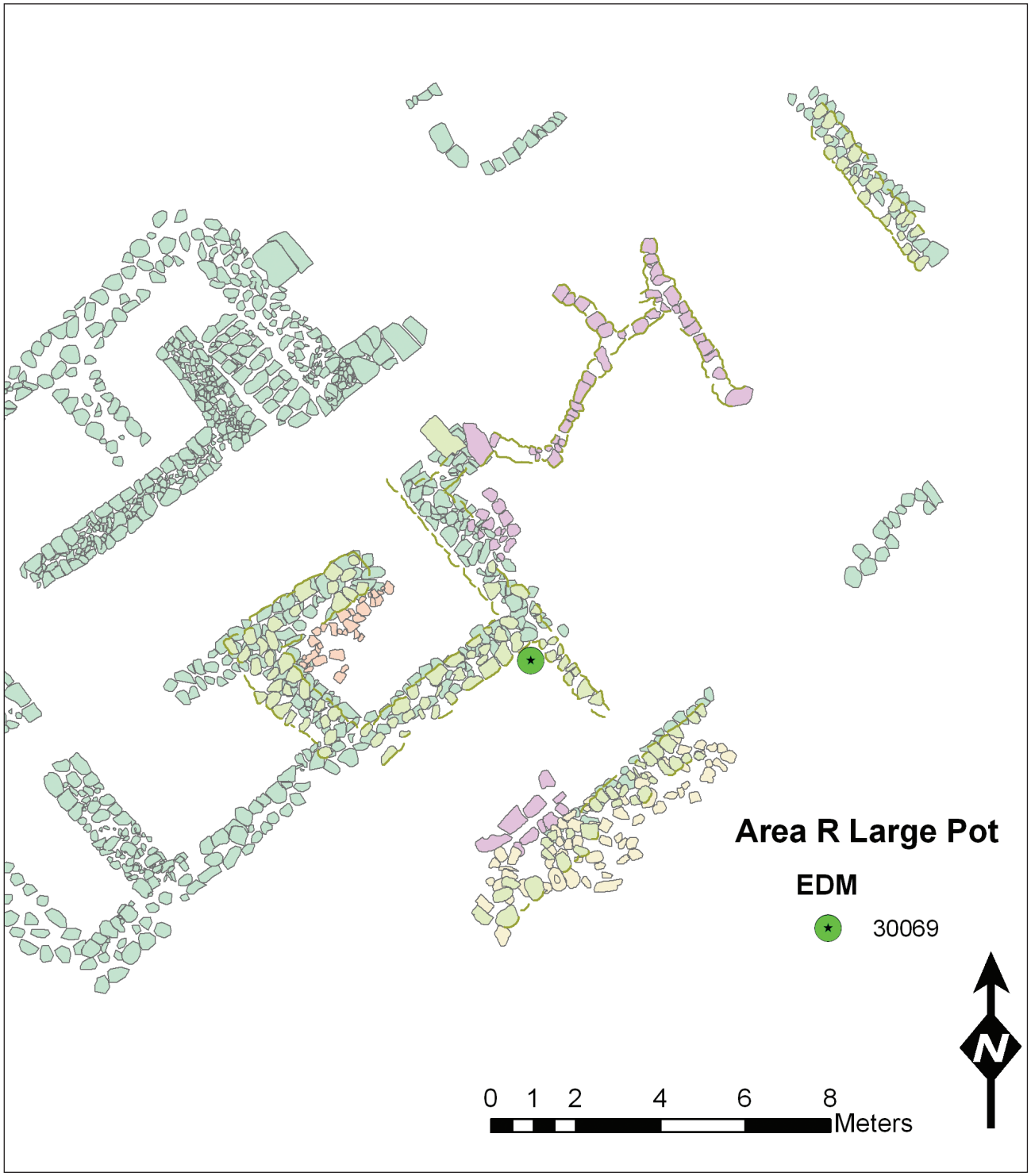

Figure 2.204 Location of the tenth-century BCE ceramic vessel (Figures 2.202, 2.203) found outside the monumental building in Area R, Khirbat en-Nahas.

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Layer R2: The Monumental Structure

The most prominent feature of Area R is the monumental building, an almost square structure measuring 14.75 m long and 13.16 m wide. When considering this building, which had a second story, the large perimeter wall (ca. 22.3 x 32.6 m) must be included. Layer R2b represents the original construction of the building itself and Layer R2a the additions to that structure. It is likely that no great period of time separated these two layers, and here they are considered together. The rooms of the monumental structure were numbered during excavation, counterclockwise as they were encountered, starting with the southwestern corner Room 1 that was excavated in 2006 (Figure 2.205). The rooms are described in detail below. The Area R structure consists of five rooms (Rooms 1 and 5–8) and a stairwell (Rooms 3 and 4) surrounding a central courtyard (Room 2). The walls of the structure, both interior and exterior, are generally about 1 m (two to three stone rows) in thickness, constructed of dry-masonry (Appendix 2.R.3,4, Layer R2b walls; Figure 2.205). The interior walls interlock with the exterior walls. The most common building stones are dolomite and shale from nearby formations, broken or worked to the appropriate size and shape along their natural bedding planes. In extremely rare instances, apparent tool marks are visible on one or more surfaces of these stones. One example are the probable tool marks on one surface of an approximately 0.54 x 0.34 x 0.30–m stone around 1.2 m above floor level in the northeast corner of wall LR09L086. Much less common are sandstone boulders. When used, the sandstone was either unworked eroded boulders or reused ground stone artifacts. Although the closest rock formations are granite, this is the least common building stone. When granite was used, it too was usually unworked boulders. Smaller stones are used for snecking; these are almost uniformly of dolomite and shale (Figures 2.206S, 2.207S).

The Perimeter Walls

Surrounding the monumental building on all four sides is a perimeter wall or fence. The perimeter wall measures 32.6 m long on the sides of the building (northwest/southeast) and 22.3 m wide across the front and back (Figure 2.196). Where the top of the wall is clear enough to be accurately measured, on the west side and in the back, the perimeter wall measures around 0.9 m in width. Two segments of this wall (LR09L103 and LR09L114) were excavated down to their foundations in 2006. Collapse and fill were removed from the top of the side wall (LR09L147) in the 2009 field season, but only a segment of this wall could be followed. Three corners are visible on the surface, but the northwest corner could not be located. No entryway has yet been found in the perimeter wall, despite the fact that one of the excavated wall segments (R09L103) runs directly across from the entrance to the building, where one would expect the entrance to lie. The perimeter wall appears to be unbroken around the building, suggesting a ladder, likely of perishable material, was used to enter the courtyard, increasing the privacy or defense of the structure. Very little collapse was observed around the perimeter wall, suggesting that its height was not very high. However, stones may have been removed from this tenth-century. BCE structure and incorporated in neighboring late tenth- to ninth-century BCE structures.[86]

The Extramural Courtyard (R3—Courtyard Complex) and Entranceway. The perimeter wall demarcates a semiprivate exterior area outside the building. In front of the building, this consists of a rectangular space around 11 x 22.3 m in area in front of the entrance to the monumental structure. Windblown sediment covered the deep deposits of metallurgical waste below this thin (ca. 20 cm) layer of sediment that is fine yellow-brown Aeolian silt encountered across the courtyard at the floor level of the main building. The stratigraphy of this area is very complex. In clearing this fill, several meters from the main structure, an anthropomorphic female figurine fragment, lavishly dressed and adorned, was found. Only the torso with arms and part of the hip survive (EDM 30145; Figures 2.207S, 2.208, 2.209S, and 2.210). The base of the figurine was hollow. Next to it, the remains of a fenestrated stand were also recovered (L1815, EDM 30146). Possible Iron Age parallels to this figurine type have been found in Phoenicia and at the so-called Edomite sanctuary at Qitmit, which is dated to the very Late Iron Age (Beit-Arieh 1995).[87] Other Iron Age figurines have been found in the ELRAP explorations in the Faynan district (see Chapter 10, this volume).[88]

Several installations, some of unknown function, were found in the courtyard in very close proximity to the outside walls of the monumental building (Figure 2.211). These installations were added to the primary Layer R2b architectural plan and are therefore attributed to Layer R2a, a somewhat later phase in the occupation of the main structure of Layer R2b. Two installations and a wall were added in this stage.

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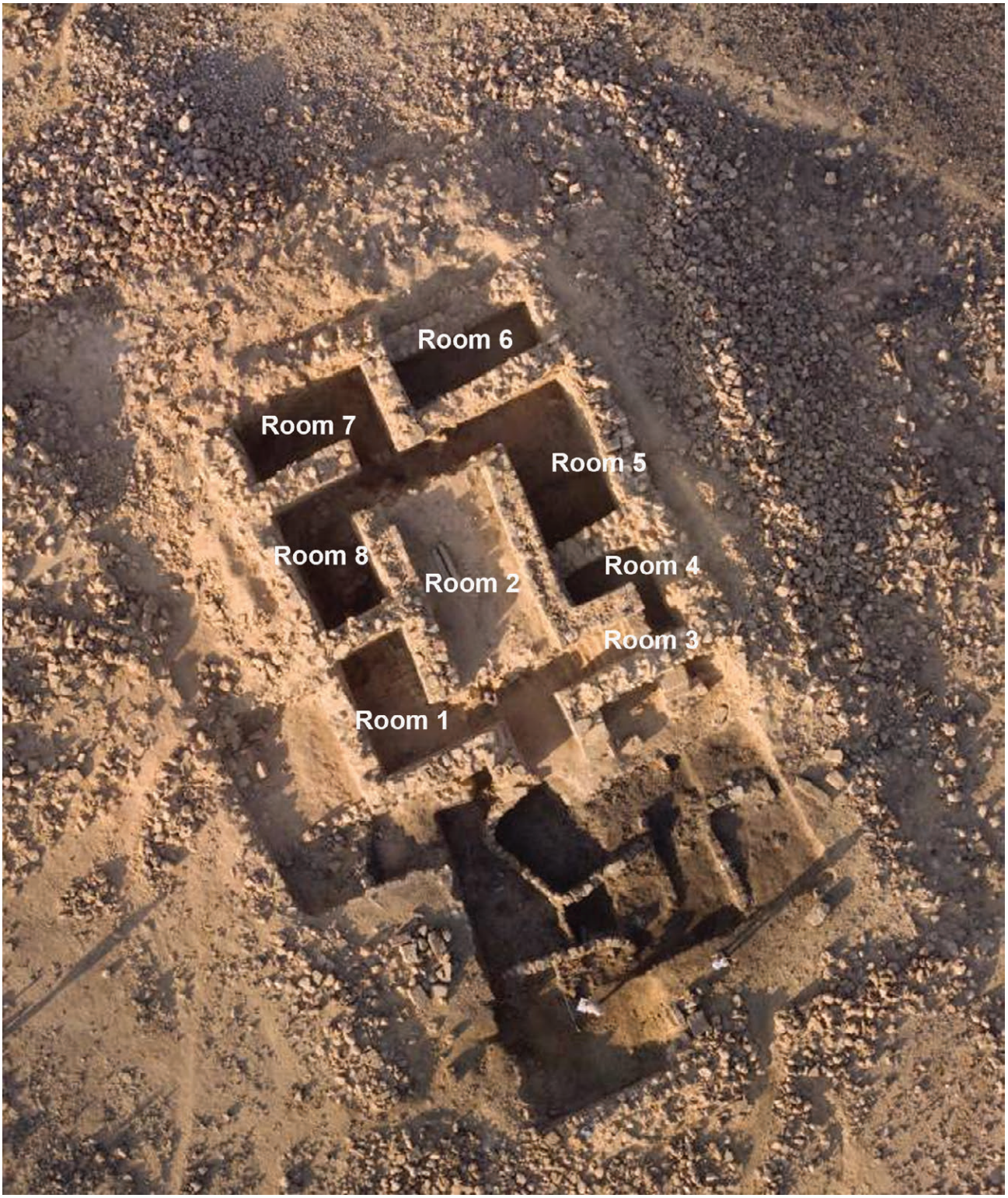

Figure 2.205 Final aerial view of Area R excavation, including room numbers of the Layer 2 building.
Photo: UC San Diego Levantine Archaeology Laboratory.

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Figure 2.208 The Area R ceramic anthropomorphic figurine. *Photo: UC San Diego Levantine Archaeology Laboratory.*

One of the installations (L1809) was built against the frontal wall of the structure to the northeast (L1800) of the entrance (Layer R2a; Figure 2.211). It consists of a flat single-course, single-row platform of unclear function, around 1.50 x 0.50 m in dimension (Figure 2.211). Inside the platform, there was what seems a casual accumulation of stones, implying that the surface was originally of packed earth. The installation may have served as a shelf for artifacts being laid next to the entrance to the building that is at immediate proximity or as a bench, again in direct context to the entrance.

A second installation was exposed at the excavation of Unit 3, the area between the southeastern wall of the main structure (L1819) and the parallel perimeter wall of the courtyard (L1812). Part of the installation remains buried within the section to the southwest. The exposed part comprises two parallel stone lines roughly built of relatively large stones (ca. 0.40 x 0.50 m average size), leaving a space of around 40 cm in between (Layer R2a; Figure 2.212S). At least one of the building stones had been used as a large grinding slab. The function of the installation remains unknown. The absence of artifacts and plastering on the inside of the "channel" precludes ascribing a hydrological function to this feature. It should be noted that a similar arrangement of two roughly laid parallel stone lines was also discovered inside the structure at Area T (this chapter).

The third structure that may be identified with Layer R2a is a poorly preserved wall (L1818), linking the corner between the northeastern and southeastern walls of the main structure (L1800 and L1819) and the southeastern perimeter wall (L1812). A single course of the wall has survived.[89]

Additional factors support the allocation of the three installations described above to the later R2a subphase. All three were founded close to the monumental building and at the surface level of the courtyard that was presumed contemporary. Second, all three installations are built directly over a layer of metallurgical debris upon which the main building and the perimeter fence were constructed. In addition, the installations seem to have been built as practical additions to the main R2b complex when it was in operation and not as makeshift installations erected after its abandonment. Finally, all three installations were exposed beneath the outer collapse debris from the main building complex.

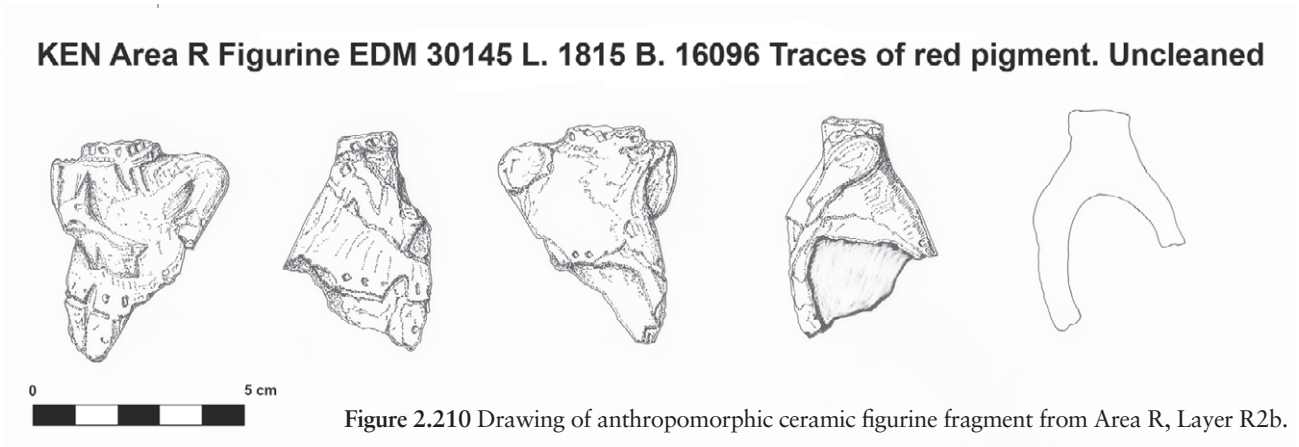

Figure 2.210 Drawing of anthropomorphic ceramic figurine fragment from Area R, Layer R2b.

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Figure 2.211 Installation by the northeastern wall of the main structure and entrance.



Figure 2.214 Detail of the stone bench, throne, or dais found attached to the exterior of the Area R building. This installation points to some of the administrative activities carried out in the courtyard in front of the monumental tenth-century BCE structure in Area R. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

An architectural indication of administrative or social control activities and the Area R building came to light during the 2009 excavations. Attached to the northeastern exterior wall and to the west of the entrance is an installation that can best be described as a throne seat or dais (Figures 2.213S, 2.214). This is a large, high bench that may have served as the seat of an elite official, located around 1.8 m northwest along the wall from the buttress wall at the entrance of the building. It is constructed of two large rectangular limestone or dolomite stones, one set atop another, against the building's exterior wall. The top stone measures 1 x 0.65 x 0.38 m. The stone below measures 0.98 x 0.83 x 0.31 m. The bottom stone is offset slightly forward, creating a step that seems to have served as a seat. Large cobbles were placed behind the larger lower stone block to help balance it. Small flat stones were also used to help prop up the upper stone. The stones do not interlock with the stones of the wall, so the bench must be seen as an addition to the main structure. The bench is in the light during the morning hours but in the shade of the wall during the afternoon and heat of the day. The bench is set at an elevation that makes it possible for one sitting upon it to look over the perimeter wall, or for a standard, statue, or person upon the installation to be viewed by others outside the wall.

The structure was entered through a passage clearly designed to be imposing. Measuring 1.95 m wide, it is the widest passage in the structure by approximately

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Figure 2.216 The Area R monumental gateway and doorsill in situ, before excavation of Layer R1b over the northwestern wall. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

half a meter. Flaring walls or buttresses were constructed on both sides of the passage, making the entranceway around 2.05 m wide. The door sill (probably of dolomite) consists of a large single block of stone, measuring 1.01 m long x 0.35 m wide, placed across the front entrance (Figures 2.215S, 2.216). Against the thick buttress walls, on either side of the entrance, were large stone blocks that may have functioned as benches for guards. It is likely that the passage was constructed to hold a door, but no door sockets were found.

Room 1

Room 1 is located in the northeastern corner of the monumental building. It was excavated in 2006. It measures around 4.35 x 2.45 m wide. It is entered from the courtyard (Room 2, Figure 2.196) thorough a passageway approximately 1.5 m wide in the room's northwest corner. This entrance is immediately to one's left as one enters the building from the exterior and crosses the door sill.[90]

A low stone blocking (L1824) separates Room 1 from the courtyard (Room 2). This blocking marks the end of a partial pavement surviving in the courtyard (Figure 2.217S). At the inner southeastern corner of the gallery, the neck of a jug with a cup-shaped spout was found. This characteristic Iron Age II vessel was probably used for the allocation of a precious liquid, possibly wine or oil. The surface of the Room 1 chamber was covered with light ash in which some debris was embedded (Figure 2.218).

The general volume of pottery in this level confirms the identification as an occupation layer (L1834). Among the finds were a cache of three delicately painted small cups, one of them intact and the other two restorable, and nine fragments of what seem to be a single Cypro-Phoenician juglet (Figures 2.219S, 2.220, and 2.221S).

The surface of Room 1 (L1839) seems to have been of packed earth, possibly with occasional embedded stone slabs. The slabs were found mainly near the northwestern wall (L1821) and may have been part of a low shelf or installation. No plaster was detected on the inner walls, but the quality of construction is good, with clay effectively used for consolidation (Figures 2.221S, 2.222). The absence of more paving stones in this room may indicate they were robbed out in antiquity. The possibility that woven rugs were used on floors like the one in Room 1 should be considered.

Room 2

Room 2 is the central courtyard. The exterior entrance, like the entrances to all the rooms, opens into this courtyard. The courtyard measures around 3.70 x 9.61 m. After the wall lines were made visible through removal of collapse and fill, the majority of this courtyard was left unexcavated. However, in 2006, a section was excavated across the northern portion of the courtyard space, from the entrance of Room 1 to the entrance of Room 3 (what was later clarified as the stairwell).

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Figure 2.218 Occupation level of the northeastern Room 1 in the Area R monumental building.



Figure 2.220 Detail of cache of well-preserved ceramic cups found on the floor of Room 1, Area R building, dating to the tenth century BCE. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

Fragmentary remains of a pavement were uncovered in the 2006 section. In 2009, a second section was excavated across the back portion of the courtyard, from the entrance of Room 5 to the entrance of Room 8 in the southern aspect of the building (Figures 2.196, 2.205). A scarab (R09F0475, Figure 2.223) was found in the sieve from sediments taken from this latter section.

Room 3: The Stairwell

Evidence for a second floor in the monumental building in Area R came to light in a narrow room-like space in the northwestern aspect of the structure (Figure 2.196). On entering the monumental structure, the entrance to a stairway is located immediately to one's right. This mirrors some of the building principles observed

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Figure 2.222 The northwestern wall of Room 1 (L1821) in the Area R building shows the careful crafting that went into the construction of this building. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*



Figure 2.223 The Room 2 scarab (R09F0475); see Chapter 11 for discussion. *Photo: UC San Diego Levantine Archaeology Laboratory.*

in the large building found in Area T (this chapter). The entrance to the stairway is around 1.26 m wide. The staircase is constructed of roughly shaped dolomite stones set on a solid stone and sediment base. The stones used in the steps are generally large and rectangular, 20 to 50 cm long, placed side by side, with each step consisting of three to four rectilinear stones. When the stones were too thin to make the appropriate height, one stone was sometimes set upon another. The steps are around 15 to 20 cm high.[91] Ten steps are preserved (Figure 2.224). The stairwell room was excavated down to the top of the steps. A number of large ceramic fragments, but no complete vessels, were found on top of the lower steps.

Room 4

Room 4 is a continuation of the Room 3 stairwell. It was found full of large chunks of slag and tap slag, piled as high as the wall (LR09L007) separating it from Room 5 to the southwest. The space within this room measures only 1.8 m wide—approximately half a meter wider than the stairwell in Room 3—by 3.0 m long. The stairwell continued through Room 3, around wall LR09L008, through the approximately 0.98-m-wide passageway into Room 4, and up through Room 4 to a second story. A few stacked stones (LR09L004) were found in the passage between Room 3 and Room 4, supporting this theory. Alternatively, a platform may have been erected here on top of the slag fill.[92]

Room 5

Room 5 is the central room wedged between Rooms 4 and 6 on the western side of the Area R building complex (Figure 2.225S). It was entered through a passageway at the southwest corner of the Room 2 courtyard. The entrance from the courtyard measures 1.27 m in width. The room measures 5.05 m in length and 2.88 m wide. Room 5 was excavated down to the level of the crushed slag upon which the building was constructed. A probe through the northeastern half of the

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Figure 2.224 The stairwell (Room 3) leading to a second floor found in the tenth-century BCE monumental building in Area R, Khirbat en-Nahas. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*



Figure 2.226 The Room 5 votive vessel (R09F0225). *Photo: UC San Diego Levantine Archaeology Laboratory.*

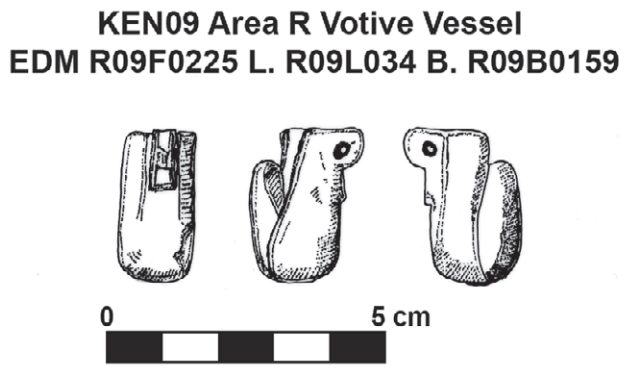

Figure 2.227 Drawing of small votive vessel found in Room 5, Area R, Khirbat en-Nahas.

room excavated through this slag down to a depth of around 30 cm.

High in the dense stone collapse of the Layer R1b fill of Room 5 (LR09L034), a tiny chalk votive vessel was found measuring less than 3 cm in length (Figures 2.226, 2.227). While this was damaged during excavation, two pieces were recovered.

Within the doorway between Room 2 and Room 5, the only cooking installation was found in Area R (R09L144). This was uncovered while excavating the section through the southern aspect of the courtyard (Room 2), which extended into the doorway of Room 5 (R09L129). The feature was identified first as an oval pocket of hard-packed bluish ash, around 50 cm in diameter (Figure 2.228S). Small chunks of dark brown clay were observed and collected mixed amid the stone wall collapse, which extended down to the top of this ash pocket. This clay did not appear to be baked and was initially believed to be part of the floor. After cleaning the wall next to the ash pocket, this brown clay was visible, adhering in an arc on the wall, traceable to about 10 cm above the ground level (Figure 2.229S).[93]

Room 6

Room 6 is located in the southwest corner of the building. The entryway, around 1.30 m wide, is in the northeast corner of the Room 5 opening on to the courtyard. The room measures around 1.74 x 5.05 m. Room 6 is unusual for its narrow width, which is about three-fourths of a meter narrower than adjacent Room 7. Together, these two rooms represent the back of the Area R monumental structure. The back wall of Room 6 (R09L121) is also approximately 10 cm narrower than the back wall of Room 7 (R09L150; Figures 2.196, 2.205). Both walls interlock with wall

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LR09L086, which divides Room 6 from Room 7. It would seem likely that one of these walls dates to a later (R2a) building phase, but it cannot be determined which. Within Room 6 was an unusual ash pocket (R09L057, R09L063) extending from a point in the collapse down to about floor level. Within this ash were bone and a large amount of pottery, including portions of a cooking vessel and a large pithos (see Chapter 5, this volume). This cluster of ceramics, found just within the unexcavated doorway, spreads over an area of around 1 m in diameter. This room may have functioned as a kitchen or storage room for domestic supplies for this elite residence.

Room 7

Room 7 is situated in the southeastern most part of the Area R building complex. The back wall of Room 7 is the only wall that does not show the remarkable preservation of the rest of the building. The upper courses of the wall collapsed into the tertiary wadi depression south of Area R. Only 2.37 m of this wall, extending from the northwest corner of the room, survives, whereas the wall was probably once around 4.88 m in length. This wall is, however, more than 10 cm wider than the back wall of neighboring Room 6. Both walls interlock with wall LR09L086, which divides Room 6 from Room 7. It would seem likely that one of these walls dates to the later Layer R2a building phase, but it cannot be determined which. Room 7 is notable for its small finds. These include a large number of unidentified metal objects found at about floor level.



Figure 2.230 The Room 7 scarab (R09F1635); see Chapter 11, this volume. *Photo: UC San Diego Levantine Archaeology Laboratory.*

Also found in this room, although at a level significantly above the floor, was one of the area's two scarabs (R09F1635, Figure 2.230). According to Münger and Levy (Chapter 11, this volume), the motif on the scarab base is one of the many examples for the posthumous veneration of a legendary Egyptian pharaoh of the eighteenth Egyptian dynasty. However, he dates this scarab to the twenty-second Egyptian dynasty (946/945 to c. 735 BCE). Given the ^{14}C dates from Area R described below, this scarab fits well with the early part of the twenty-second dynasty and the tenth century BCE.

Room 8

Room 8 (Figure 2.231S) is opposite Room 5 and situated on the eastern side of the monumental building between Rooms 1 and 7. It is accessed through a 1.4-m-wide doorway, in the southeast corner of the courtyard (Room 2). Room 7 measures around 2.35 x 4.33 m.

Room 8 is notable for being the only room with which there was an associated lintel. This lintel (R09L052) measures around 1.38 x 0.25 x 0.20 m and is made of bedded dolomite/shale (DLS) (Figure 2.232S). It broke longitudinally across a natural bedding plane after it was moved. The lintel was found on the surface near the doorway.

Metallurgy Below the Monumental Building. Before examining the metallurgical activities found in the courtyard area outside the monumental building, it is important to note what was found below the building itself. Beneath the monumental building complex are a series of metallurgical layers consisting mostly of crushed slag and excavated as Layers R3a and R3b. Like Areas T, S, M, and W, the buildings of the monumental structure in Area R seem to have leveled slag mounds to establish the foundations for this building. However, the metallurgical sequence in Area R is a complex one to unravel. Consequently, two interpretive models will be discussed below for the extramural courtyard.

Metallurgical Activities in the Extramural Courtyard R3. The Aeolian deposits that covered the courtyard area defined by the perimeter wall to the northwest of monumental building were removed to reveal extensive deposits of crushed slag, well-preserved walls, metallurgical installations, and other debris (Figure 2.196). Initially, these black layers appeared to be stratigraphically below the monumental building (Figure 2.233). However, as the excavation proceeded, an alternative

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interpretation could be made. While the radiocarbon dates show that the Area R building dates to the early tenth century BCE, the courtyard deposits in front of the building may in fact come from a later Iron Age phase—the late tenth to ninth centuries BCE—that were cut into this area and in many cases abut the building. To distinguish the loci from this area and those found in direct association with the monumental building, they are distinguished with the prefix "Courtyard" (see below). The following describes these metallurgical remains found in this extramural courtyard area.

The loci from the layers in the extramural courtyard filled and covered stone-built walls of structures that must have been connected with copper production (Courtyard Layer R3b). No complete architectural structure was excavated in these broken slag-dominated layers, and the precise nature of these facilities could not be determined. Here the excavators encounter a stratigraphic dilemma. As seen in Figure 2.233, the walls may pass beneath the Layer R2 monumental building, as there is no clear relationship between the two layers. Alternatively, the Courtyard Layer R3b structure may abut the foundations of the monumental building. The Iron Age builders appear to have leveled the ground and constructed the Level R2 building without regard for what lay below. It is clear from the 2006 probe in Room 1 (L1844), Room 2 (L1829), and the 2009 probe in Room 5 (R09L044) that broken and crushed slag extends to a depth of at least 30 cm and more beneath the building. All the rooms of the structure were excavated to the top of this slag level. Nevertheless, the Layer R2 building was not removed. The courtyard in front of the building was chosen for excavation because it was free of structures. Loci were defined beneath the extramural courtyard to investigate the metallurgical activities that either predate or postdate the construction of the monumental structure. Metal production activities in this area could not be contemporary with the monumental building as it would have made it impossible to access it.



Figure 2.233 The Layer R3b walls, beneath the Layer R2b structure. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

The Extramural Courtyard R3b Structures

A number of wall lines were found below the surface of the courtyard. The walls are made of roughly shaped granite, dolomite, and sandstone, placed in single lines without much regard for form. Corners were constructed of diagonally stacked stones, giving the corners a rounded appearance. Unfortunately, although considerable exposure of these structures was made, they do not clarify function or the complete plan of these architectural installations. Most of these walls were excavated to less than the height of a meter and what was thought to be contemporary surfaces inside the facilities (Figure 2.234). However, as furnaces were built against the walls, which were extremely heat damaged, there is little doubt they were connected with copper production. All walls consist of a single row of solidly built stones that may have been consolidated with rough clay lodged between the mainly dolomite building stones. No exterior surfaces related to this structure were discovered.[94]

The architectural complex of Courtyard Layer R3b was completely covered and surrounded by a massive fill consisting of slag of various types, as well as hundreds of tuyères and furnace fragments (Figures 2.235S, 2.236S). There were also several remarkably preserved furnaces found in this area. In the fill were also tools related to copper production, mainly hammer stones and grinding slabs. All of these elements seem unrelated to the Courtyard Layer R3b structures and were most probably

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Figure 2.234 The architectural complex in the extramural courtyard northwest of the monumental building. The "round chamber" is seen at the center. Wall L1851 is at the front, with short wall L1852 connecting. Note the layers of slag in the section of the round structure, representing the thick slag fill within which the walls were exposed. The main structure is at the background. These extramural courtyard structures may have been dug into the slag mound that predates the monumental building after it was abandoned (see the horizontal slag layers below it). *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

introduced here either as a simple operation of waste disposal following copper production, which also took place in this area.

As noted above, the introduction of the slag into the spaces within and between Courtyard Layer R3b architecture destroyed most occupation surfaces. No artifacts related to this layer could be identified during the 2009 season, as what was found within the fill must be related to its deposition rather than the structure in which it was found.

Only one element found within the bottom courses of the central part of wall L1836 of the round chamber might be an indication to function. There is a vertical rectangular space around 60 cm tall formed of three courses of building stones on each side and a flat stone serving as lintel. The resulting space is around 40 cm wide. Nothing within the chamber is connected to this element, as any installation or connecting architecture that may have existed would have been destroyed during the introduction of the slag fill.[95]

Finally, a layer of crushed slag was discovered below the walls of the round structure. The layer either predates the structure and represents an earlier phase of copper production or is contemporaneous with it and was brought over as foundation bed for the buildings. Clear signs of smelting activity in or very near the area emerged from the high frequency of furnace fragments, including very large pieces throughout the massive fill layers excavated under the extramural courtyard surface.

Furnace fragments included many examples imprinted with the fingerprints of the furnace makers, as well as pieces to which slag, carbon, and tuyère pipe pieces remained attached. Large quantities of tuyère pipes have also been discovered, among them an unusual number of completely preserved artifacts, often with slag attached to the ends. In one relatively narrow locus (L1847), tuyère pipes, several of them intact or nearly intact, comprised a substantial volume of the overall fill that also contained slag and large pieces of furnace fragments (Figure 2.238).

The sections in the probes show that the disposal of the slag was not random. Slag fill (L1833 and L1845) within the irregular ("round") chamber of which three walls have been exposed is arranged in diagonal layers approximately 45 degrees declining from the northeast to the southwest (Figure 2.239).

The distinct diagonal layers disappear outside the perimeter of the chamber, where the slag fill becomes random and mixed. The distinction in slag type fills has been noted in the opposite section. There fine layers of crushed slag dominate the area between the front wall of the Layer R2b building (L1800) and wall L1851, which cuts across the probe in the courtyard on a southeast–northwest axis (Figure 2.240S). Beyond that point, slag fill becomes again mixed and indistinct.

There is some connection between the distinctions in slag fill typology and the obsolete ruins of the earlier phase architecture. In the introduction of the fill,

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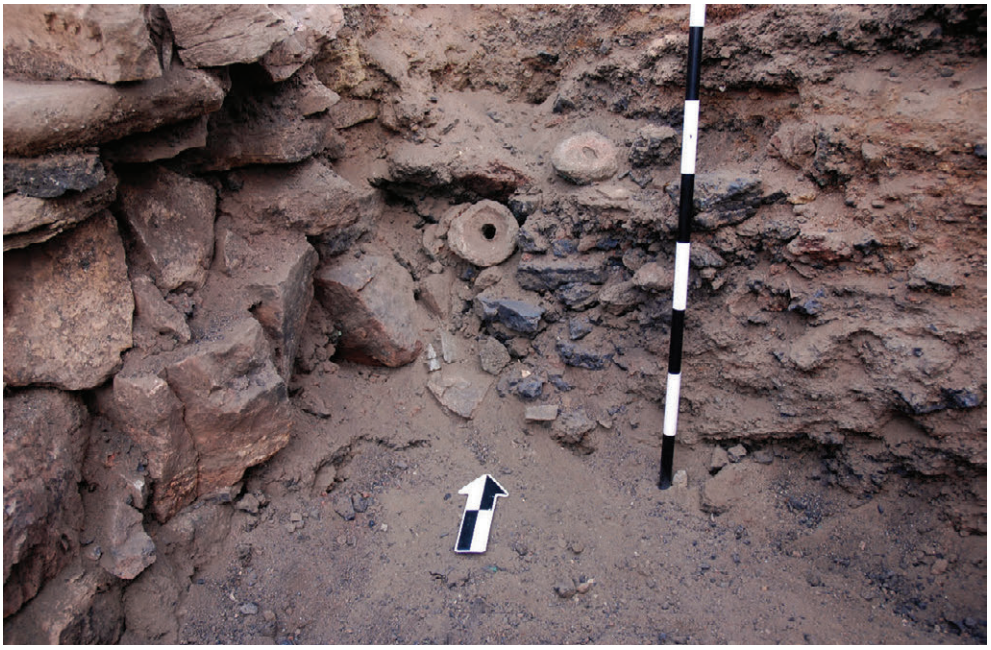

Figure 2.238 Two of several large tuyère pipes discovered within a narrow waste context (L1847) under the surface of the courtyard. These large-diameter tuyère pipes are typical of the late tenth- to ninth-century BCE copper production system (see Chapter 13, this volume).



Figure 2.239 The slag fill within the "round chamber." The arrow marks the more distinct diagonal layers of slag deposit. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

consideration was given to the spaces created by the older walls. On the other hand, there is no evidence that the walls were originally built to accommodate distinct types of fill; rather, the installations had some other function. It is difficult to interpret what purpose would this serve, but no other example of the careful allocation of slag is known from any other part of the site, and the opening in the bottom of the southeastern wall of the round structure (see below, L1836) cannot be explained within the context of casual rough waste disposal. Possible evidence for the immediate source of the crushed slag has been discovered immediately to the southeast of that layer, where a large concentration of tap slag had been exposed around 50 cm below the surface level of the courtyard (Figure 2.241). This was apparently a concentration of raw material to be crushed for copper, the waste being distributed in the adjacent opposite spot.

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Figure 2.241 Tap slag layer under the courtyard surface level. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

Finds from this layer were overall poor, consisting mainly of copper-related artifacts such as the waste material, hammer stones (dimpled and plain), grinding slabs, and mortars linked to production. Pottery was relatively scarce and consisted of sherds of rough container vessels, many of them locally made as indicated by the slag inclusions (see Chapter 5, this volume). No fine ware examples, like those discovered inside the monumental building, were found.

Installations and Furnace Remains

During the excavation of the metallurgical loci beneath the Area R extramural courtyard, a large number of furnace fragment remains were uncovered. In most cases, these were very poorly preserved but hinted at the construction techniques of the ancient furnaces (Figure 2.242S). For example, LR09L123 is a large concentration of slag and furnace fragments next to wall LR09L106, measuring 2.0 x 0.85 m.[96]

Well-preserved furnace elements were also uncovered. One of these is a nearly complete tuyère pipe found on top of a bed of charcoal (R09L071), above the R09L123 furnace remains. The pipe is set immediately next to wall LR09L106, with the opening of the pipe pointed at an oblique angle of about 140 degrees to the wall (21.243). The axis is at 270 degrees from magnetic north. The pipe measures 0.31 m in length, is 0.15 m wide, and stands 0.13 m high. Geomagnetic samples were taken from the slag adhering to the mouth of this pipe to test whether the pipe is in situ, although no other intact furnace remains were observed here. Other large tuyère pipe fragments were also found next to walls that may have been used to support their furnaces (Figures 2.243, 2.244S, 2.245).

Finds in extramural Courtyard Layer R3a consisted almost entirely of artifacts directly related to copper production. Most common was the waste material mentioned above. Also found were objects such as hammer stones (dimpled and plain), grinding slabs, and mortars. Pottery was relatively scarce and consisted of sherds of rough container vessels, many of them locally made as indicated by the slag inclusions (see Chapter 5, this volume). No fine-ware examples were found here.

The Furnace

The most important metallurgical discovery in this area was the mostly complete base of a furnace (R09L142). This furnace was excavated below the 2006 excavation levels; indeed, it was recognized that a furnace might exist here in 2006 when large, collapsed furnace fragments were encountered that could not be excavated due to time constraints (Figure 2.246). The furnace is a saucer-like structure with a basin measuring around 1.01 x 0.80 m across (Figures 2.247, 2.248). The hard clay walls are 5 cm thick. It survives to 0.31 m high at the spot where it appears to begin to curve upward to allow the escape of smoke. This is significantly broader than the 0.40-m diameter proposed for the contemporary (tenth to eighth century BCE Late

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Figure 2.243 An almost complete tuyère pipe (R09L071).



Figure 2.245 Close-up of the tuyère pipe fragments (R09L093) near wall LR09L094. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

New Kingdom) furnace at Timna, Site 30, excavated by Beno Rothenberg (1990); see also Chapter 13 (this volume) for a discussion of this and other pyrotechnological installations in the Faynan district. The base of the furnace is surprisingly free of slag, although slag was found adhering to curved pieces of furnace, believed to be the cylindrical neck of the furnace, found within the furnace basin.

The remaining top of the furnace was found immediately next to a rectangular installation composed of small stones and chunks of slag (R09L151, Figure 2.249S). Two dimpled hammer stones were reused in the construction of this installation. This feature bridges the gap between wall LR09L104 and the furnace itself. The purpose of the installation remains unknown, although it seems not unreasonable to suggest it served either to support the furnace or as a foundation for metallurgical activities. This installation and the furnace were both covered by a thick layer of ash, slag, and baked clay furnace material (R09L135).

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Figure 2.246 The Iron Age furnace in the extramural courtyard in front of the Area R monumental building during the initial excavation.



Figure 2.247 The furnace basin (R09L145), with the stone and slag installation (R09L151) near wall (R09L104) in the background. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

Radiocarbon Dating and Area R

A total of 17 radiocarbon dates were processed from Area R at the Oxford Radiocarbon Accelerator Unit (Table 2.19). Of these, 7 dates come from the 2006 excavations and 10 from those carried out in 2009. Of key interest is the dating of the monumental building. Five radiocarbon dates were processed from the building. Of these, three come from Room 1, one from Room 7, and one from Room 8. All samples for AMS dating were identified to species prior to being processed (see Table 2.19). All of the radiocarbon dates were calibrated using the INTCAL09 curve of Reimer et al. (2009). The calibrated results for each individual date are shown in Tables 2.19A and 2.19B (note these are not modeled results).

We used a Bayesian modeling approach in the analysis of the radiocarbon results, incorporating the radiocarbon dates and the stratigraphic sequence based on the excavations (Bronk Ramsey 2001). Both areas of the Area R excavations were modeled, using the data shown in Tables 2.19A and 2.19B. An outlier detection approach

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Figure 2.248 Close-up of the furnace basin. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

was used to assess whether any of the radiocarbon determinations were in poor agreement with the model parameters imposed (Bronk Ramsey 2009). We used a t-type outlier model, with prior probabilities set at 0.05, for the models that were initially run.

The first model is from the Area R monumental building sequence. The model was run with outlier detection of 0.05 set for each determination. The analysis showed that one determination (OxA-19044) was four times more likely to be an outlier than its prior setting. The result does indeed look older than the other samples within the R2b phase. The inclusion of this determination here has a significant effect on the start boundary for this phase, as can be seen in Figure 2.250. If we considered that this determination might be problematic, for example, due to an undetected inbuilt age, then we could increase the prior probability of it being an outlier and see what effect that has on the posterior results (it ought to be noted, though, that all of the dated samples were composed of exterior charcoal, or the last one to two identified tree rings). When we do this, the effect is significant, as can be seen in Figure 2.251, in which we increased the posterior outlier probability to 0.60. The effect is to change the age range associated with the start boundary (Start R2b) for this phase, which provides a date for the time of initial construction. The results are shown in Figure 2.252; the boundary for R2b in Model 1 is shown above, and below is the equivalent for Model 2. We consider the most likely date for the start of R2b is probably reflected by the more recent distribution of the Model 2 boundary, which is 1157 to 933 BP (66.6 percent probability).

The modeled spans for each of the cultural levels for Model 2 are shown in Figure 2.253, which show that for R1b and R2a, the estimated span lengths are both 0 to 70 years (68.2 percent probability) but longer for the R2b phase (0–220 years). The wider range for the latter reflects the effect of the result of OxA-19044 on the posterior distributions. More dating from this phase might shed further light on the situation and allow us to consider more confidently whether OxA-19044 is indeed problematic or whether the occupation represents a longer period of time.

The model for Area R's extramural courtyard is shown in Figure 2.254. It consists of a simple two-phase model (Layers R3a and R2b). Outlier analysis shows that there are no outliers in the group that was modeled. The results show that the start of building activity (represented by the Start R3a boundary) is 1008 to 917 BCE (95.4 percent probability) (Figure 2.255). The precision of the estimate is not helped by the bimodal distribution of the boundary. The analysis shows that the activity in prehistory in this area of the site had finished by 934 to 844 BCE (at 68.2 percent probability). The overall spans of time represented in both phases of the extramural courtyard area are shown in Figure 2.256, which illustrates the intervals between the phase boundaries. In both cases, the span estimates are potentially brief; R3a spans between 0 and 42 years and R2b for 0 to 69 years (at 68.2 percent probability).

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Table 2.19 Radiocarbon dates from Khirbat en-Nahas, Area R.

A. Area R Extramural Courtyard Radiocarbon Dates

Lab Number	EDM	Season	Locus	Sample Material	Species	Layer	Stratum	Date BP	Cal Date BCE (68.2 and 95.4 percent probability)	Bibliography
OxA-18979	30373	2006	1827	Charcoal	*Tamarix* sp. exterior rings	R2b	IV	2766 ± 26	893–812 900–806	This volume
OxA-18978	30445	2006	1833	Charcoal	*Phoenix dactylifera* exterior rings	R3a	V	2812 ± 27	969–845 991–834	This volume
OxA-19045	30602	2006	1847	Charcoal	*Tamarix* sp. exterior rings	R3a	V	2799 ± 28	996–914 1019–849	This volume
OxA-19046	30649	2006	1847	Charcoal	*Phoenix dactylifera* exterior rings	R3a	V	2821 ± 28	1007–930 1050–904	This volume
OxA-23153	815	2009	70	Charcoal	*Tamarix* sp. outer two rings	R3a	V	2781 ± 27	975–896 1002–843	This volume
OxA-23154	1074	2009	73	Charcoal	*Tamarix* sp. outer two rings	R3a	V	2858 ± 27	799–771 810–599	This volume
OxA-23155	1413	2009	96	Charcoal	*Tamarix* sp. outer two rings	R3a	V	2753 ± 28	919–840 974–824	This volume
OxA-23156	1607	2009	117	Charcoal	*Retama raetam* outer two rings	R3a	V	2770 ± 27	970–848 995–838	This volume
OxA-23157	1973	2009	142	Charcoal	*Retama raetam* outer two rings	R3a	V	2801 ± 28	994–915 1020–848	This volume
OxA-23245	742	2009	65	Charcoal	*Haloxylon persicum* outer two rings	R3a	V	2772 ± 24	971–850 995–840	This volume
OxA-23246	820	2009	70	Charcoal	*Tamarix* sp. outer two rings	R3a	V	2783 ± 25	974–898 1003–844	This volume

B. Area R Monumental Building Radiocarbon Dates

Lab Number	EDM	Season	Locus	Sample Material	Species	Layer	Stratum	Date BP	Cal Date BCE (68.2 and 95.4 percent probability)	Bibliography
OxA-23244	1600	2009	128	Charcoal	*Acacia* sp. outer two rings	R1b	I–III	2764 ± 24	971–850 995–840	This volume
OxA-23243	593	2009	59	Charcoal	*Acacia* sp. outer two rings	R2a	IV	2789 ± 26	974–903 1007–846	This volume
OxA-23242	691	2009	64	Charcoal	*Tamarix* sp. outer two rings	R2a, R2b	IV	2735 ± 25	899–839 924–817	This volume
OxA-19042	30555	2006	1839	Charcoal	*Tamarix* sp. exterior rings	R2b	IV	2883 ± 28	1114–1015 1192–945	This volume
OxA-19043	30200	2006	1817	Charcoal	*Tamarix* sp. exterior rings	R2b	IV	2826 ± 27	1101–930 1053–906	This volume
OxA-19044	30299	2006	1822	Charcoal	*Acacia* sp. exterior rings	R2b	IV	3064 ± 28	1391–1309 1410–1266	This Volume

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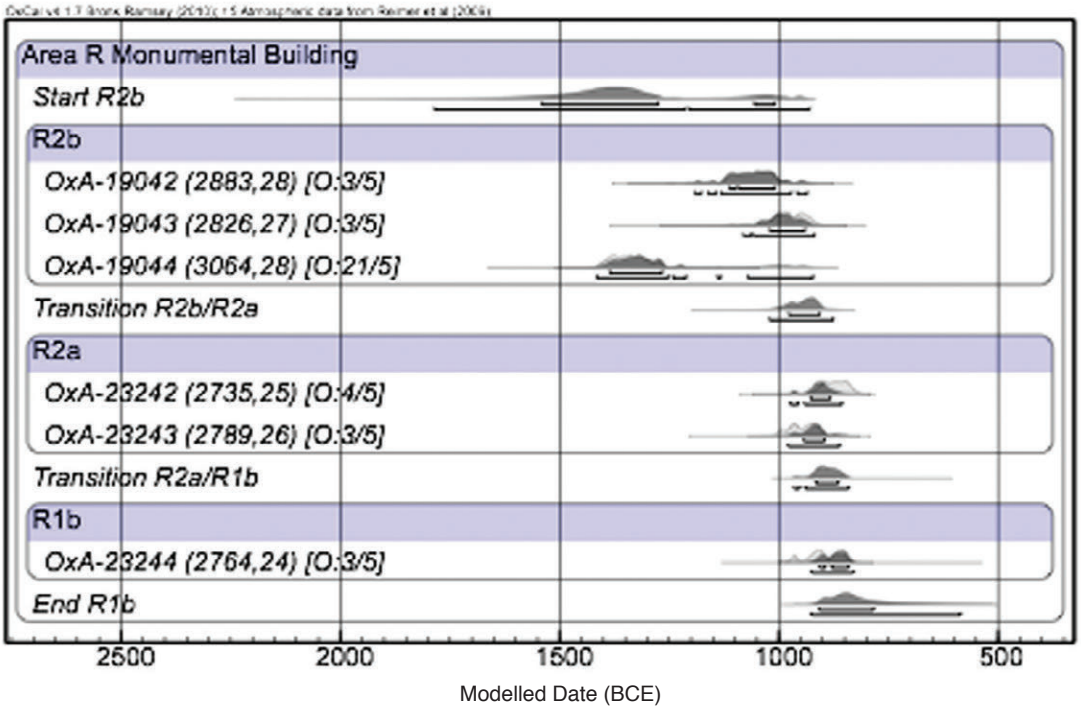

Figure 2.250 Area R Bayesian analysis of radiocarbon dates from the monumental building (Model 1).

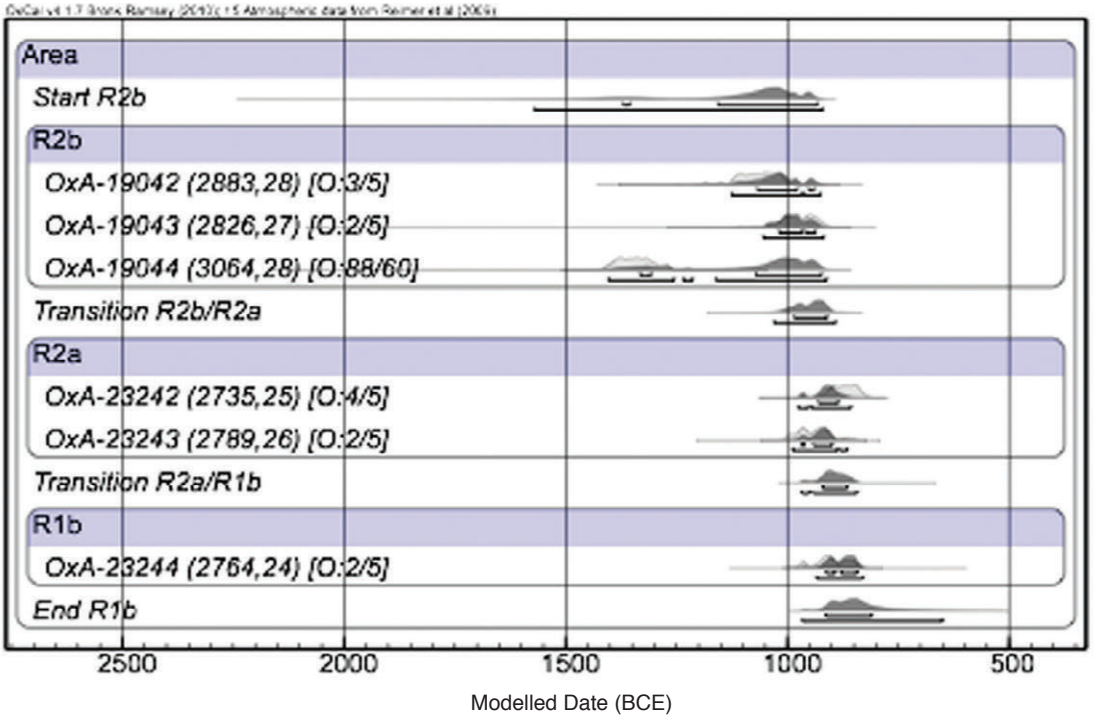

Figure 2.251 Area R Bayesian analysis of radiocarbon dates from the monumental building (Model 2).

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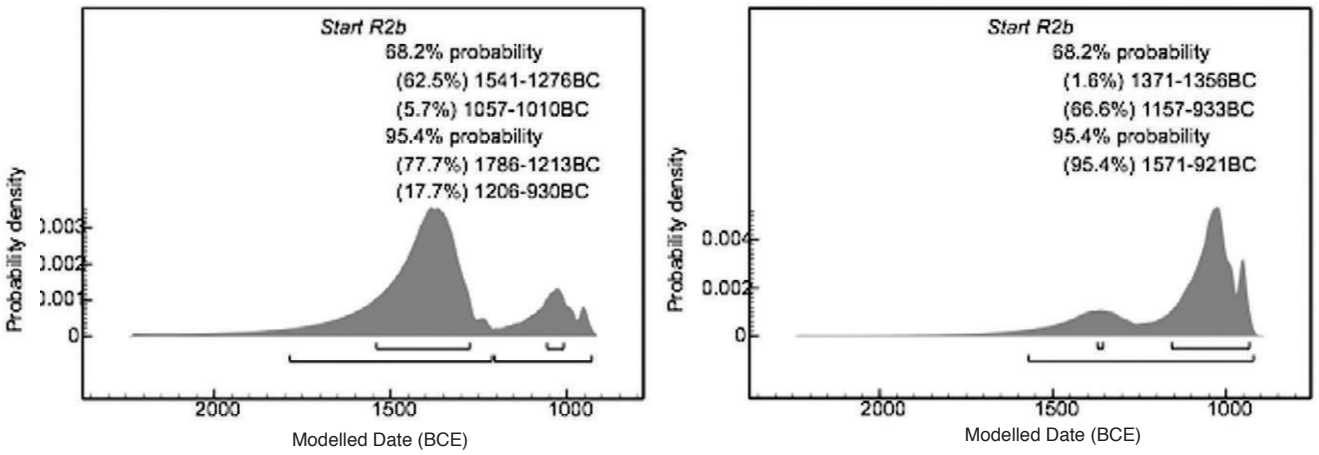

Figure 2.252 Area R monumental building start date for Layer R2b indicating time of initial construction; the boundary for R2b in Model 1 is shown above, and below is the equivalent for Model 2.

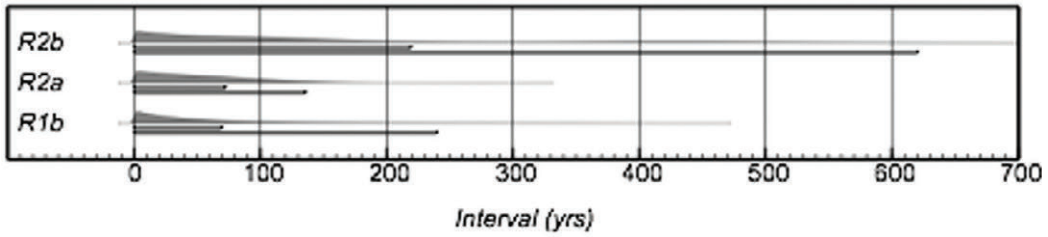

Figure 2.253 Area R modeled occupation spans for main occupation layers in the monumental building (see text for details).

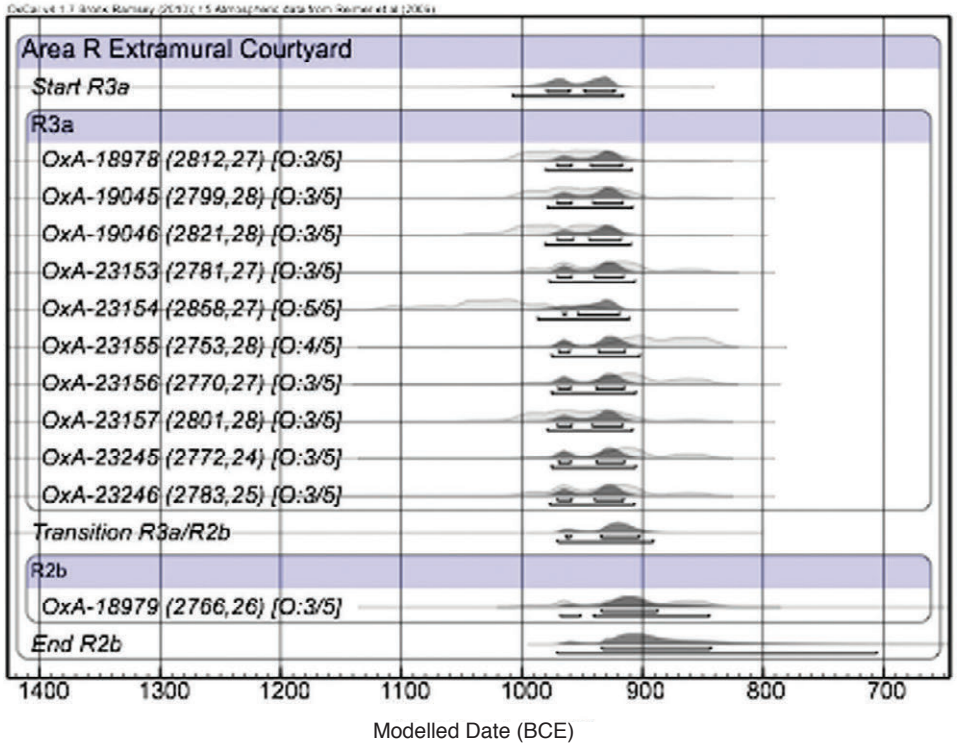

Figure 2.254 Area R Bayesian analysis of radiocarbon dates from the extramural courtyard where industrial copper production activities took place.

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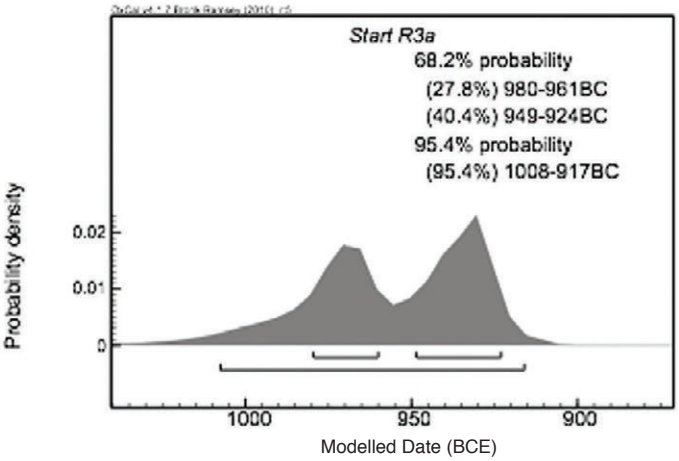

Figure 2.255 Start date of metal production in Courtyard Layer R3.

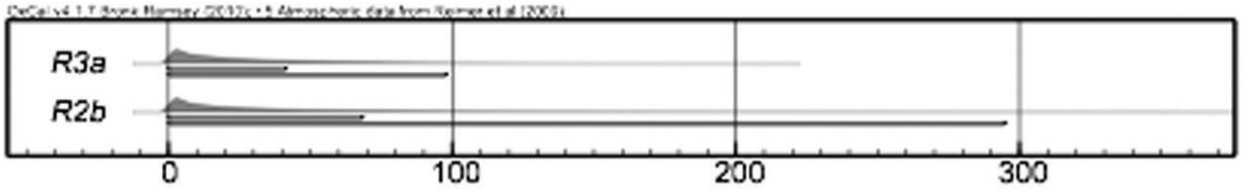

Figure 2.256 Area R modeled occupation spans for the main metallurgical activities in the extramural courtyard.

Beads

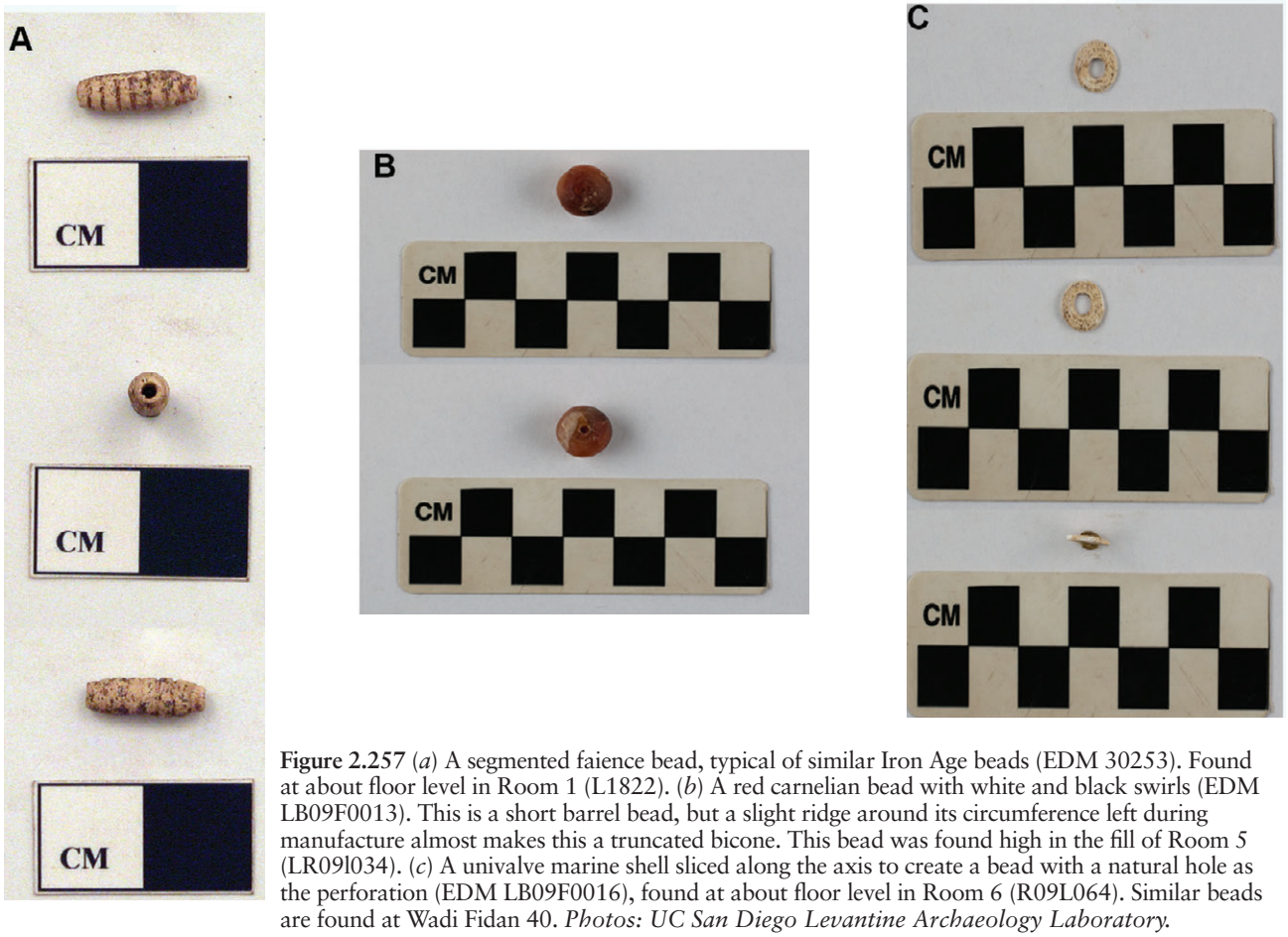

Figure 2.257 (*a*) A segmented faience bead, typical of similar Iron Age beads (EDM 30253). Found at about floor level in Room 1 (L1822). (*b*) A red carnelian bead with white and black swirls (EDM LB09F0013). This is a short barrel bead, but a slight ridge around its circumference left during manufacture almost makes this a truncated bicone. This bead was found high in the fill of Room 5 (LR09l034). (*c*) A univalve marine shell sliced along the axis to create a bead with a natural hole as the perforation (EDM LB09F0016), found at about floor level in Room 6 (R09L064). Similar beads are found at Wadi Fidan 40. *Photos: UC San Diego Levantine Archaeology Laboratory.*

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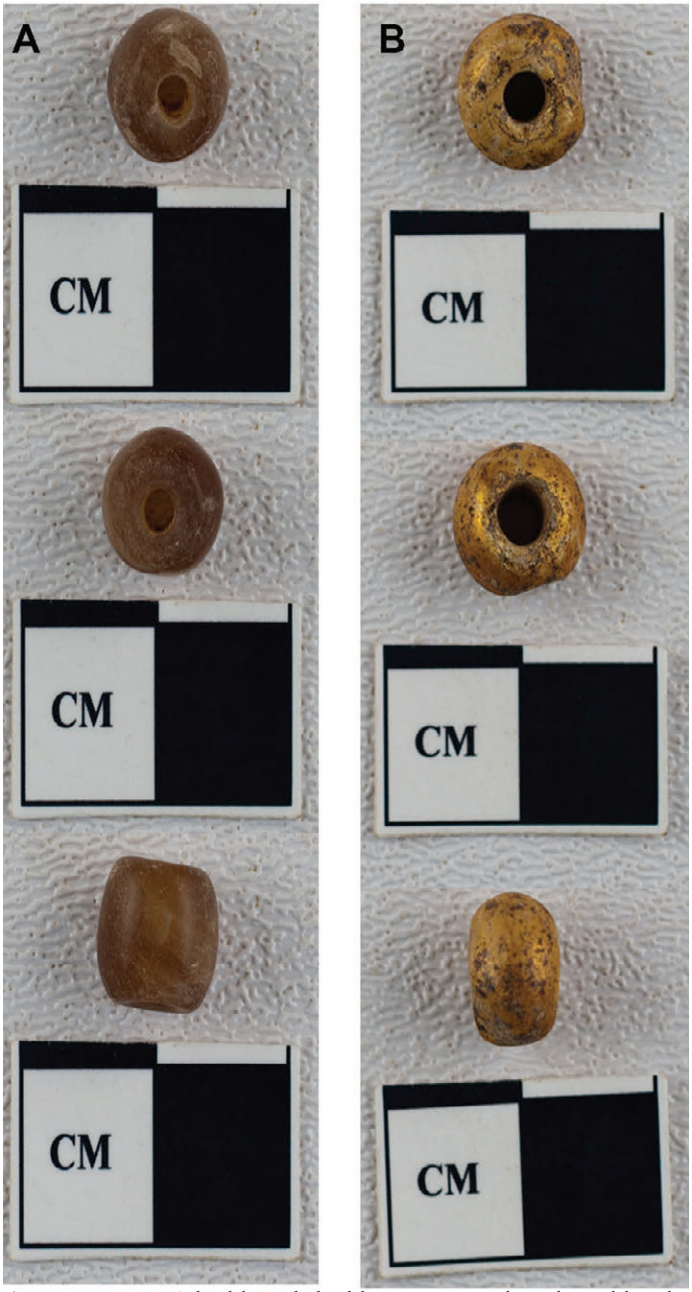

Figure 2.258 (*a*) A highly polished brown agate short barrel bead (EDM LB09F0041), found in the lower levels of the Layer R1b fill in Room 8 (LR09l100). (*b*) A short barrel bead confected of copper alloy leaf over stone (EDM R09F1731). The bead appears at first glance to be gold, but X-ray fluorescence analysis showed that no gold was used in its manufacture. The bead was found at about floor level in the section through the Room 2 courtyard (LR09l129), near where one of the scarabs was also found.

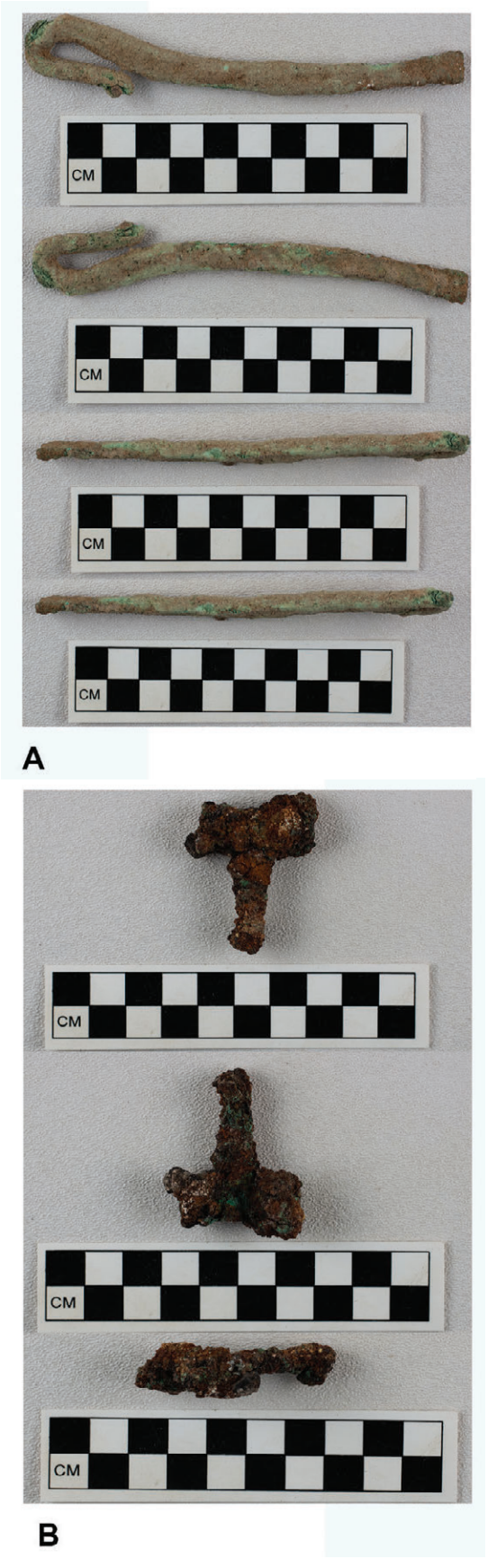

Figure 2.259 (*a*) A fragment of a hooked copper or copper alloy pin (EDM R09F0747). This object was found at about floor level in Room 6 (LR09L064). (*b*) An unidentified metal object, possibly a tang for a javelin, that appears to be rich in both copper and iron (EDM R09F0773), found at about floor level in Room 6 (LR09L064). *Photos: UC San Diego Levantine Archaeology Laboratory.*

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Figure 2.260 (*a*) unidentified metal object that appears to be rich in copper (EDM R09F0149). (*b*) An unidentified metal object, possibly the butt of a sword, that appears to contain both copper and iron (EDM R09F0588). This object was found in Room 6, near floor level (LR09L059). *Photos: UC San Diego Levantine Archaeology Laboratory.*

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Summary and Conclusions—Area R

Two main areas were investigated in Area R during the 2006 and 2009 excavation season: the monumental building and the extramural courtyard. The monumental building measures 13.16 x 14.75 m and consists of a large internal courtyard (Room 2), measuring around 3.70 x 9.61 x 3.70 m that is surrounded on three sides by smaller rooms (Figure 2.196). The radiocarbon dates discussed above from Layer R2b indicate the initial construction phase of this building to the early tenth century BCE—like the gatehouse in the fortress complex and the Area T building. The structure is in turn surrounded by a perimeter wall (ca. 22.3 x 32.6 m), creating a well-defined elite residential complex. Both interior and exterior walls of the monumental building are approximately 1 m thick. No windows were found in the building. In the northwest corner of the structure, a staircase gave access to rooms (Rooms 3 and 4) that existed on a second story. That a second story existed is suggested by the vast quantity of building stone collapse removed during excavations and by the thickness of the interior and exterior walls. This collapse was found in every room, as well as on the exterior of the structure, and continued from the surface down to floor levels. This building plan is in keeping with courtyard buildings found contemporaneously across the southern Levant (Netzer 1992). Glueck (1935) is probably correct in suggesting that the structure is not a defensive tower, and we suggest it is more likely a defensible elite residence. Excluding the two rooms that probably constitute the stairway, five rooms were identified and excavated around the courtyard. Due to abandonment processes, finds were rare in these rooms, but what was found suggests wealth related to the metal production that took place at the site. Some of the metal finds from this building are from weapons (hilt of a sword and javelin), suggesting that residents of this structure had security concerns (Figures 2.259, 2.260, 2.261S). The discovery of beads, pendants, and amulets may be another indicator that the residents of the Area R building belonged to the elite of KEN (Figures 2.257–2.260).

This monumental building, like most of buildings at Khirbat en-Nahas, was built atop a layer of crushed slag. The site for the Area R structure was likely chosen in part because of the commanding view of the entire site—especially with its second floor. The most important find in the metallurgical debris associated with the extramural courtyard is the largely intact basin and partial wall of a copper smelting furnace. This furnace varies significantly from contemporary furnaces known from the other side of the Arabah, enriching our knowledge of Iron Age copper working practices (see Chapter 13, this volume).

The closest architectural parallels to the monumental building in Area R are from the Negev highland region. Widespread Iron Age IIA settlement has been documented in this region by Rudolf Cohen, Moti Haiman, and others (Cohen 1979; Cohen and Cohen-Amin 2004; Haiman 1994, 2003; Shahack-Gross and Finkelstein 2008). The function of the Iron IIa sites in the Negev has been a highly contentious subject as many of the sites have been interpreted as fortresses and ascribed to United Kingdom control of Solomon's southern border (Cohen 1979; Cohen and Cohen-Amin 2004). Some 400 Iron Age II sites have been recorded in this region, 50 of which have been interpreted as "fortresses." Some researchers view these enclosure sites as belonging to pastoral nomads undergoing a phase of sedentarization (Finkelstein 1984; Rothenberg 1967). A third model suggests an IA II settlement system with fortresses, year-round settlement, and seasonal camps (Haiman 1994, 2003). These models will be discussed in relation to the ELRAP research in the conclusion (Chapter 15, this volume). For Area R, some of the larger Negev "fortress" sites are of direct importance as they contain buildings with entrances that are delineated with buttresses. For example, in Area Gimel, the Atar Haroa site has one of these buttress buildings situated some 50 m north of the oval fortress in an undefended locale. The plan is almost identical to the Area R building, with a wide entrance flanked by buttresses and five rooms organized around an inner "courtyard" (Cohen and Cohen-Amin 2004:37). One radiocarbon date from a date palm pit places the building between 1120 and 890 BCE with two standard deviations (Shahack-Gross and Finkelstein 2008:970). This structure lacks evidence of a second floor and measures around 8 x 12 m compared with the Area R buttress building, which measures 13.16 x 14.75 m and has walls that are twice as thick as those at Atar Haroa. Nonetheless, Cohen and Cohen-Amin (2004) refer the Atar Haroa structure as the "House of the Officer." Other Negev sites with buttress buildings include Nahal Boker, Horbat Mesura, and Nahal Avdat (Cohen and Cohen-Amin 2004). Another interesting parallel between Khirbat en-Nahas Area R's building and the central Negev buttress buildings is the relationship

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between the presence of a surrounding wall around these large-scale building (e.g., Har Hemet, Mezad Sirpad, and Mezad Nahal Yeter). In haste, Cohen excavated and probed 37 of the 50 major IA IIA sites in the central Negev. Consequently, it is probable that important architectural features were lost during the course of this work. That said, the architectural similarities, handmade "Negbite ware" pottery, Midianite ceramics, and radiocarbon dates from Khirbat en-Nahas in the northern Araba's Faynan region and the central Negev show possible socioeconomic connections between the Negev highlands and the Faynan region during the Iron Age IIA (tenth century BCE).[97]

Concluding Remark Concerning the Excavations at Khirbat en-Nahas

The UCSD–Department of Antiquities of Jordan excavations at Khirbat en-Nahas (KEN) have established a new chronological scheme for the Iron Age archaeology of southern Jordan. By extending the Late Bronze–Iron Age chronology of Edom by more than 500 years and demonstrating industrial-scale copper production in Faynan from the early tenth to ninth centuries BCE, it is necessary to reassess the process that led to secondary state formation in this part of the southern Levant. Central to debates concerning the nature of social organization during the tenth century BCE, the results presented in this chapter demonstrate that local complex societies (kingdom/small state) were present in the southern Levant at this time. This has important ramifications for understanding historical aspects of the Hebrew Bible and other ancient texts from this period. To understand the full significance of the excavations at KEN, this work is considered in the concluding chapter (Chapter 15, this volume), together the wealth of other survey and excavation data recovered and analyzed for the final publication presented here.

Notes

1 Measurements are given in meters and should be considered estimates in all cases, due to the imprecise and asymmetric nature of ancient structures. When a given dimension varies slightly, we will report the average value (indicated by an asterisk); when it varies substantially, we will report a range of values. When published dimensions were available, we have used them; otherwise, we have measured from published plans. Gatehouse "width" and "depth" are from the perspective of one standing outside of the gatehouse and facing the building's façade. Towers on the façade will be included in the gatehouse's dimensions; other buildings or walls that are appended to the back or sides of the gatehouse are not included.

2 Chamber width and depth are given from the perspective of one standing in the doorway of the chamber looking in; note that this is different from the perspective taken for overall gatehouse measurements.

3 Stern (1993) says that the foundations of the gate measure 21 x 20.5 m, but these dimensions do not seem to correspond to his published plans (Stern 1993:Figures 55, 57). We have followed the dimensions of the gate in the plans here.

4 Remains of a third gate at Gezer were found, which the excavators thought had two chambers and dated to the late seventh to early sixth centuries (Stratum VI; see Dever et al. 1971:118). However, only the tip of one pier was found, and the dimensions and nature of the gate remain largely unknown (John Holladay, personal communication, September 16, 2010).

5 The plans for this phase of the gatehouse, generously shared in prepublication form by John S. Holladay, show the first two chambers as one enters the gatehouse as abnormally large and asymmetric. The southwestern chamber is around 5 m wide; the southeastern one is around 6.3 m wide. The two remaining chambers are both around 2.5 m wide.

6 The excavators disagree on the number of chambers present in this gatehouse. Woodhead says the gate is four chambered; Ussishkin thinks it might have been a shorter six-chamber type (Ussishkin and Woodhead 1997:20–23).

7 This gate was assigned to the stratum "IIIB" by the excavators (Lamon and Shipton, *Megiddo I*, 74). According to Yadin, the excavators were forced to the awkward conclusion that there were two superimposed gates (the present four-chambered gate and the later two-chambered gate) in the same stratum. To alleviate this, they came up with the fiction that the four-chambered gate was begun and then, before it was finished, was redesigned into the two-chamber gate (Yadin 1972:159–160; cf. Lamon and Shipton 1939:74).

8 Because of the early date and the correspondingly crude methodology of excavation, it is impossible to be certain of the dating of much of the Iron Age remains at Tell en-Nasbeh. The dates given are Zorn's best estimates based on the evidence at hand and on the (well-founded) premise that Nasbeh should be identified with biblical Mizpah of Benjamin (Zorn 1993:xxviii).

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9 Zorn suggests that destruction by the Assyrians in 701 BCE is the second-best candidate for the end of this gate (Zorn 1993:497).

10 This is the width of the south wall's passage; the passage between the middle sets of piers was around 4.3 m, and the passage through the northern wall (misidentified by the excavator as an off-center gap of poorly preserved foundation walls) was not clearly discernable (see Zorn 1993:702–703).

11 Dates given here (for both of Dan's gatehouses) are those of the excavator. For a recent revision that down-dates the relevant strata by about a century, see Arie (2008).

12 Based on the only uncovered remains of the E half of the structure.

13 The three excavated chambers of this gatehouse vary dramatically in their size. While all three have similar widths, the southwest chamber is 5.7 m wide, the northwest chamber is 2.4 m wide, and the northeast chamber is 3.5 m wide. Another unusual feature of this gatehouse is that the larger chambers lie along the same axis as the passage, as opposed to most gate chambers that are perpendicular to the gate passage.

14 This gate is unusual in its construction; the 1.7-m-wide passage is only in reference to the outermost pair of piers (i.e., at the gate's façade). The passage between the gate's middle piers widens to 3.2 m, and the passage between the inner set of piers is 3.3 m (Pratico 1993).

15 The point at which the gatehouse was renovated into a four-chamber building is unknown; Mazar (1997:118) notes that "the lack of floors … and the very small amount of pottery from reliable contexts rendered the analysis and dating of this gate a difficult task." Mazar prefers to lump the Stratum III and II gates together into the eighth to seventh centuries (1997:111).

16 The depth dimension of the gatehouse is uncertain for this stratum because the façade of the gatehouse was not preserved well.

17 The passage narrows to around 3.5 m between the irregularly shaped first set of piers/towers.

18 The dimensions given here are an extrapolation based on partial excavation of the structure and the assumption of symmetry.

19 There are a number of possible origins for the Layer A1b fill: (1) the fill was intentionally used for consolidation material between the stones of the walls, (2) it is remnant mud brick material that washed down from the upper crust of debris, and (3) it represents wind-blown sediment. A very similar fill appeared in all the rooms of the gatehouse and in the building in Area R (see below). The fill is light brown, dense, and dry and contains a large number of stones of various sizes, all of which were part of the collapse of the structure's walls. No plaster was identified and no inner stratigraphy in this layer was detected in the sections. The appearance of this debris layer is uniform and should be attributed to a single "traumatic" event or to several events of the same nature within a relatively short span of time that did not allow other materials, such as wind-blown sediment, to settle in. It should also be noted that no installations or structures were identified in this debris.

20 The industrial waste is manifested mainly in thin ashy layers containing slag and other related waste such as tuyère and furnace fragments. Nowhere was the appearance of copper production in the passageway or the southeastern chamber waste as substantial as discovered in the season of 2002 in the two northern chambers. No sign of furnaces or significant smelting or melting activities were detected in the main passageway between the guard rooms. This picture contrasts with that found outside the gate structure, in the southern probe (Probe 6, Figure 2.16). There, a layer (L157) contained many pieces of slag along with furnace fragments and tuyère pipes (Figure 2.15S). Apparently the area outside the gate structure was used for industrial waste disposal, along with portions of the gatehouse structure that were not used in the industrial process itself.

21 Artifacts from Layer A2a are mainly related to copper production waste. They include a relatively large number of pounding and girding artifacts, as well as some tuyère and occasional furnace fragments. Only two unusual artifacts emerged from this layer: a stamped sherd (L157, B4030) and what may be a fragment of a hematite mace head (L171, B4225). A number of metallurgical installations were found in Layer A2b, including a well-preserved circular one attached to the southern wall of the gatehouse (Figures 2.19S, 2.20). The installations by the southern wall (L30, L31, L39, and L62) are all circular, of various sizes, and built of small- and medium-sized field stones (Figure 2.20). Size ranges between 40 and 80 cm in diameter. These structures are probably associated with metallurgical activities that took place during the ninth century BCE.

22 See Note 21.

23 See Note 21.

24 Loci in Layer F1a represent the mound of wall collapse. The loci assigned to Layer F1b consist of the fill and wall collapse around the fortress area. Loci-associated production and activity areas have been assigned to Layer

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F2a. This includes the ash layers and large stone basins that seem to have been associated with copper melting. Layer F2b is associated with the main occupation phase. These include the two main rooms and the walls of the main structure. Layer 2 has been assigned to the mound of crushed slag that is found against the structure. Finally, Layer 3 is the fortress wall. Harris matrices of Area F can be found in Appendix F.5. The following presents an overview of the activities linked to the different occupation layers in Area F.

25 Layer F1a collapse included L837, L805, L803, L804, L819, L836, L838, L832, and L857. Four loci that were not part of the wall collapse but were representative of the topsoil were included in this layer. These were L823, L810, L802, and L801. L801 represents the top of the crushed slag mound that can be seen in Figure 2.48S that extends southeast of the Area F structure toward the fortress interior.

A single installation (L800) was found in this layer (Figure 2.49S). This was a circular feature and initially thought to be a cairn or gravestones. Removal of the installation and excavations beneath revealed that a large rectangular area had been dug and then backfilled with sediments from the upper layers. Three pieces of human bone were recovered from the fill associated with the cairn that intruded into an earlier crushed slag deposit. It not possible to determine the date of the cairn, but it postdates the occupation of the Area F structure.

26 Both samples are dated to the late tenth century BCE. A similar fire installation to L898 was found in Room 1 (L820) together with ash pockets, fragments of bellows pipes, and ceramics. Nearby, a white sandstone basin with burning marks was unearthed (L856).

27 See Note 26.

28 In summary, the metal workshop of Area F presents a unique architectural unit and artifacts that are different from all the other buildings excavated at KEN. The building was constructed on top of some slag layers indicating earlier smelting activities in this area or nearby (Layer F3). Slag continued to accumulate, in particular against the southern wall of the building, indicating continuous smelting activities adjacent to the workshop itself (Layer F2). The main phase of activity in the workshop was during the late tenth and early ninth centuries BCE and included the construction, initial working (Layer F2b), some organizational changes, and the addition of installations (Layer F2a). These installations are unique in the entire excavated assemblage of KEN architectural features. This is augmented by the high concentration of clay bellows pipes (they are extremely rare in the "typical" metallurgical deposits or "slag mounds").

29 The Deutsches Bergbau-Museum probes were shallow, roughly dug, and loosely recorded, intended primarily to collect slag and charcoals for analysis in the laboratory.

30 We use here *contexts* and *horizons* to avoid confusion with the terminology of the 2006 field season. In the original field report of E. Monroe, *context* is a stratum and *horizon* is a layer. As mentioned above, all of the contexts and horizons excavated in 2002 are part of Layers M1 and M2 of the 2006 excavations.

31 In the original 2002 field report, this is Room 5.

32 See Note 28.

33 See Note 28.

34 In ELRAP's 2002 field season, each metallurgical horizon was defined as a separate layer. In 2006, we used loci for such contexts. The excavated materials from 2002 belong to Area M, Layers M1 and M2a in the slag mound and M2b to M3 in Room 1 (see above).

35 The most interesting example of this wall collapse is in L649, in the northern part of Room 2, where several courses of wall L632 fell as one. Although the wall seems to have fallen here (an earthquake?), this situation was not replicated elsewhere in Area M. Large numbers of ground stones were uncovered in Layer M1b, in and around both Structure 1 and Structure 2. Most abundant were dimpled hammer stones that were found in great abundance mostly outside the structures.

36 In this area, Layer M2 consisted of L602, L605, L606, L608, L609, L610, L612, L615, L616, L617, L620, L622, L627, and L629. The separation into stratigraphic units in the slag mound was less clear than in the excavations of the structures; loci were distinguished by color and characteristics of the sediments, including different concentrations of archaeometallurgical artifacts.

37 As mentioned above, Room 1 may have been abandoned in Layer M2a, with the construction of installation 634 (see Room 1 description below). After abandonment, Room 1 was used for metalworking or more probably as a designated space for dumping metallurgical waste (L619), which eventually spilled over the wall and on top of other deposits (L630). The use of Room 1 as a dumping space for metallurgical waste and the accumulation of fills on both sides of it are the reason for the good preservation of the walls, which in their damaged state could not stand alone too long. The walls themselves became part of the slag mound deposits.

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38 It is also clear that contemporaneous smelting activity took place just outside and to the south of Structure 1, with interaction between the two different areas, including deliberate protection of the walls of Room 1 and maybe eventually decommissioning it (see above). Beneath one of the walls of Structure 1, a small, mostly intact dipper jug (EDM 90869) was uncovered, most likely a foundation deposit. Structure 2 was only partially exposed. It is more substantially built than Structure 1 and is probably more industrial in function.

39 A thick layer of reddish silty clay attached to the exterior face of these walls was likely a plaster (or mud bricks) applied in an attempt to protect the walls from the metallurgical production process, possibly from the building's very foundation (see above). The southern corner of Room 1 was excavated in 2002 (see above). The excavations in the slag mound to the south of the room revealed no evidence of architecture, and it seems that this area, toward the edge of the site and the local drainage, was an open space designated for metallurgical activities throughout the Iron Age occupation.

40 Most of the southern side is enclosed by the same wall that extends into Rooms 3 and 2. The total length of the eastern side of the room, including this wall intrusion, is 5.85 m. Room 4, like Room 2, apparently had a cobbled floor during Layer M2b, represented now by only a few patches (L736 and L737 in the south, L740 in the north) that were covered over by the Layer M2a beaten earth floor.

41 Room 1 has a partition, dividing it into two unequal spaces. This suggests a "five-room" or an elaborated "four-room" plan.

42 L732 in Structure 2 is associated with Layer M2b. It was rich with variety of ground stones, including hammer stones, dimpled hammer stones (one was a reused rubbing stone), a small chalk mortar (EDM 91765), and a large, dense, deeply cut red grinding slab with a lozenge-shaped cavity (EDM 91745). Some evidence of metallurgical activity, such as furnace fragments, was also uncovered. Other artifacts were scarce and included some pottery sherds and a unique concentration of sulfurous sandstone.

43 See Note 42.

44 A small white bead with a groove running down its center (EDM 91717) was uncovered here, as was a red stone bead (EDM 91774). Utilitarian items, including a dimpled hammer stone and a plain hammer stone, were found here. Directly next to this northern pavement in the northwest corner was a roundish installation (L720) of unknown purpose rising about 0.60 m above the floor and around 0.60 m in diameter. It was made of flat cobbles held together in bright red clay. This red clay was also used in an installation in the southeastern corner of the room (L646). This installation consisted of a square layer 3 to 5 cm thick of fine red clay with film of bright yellow clay sealing the corner of walls L668 and L637. It made use of the bases of these walls that consist of very large stones. Small stones along the edge of the installation may be part of it, and although the installation was destroyed with wall collapse, remnants of it were visible on the southern wall exposed to at least 40 cm above the floor.

45 The original inclination of the metallurgical deposits, clearly exposed in the sections of the southern pit in the slag mound, indicates intentional dumping of metallurgical waste. While the center of dumping was south of Structure 1 in Layer M2, the center of the dumping area, or the top of the slag mound, seems to be located where Structure 1 was later constructed, after leveling up the local landscape. In addition to the bulk of inclined deposits, we recognized several surfaces that may represent episodes of smelting activities that took place in the excavated locations themselves. The entire deposits of Layer M3 are located above a clear break in activity at this area, represented by a thick yellow-brown dust and ash of L667.

46 About four courses of stones were laid upon each other to construct the feature. In the bottom level of installation L673 was a thick layer of soft earth, mostly gray in color and with only small amounts of slag (L674). In places, there are red spots derived from decomposed clay bricks. The installation itself was built upon L675, a layer of grayish-black fill with many stones mixed into it covering Layer M5b.

47 See Note 46.

48 Lack of surfaces associated with Layer S1 impedes assigning specific functions to the structure. There were no signs of animal dung in and around the structure, ruling out its use as an animal pen during this last occupation phase. However, the large deposits of broken slag that filled the structure (cf. L263) suggest that it was used as a dump sometime during its abandonment in the ninth century BCE. See Appendix S.1 for a list of the loci from this layer.

49 This layer of rock fill extended to a depth of more than 1 m. Outside the structure (Layer S1), to the east and west, the loci mostly represented clearing the ground surface, topsoil, and shallow fills. An S1 pit was located to the south of the structure filled with metallurgical waste that included large amounts of furnace slag as well as tapped slag. Additional large quantities of slag were recovered from just north of the structure.

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50 There was a marked difference between the topsoil inside and outside the S1 structure. Inside, light brown silty sediment with collapse dominated (L283, L257, L259, and L261), whereas the loci outside the structure to the east consisted of a darker brown sediment with clay content (L258, L343, L260, L267, and L268). This darker sediment may have contained more organic material than inside the structure (related to animal husbandry?). To the west of the structure, the difference was not as marked and consisted of sandy silty sediment containing a few artifacts (L335).

51 See Note 50. The lower extensions of the topsoil loci inside the structure (Layer 1) were divided by the balks that cut the inside of the structure (Layer 1) in three parts (L280, L271, and L274). Later, when the AAA squares were opened, the northwest interior corner was excavated (L283) in conjunction with the rest of the interior loci. The light-colored silty soil mixed with dense collapse was a common feature for them all as well as the very low density of finds. The balks were all removed at this layer, exposing the top of the four-room building (Layer 2b). After these loci were closed, the perimeters of the loci below followed the outline of the architecture of the building below (Layer 2b). The upper layers of Layer 1 inside the structure were represented by L299, L292, L296, L302, and L300. The lower layer, including collapse inside the structure, was represented by L305, L312, L317, and L316.

52 Moderate amounts of worked stones, including hammer stones, dimpled hammer stones, grinding slabs, and polishing stones, were also recovered. The metallurgical finds were very similar to what was found in the other rooms, such as partially processed copper, copper metal, and prills. Secondary melting activity may have taken place here during the earlier layers. No surfaces were noted within this layer, and again it is very possible that the Layer 1 layers were contaminated from lower layers due to the filling of the semi-subterranean structure below (Figure 2.98).

53 See Note 52.

54 There was no ash mixed with the fill, suggesting that if metalwork took place in this room, ash was periodically disposed of elsewhere. The slag collected from Layer S2a in Room 2 came mostly came from the southwest corner of the room, with origins in Room 4. The slag concentration probably related to Layer S3 below the S2b surface. Once the S2a layer was removed, large numbers of worked ground stone appeared on the S2b surface below.

55 It is dated to the New Kingdom and could therefore fit with the first half of the twelfth century BCE (Levy et al. 2004). Other artifacts in both loci included copper metal pieces, partially processed copper, and slag with copper along with possible iron metal. A few tuyère pipe and furnace fragments were also recovered from Room 4, but these seem to have originated from the copper production area south of the structure. The wall (314, 315) separating the room from the production area was damaged, possibly when the Layer 2a waste pit was dug and infilling from Room 4 could have occurred. The hammer stones and dimpled hammer stones found with polishing stones and other metallurgical finds may also indicate secondary metal production (Figure 2.104S).

56 When the waste pit was dug, the Layer S2b layer was disturbed; Layer S2a was at places intrusive to Layer S2b. Furthermore, the furnace (Layer 2b, L324) just mentioned was of a higher elevation than its surroundings, making it appear as intrusive in L327 from below. When L327 was excavated, a wall (W329) appeared, limiting the locus to the east. North of the wall (W329), a Layer S2a copper production surface was exposed, contemporary to W329 and L327. The surface (L328) consisted of a large patch of mud brick in the center of the locus with several concentrations of ash (Figure 2.105). Primary smelting possibly could have taken place south of the structure, but it seems more likely that refining of copper was the main operation in Area S, whereas primary smelting took place in Area M.

57 Locus 322 represented the central portion, and the soil continued to be the slightly darker silty fill mentioned from Layer 1. The finds extracted from here were mostly concentrated close to W288, bounding the structure in the east. A possible stone mold was collected (B6727, EDM 71039) showing four long grooves on one side and two grooves on the other. Several hammer stones and dimpled hammer stones were recovered as well as metallurgical related finds much like within the structure. Among them were copper ore, furnace fragments, partially processed copper, prills, and slag with copper. L322 may have been a fill above a production surface relating to Layer S2b, but due to time constraints, full excavation was not possible. L336 was opened below (Layer S2b), and the density of finds increased, although no proper surface was reached. The courtyards were included in the copper production activity. The darker soil may indicate production as well as higher contents of organic material. Some of the production could have moved from within the structure to the courtyards during Layer S2a.

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58 A very large piece of corroded metal was collected from the northern portion of the locus (B7506, EDM 71497). The furnace fragments and tuyère pipes were collected in very low numbers and probably did not originate from the room but from the production area to the north and south of the structure. Several worked stones were recovered from Room 2 as opposed to Room 1. Hammer stones, dimpled hammer stones, and grinding slabs were found on the surface, although not necessarily in situ. As mentioned above, there were no indications of an abandonment phase between Layers 2a and 2b, and the activity inside the structure may not have changed considerably. The most obvious change of layers shows in the wall additions, which are quite distinct from the structure (Layer 2b) in architectural style.

59 Unfinished carnelian pieces along with quartz, ostrich eggshell, and several beads were found in Room 3 that may point to bead production. Intense activity took place here, as indicated by thin superimposed surfaces with patches of slag. A blocked small entrance was found that connected this room to the courtyards on the east side of the building. The blockage of the entrance most likely took place at the end of Layer S2a occupation, leaving Room 3 connected with the courtyards at least during Layer 2b as well as early Layer 2a.

60 As stated above for Room 3, there was no clear division between the Layers S2a and S2b here; this is another indication that the transition was gradual and that the main activities stayed the same. Hammer stones and grinding slabs were also found in both layers. Beads and worked shell were also present in the room, but the number was lower than Room 3. In addition, no raw material for bead work was found.

61 Some melting of copper could have taken place in the furnace (L324) south of the structure. Ethnoarchaeological studies by some of our team members at a hereditary bronze casting workshop in south India show the importance of crushing slag to extract the smallest amounts of metal (Levy, Levy, et al. 2008). In the Indian workshop, the earthen casting floors were dug up and the metalliferous sediment was carefully washed to extract any residual metal. Crucibles were scraped clean of their slag, which was crushed into fine sediment that was re-smelted along with the metalliferous sediment from the workshop floor. This is an excellent model for helping to understand the function of the Area S building and its immediate environs.

62 Lower level Layer S4, L351, Room 3: Approximately a quarter of Room 3 was probed. A surface appeared below the slag fill (L347) as hard-packed pise with a post hole in the northwest corner. A single stone wall line (W359), one course deep, ran below and parallel to foundations of Room 3 in the northeast. Several pieces of ore and partially processed copper were found here. As the surface was removed, virgin soil appeared below as yellowish sandy sediment mixed with gravel (Figures 2.116S, 2.117S).

63 The installation (L356) found in association with the surface (L350) consisted of a small rectangular feature built from tiny, uncut stones, partially covered with clay/pise material. There were small divisions inside the installation perpendicular to the outer rectangle "frame." The inside stones were partially covered with the burnt pise material. The installation may have been used as a cooking facility.

64 L1580, the fill beneath the ash layer, consisted of a thick layer of compact mud fill. The layer ends at the crushed slag foundation that defines the boundary of Layer T3.

65 The fill removed from within Room 1 provides evidence as to the function of this room. The interior of the room was filled in antiquity with debris typically found in a midden. Similarly, the compact mud layer below the ash layer (L1524) was deposited for a specific purpose. Both fills found within the small structure were most likely used to stabilize and support stairs leading to a tower facing the interior of the site.

66 A probe initiated in the southern section of the room yielded similar results. Excavations reached the base of the west, south, and east walls and went beyond the crushed slag layer that serves as the foundation for the main structure.

67 All of the rooms were constructed with entries leading to the main courtyard. Given the different probes, the courtyard was most likely the center of activity in the structure. Further analysis of the ceramics, animal bones, and any organic remains will prove useful in determining the various activities. The suite of radiocarbon dates and analyses above provides the definitive evidence for when the building was constructed and the span of the various Iron Age occupation phases (layers) in this important structure.

68 The heights of the walls vary across the site but are the lowest in the northwestern corner of Structure 2. The walls in the interior rooms share similar construction attributes, although the height preservation of the walls varies across the structure; they are poorly constructed in the rooms of Structure 3. Wall and room measurements are listed in Appendix B.

69 This type of pillar was constructed with large square flat stones and contains small pieces of chipped stone in between the layers. Another feature associated with the W2BI construction phase are the sets of steps located in

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Structure 2, Room 4 and Structure 3, Room 14. While the foundations of the steps are associated with the main occupation floors, the stone foundations that are encased in compact mud have been assigned to the construction phase.

70 This level consists mainly of a hard compacted crushed slag layer leveled with fills and a hard compact mud. In several instances, installations were built directly into the floor, as seen in Room 6, Courtyards 1 and 2. Finally, loci associated with sediments excavated beneath the crushed slag layer—the foundation of the main structure—have been assigned to Layer W3.

71 The deposits found at the base of the entrance indicate use throughout the entire occupation period. Layers of paving stones were laid (Figure 2.164) and can be seen in the deeper deposits below. Unfortunately, no floors were found to be intact for the first phase (Layer 1B).

72 The remains of the surface are composed of a fill containing compact mud laid in between paving stones. These deposits are more prevalent against the wall in Room 2 but are absent in the center of the room. Below these deposits, the hard compact crushed slag layer that once was the installation was kept intact when the doorway to the right was sealed (see Appendix 2.W.5 for Harris matrices).

73 In addition, installations were uncovered in both areas. In the eastern probe (Figure 2.165S), a small circular installation, possibly the remains of a fire ring, was unearthed beneath the main eastern wall. Flotation and soil samples were collected. The architecture and sediments are reminiscent to those found below floor levels in Areas T, S, R, and M. The probe in this section was carried out to the base of the installation with no further finds. In the western probe (Figure 2.165S), small rock paving installation mixed with the crushed slag and fill was also encountered. The function of this installation is not known.

74 As previously stated, the design of Structure 2 is not similar to any other building excavated at Khirbat en-Nahas. This fact in itself makes this structure quite special. The majority of room functions still remain a mystery, although guesses can be made. Some clues to the function of this structure can be found in the literature from Iron Age structures in Israel. Many contain very similar room layouts and are believed to be domestic areas with two levels of habitation. The structure is indeed quite similar in design, particularly the location of the rooms and the main entrance. However, some differences are immediately evident, thus making Structure 1 special in its own right.

75 The interior wall is less stable and does not buttress the outside wall as tight as the wall to the east. Therefore, the wall must have been erected following the main construction phase. Similarly, W25 in this southern section of Room 4 exhibits a different approach to its construction. The base of the wall here is constructed with much thicker and larger stones similar to those used in the construction of the outer walls, which are then replaced with the smaller limestone and shale construction material seen throughout the site.

76 This is also true with other walls and pillars found in the courtyard (see the section on the courtyard below). While the style of using a large flat shale stone at the entrance is not restricted to this structure as it is also found in Structure 3, those walls lack the aesthetics given to these. Another important characteristic is that no installations are associated with walls in Structure 3 displaying this type of masonry. In Room 6, installations in the floor as well as along the door have been constructed. Structure 3 installations are strictly utilitarian and domestic in function, as evidenced by the threshold and the door socket.

77 In the southern section of the probe, two layers of compact mud were identified. It was first believed these layers represented the W2AII floors. However, upon further inspection, these deposits were restricted to the southern section. The northern section of the profile indicated homogeneous sediment. Thus, the layers of mud brick were most likely a result of drainage.

78 The floor was different from the adjacent room. Fine crushed slag was laid and a reddish compact **sediment** was laid over the top. A small probe into the floor revealed the crushed slag continued. A threshold and a door socket mark the entrance to this room from the north.

79 Below these deposits, two different floors were found. These were similar in construction to the courtyard in Structure 2. A layer of compact mud was laid over a layer of paving stones, crushed slag, and fill. Beneath these layers, a compact floor composed of hard compact mud brick was laid over a layer of crushed slag.

80 Floor levels were reached in all the probes. The majority of the probes were uneventful, although a couple of new installations were found. First was the installation in Room 15. A large platform constructed of fill and paving stone was unearthed against the southern wall. The function is not evident, but it appears a similar platform may have been constructed against the northern wall. Two small pillars mark the entrance to this room reminiscent of the ones in the courtyard.

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Two smaller installations were detected in Room 17. Small windows were discovered during wall cleaning. The first one is located in the eastern wall and the second one in the lower section of the northern wall. Whether these installations were constructed for light or communicating between rooms is not known. Last, the excavations from Rooms 15 and 18 reveal that there are no walls to the west, indicating the structure is much larger than previously believed.

81 A list of the most important ones is found in Table 2.16S.

82 Excavation methodology: a note on field methods regarding both field seasons: Area R was excavated according to the "latest "digital recording system of the ELRAP expedition (Levy 2010; Levy and Smith 2007). The metallurgical layers beneath the Area R courtyard required somewhat different techniques from those employed within and around the monumental structure.

Within the monumental structure, stone collapse was first documented and then removed from the surface being excavated. For logistical reasons, these stones were often piled on top of an adjacent collapse before being carried and carted away to three stone piles. Stones from the northeast portion of the area were taken to a stone pile near backdirt adjacent to Area T on the eastern side of the site overlooking the secondary drainage (Figures 2.4a, 2.4b). Stones from the rest of the building were first piled immediately behind the building, often covering the perimeter wall and the unexcavated portion of the structure. As manpower permitted, these stones were taken to a stone pile in the wadi northwest of Area R. Time did not permit moving all of these stones in 2009.

After the removal of the outer crust of wall collapse, it was generally possible to trace the original wall lines. When this was not possible, the first levels of stone fill were removed in arbitrary loci using picks and turiyahs until the wall lines were visible. After this point, loci were determined horizontally by room limits and vertically by arbitrary depths from the presumed floor level by comparison with the 2006 excavations, or according to stratigraphic changes when visible. When a point within approximately 1.5 m of the presumed floor level was reached, all sediments were sieved with ¼-inch (0.6-cm) screens. Sediment samples were taken periodically in random locations both in the fill and at floor levels for microarchaeological analyses. The dense amount of building stones necessitated the use of picks and turiyahs to reach floor levels. All backdirt was discarded in the secondary wadi west of Area T.

In the metallurgical areas both below the structure and in the courtyard, arbitrary loci were designated and excavated using a combination of turiyahs and trowels. When walls were uncovered, loci were defined using these walls as limits. Suspected features were designated as loci and carefully excavated with trowels and brushes. In 2009, all slag larger than approximately 2½ cm in diameter was collected and weighed. Samples of small, medium, and large pieces were then collected before the remainder was discarded. A sample, consisting of one guffah (bucket) full of sediment, was taken from each locus defined as a slag layer and sieved through a ⅛-inch (0.30-cm) screen, with the entire contents being collected.

All loci were documented in three dimensions using an electronic distance meter (EDM) and RECON handset. Bone, pottery, copper ore, slag, and similar materials were collected as bulk finds from these loci. Other small finds were point plotted using the digital instruments. When special finds were found in the sieve, an arbitrary point from their approximate location was recorded using the EDM, but their sieved provenience was noted in the paperwork. Appendix 2.R contains the Harris matrix and other supplementary material related to the Area R excavations at KEN.

83 Nabataean reuse of the building is indicated by some ceramic finds in the uppermost levels of fill. A reconstructable juglet, identified in the field as Nabataean/Roman, was recovered in the topmost layer of wall collapse and fill in Room 5 (LR09L019; EDM R09F0122). That a certain amount of rebuilding of the structure was carried out in the Nabataean period is shown by the discovery of a Nabataean pot base (EDM R09F0077) found within wall LR09L008, when the topmost remaining course of that wall was removed during the excavation for safety reasons. This reuse appears to have been limited to the uppermost parts of the building, which was already full of sediment in the Nabataean period. Only Iron Age pottery was found below these uppermost levels of R1b collapse and fill.

84 The feature constructed over Room 8 (R09L018) was part of the uppermost level of loose building collapse, arranged in a circle about three to five stones wide, approximately 2.9 m in diameter, open in the center (Figures 2.199S, 2.200S). The construction stands about 0.8 m and about four stones high. The interior is about 0.9 m in diameter, though the collapse makes it difficult to accurately measure. The floor consisted of the Aeolian silt fill found across the monumental structure in the collapse of which it

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was built. No artifacts were encountered during the excavation of this structure as it was probably looted. As this structure is more ephemeral than L1811 and L1813, it is impossible to date this feature.

85 The large buildings excavated at Khirbat en-Nahas show a similar pattern of site formation processes. A layer of stone collapse practically free of any matrix sediment covers the surface of these buildings. Beneath this are found more disorganized stones densely packed within Aeolian sediments, and this same pattern also appeared in Area R. Debris accumulations containing rocks within sediment were found both inside and around the building (Figure 2.201), where the debris collapsed from the ruined walls onto the courtyard, rooms, and other architectural features.

86 Two unexcavated buildings were found attached to the outside of the perimeter wall of unknown function. Along the northwest wall, a low structure, measuring around 8 x 6 m, is attached to where the perimeter wall is believed to extend beneath collapse (R09L152). To the south, a much larger building, measuring around 12 x 15 m, makes use of the perimeter wall (R09L153). Additional structures continue to the south of this, possibly part of the same building complex. Other than the fact that these two structures are connected to the perimeter wall, their relationship to the Area R building complex remains unknown.

87 Thanks to Amihai Mazar for this insight. See Beit-Arieh (1995:43–52). The sample for Area R is approximately half the size as examples from Qitmit. Based on a study of the Edomite script found at Qitmit, Christopher Rollston (Chapter 14, this volume) also dates this site as early as the eighth century BCE.

88 Apart from the decorated jug mentioned above, several loci outside the structure (L114, L1815, L1827, L1832, LR09L054, LR09L056, and LR09L060) produced painted sherds.

89 The connection with L1812 has eroded, but as no architectural evidence for an entrance was exposed, it can be assumed that such a connection did exist. The wall separated the southeastern and northeastern parts of the courtyard, which seems to have been previously connected. The reason for this architectural alteration remains unclear.

90 Room 1 is bounded by wall LR09L023, which separates it from the courtyard (Room 2); LR09L095, which separates it from Room 8 to the south; and exterior wall LR09L116 and LR09L0139.

91 The stones were in turn covered by a thick layer of mud plaster, around 4 to 5 cm thick, which is intermittently preserved on the lower seven steps.

92 Tap slag was also used as fill beneath the steps in the Area T building (this volume). These appear to have been a convenient core in constructing the stairs. The room was excavated down about half a meter into the slag layers. As it became clear that this tap slag was piled up as part of the construction of the Layer R2b building, excavation was abandoned after this point.

93 Nothing else could be determined regarding the shape of the installation because of its poor state of preservation resulting from the crushing wall collapse. Small bone fragments were found in the ash. A sample of the ash was collected for analyses.

94 Inside, a narrow patch of hard-packed sediment was found at the northeastern end of the round chamber. This possible surface is level with the lowest course of the chamber's wall L1836. The surface disappears with no clear reason toward the center of the chamber, replaced by the same accumulations of copper industrial waste that were met above its level.

95 Several fallen stones from adjoining wall L1835 may have been knocked down during that process. The outer outlet of this opening has not yet been exposed. No surfaces or installation are related to either wall L1851 or L1852, which connects the long wall with the round structure (Figure 2.237S). They too were completely covered with slag on both faces, although a least the longer wall seems to have served the transporters of the slag in secondary use as different types appear at each side (see Layer R3a).

96 It was pedestalled by excavators to 0.44 m. LR09L124 is a similar cluster of poorly preserved furnace fragments and slag measuring 1.53 x 1.10 m, pedestalled to a height of 0.53 m, next to wall LR09L094. Both these loci represent the remains of installations constructed next to walls. An installation of unknown function, consisting of a single course of cobbles and tap slag (R09L154), extends from LR09L123 at a right angle to the wall locus against which R09L123 is constructed.

97 Chapter 2 addendum—discovery of special ceramic vessel near Area R: During the course of the season, one of the local Bedouin workers employed in Area R stumbled upon an intact jug embedded in a slag mound around 80 m to the northwest of the area. The jug was collected and recorded by Area R staff and given an Area R identification number. Figures 2.262S and 2.263S show the general location of the discovery and the artifact in its original spot.

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3 New Perspectives on the Iron Age Edom Steppe and Highlands

Khirbat al-Malayqtah, Khirbat al-Kur, Khirbat al-Iraq Shmaliya, and Tawilan

Neil G. Smith, Mohammad Najjar, and Thomas E. Levy

When Nelson Glueck published the 1940 summary of his fieldwork in Transjordan in *The Other Side of the Jordan*, the "golden age" of biblical archaeology was at its peak. Glueck had carried out extensive opportunistic archaeological surveys of Edom, but only one Iron Age excavation took place at Tell el-Kheleifeh near Aqaba, which he identified with the biblical port, Ezion-Geber. These field studies enabled Glueck to propose that the Iron Age archaeology of Edom confirmed the biblical narratives concerning Davidic, Solomonic, and ethnic groups such as the Israelites and Edomites in this region.

It was not until the 1960s that a rigorous excavation program was instituted to investigate the nature of Iron Age settlement in Edom. This work was initiated by Crystal Bennett at sites located in the highland region of Edom around Petra and its environs. Based on this work, Glueck's paradigm was rejected and new assumptions regarding the Iron Age archaeology were established that argued for a very late beginning for this period, sometime in the sixth century BCE. The revised dating minimized the importance of the Hebrew Bible for understanding the history of Edom.

Following the 2002 excavations at Khirbat en-Nahas and unexpected early radiocarbon dates for the beginning of industrial-scale copper production at Faynan, the University of California, San Diego (UCSD) team felt it was important to compare the new lowland stratigraphic sequence dated with high-precision radiocarbon dating methods with sites up on the highland plateau. The result was the establishment of the Lowland to Highlands of Edom Project (L2HE), a part of the long-term UCSD Edom Lowlands Regional Archaeology Project (ELRAP) expedition. Four highland sites were sampled as part of the project and the results are reported here. These sites include Khirbat al-Malayqtah, Khirbat al-Kur (also known as Khirbat al-Iraq south), Khirbat al-Iraq, and Tawilan. These new excavations provide important data for helping to test social evolutionary models concerning the formation of what biblical and ancient Egyptian sources refer to as the kingdom of Edom.

Opposite: Overview of the excavations at Khirbat al-Iraq, Jordan. This is a typical steppe-land site on the edge of the highlands of Edom. *Photo by T. E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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Introduction

As the ELRAP Iron Age research program evolved from its first season in 2002, it became increasingly clear that to clarify the relationship between the new stratified and radiometric dated sites from the Edom lowlands with those in the highlands, new fieldwork was needed in the steppe and plateau areas of Edom. Furthermore, any new excavations in these areas would need to be carried out using the same methodology, digital archaeology methods that were used in the lowlands of Edom. In this context, Neil Smith (Smith 2009) led our investigation of the highland region immediately east of the Faynan district. From 2006 to 2007, the Lowland to Highlands of Edom Project (L2HE), a part of the long-term UCSD ELRAP expedition, carried out a reconnaissance survey (2006) and four small archaeological soundings (2007) in the highlands of Edom in the region between Showbak and Wadi Musa (Figure 3.1). The goal of this work was to conduct stratified Iron Age excavations with the aim of obtaining geospatial archaeological data and radiocarbon dating samples from the highlands of Edom so that a comparative study could be made with data from the stratified sites in the Edom lowlands. Soundings were made at three

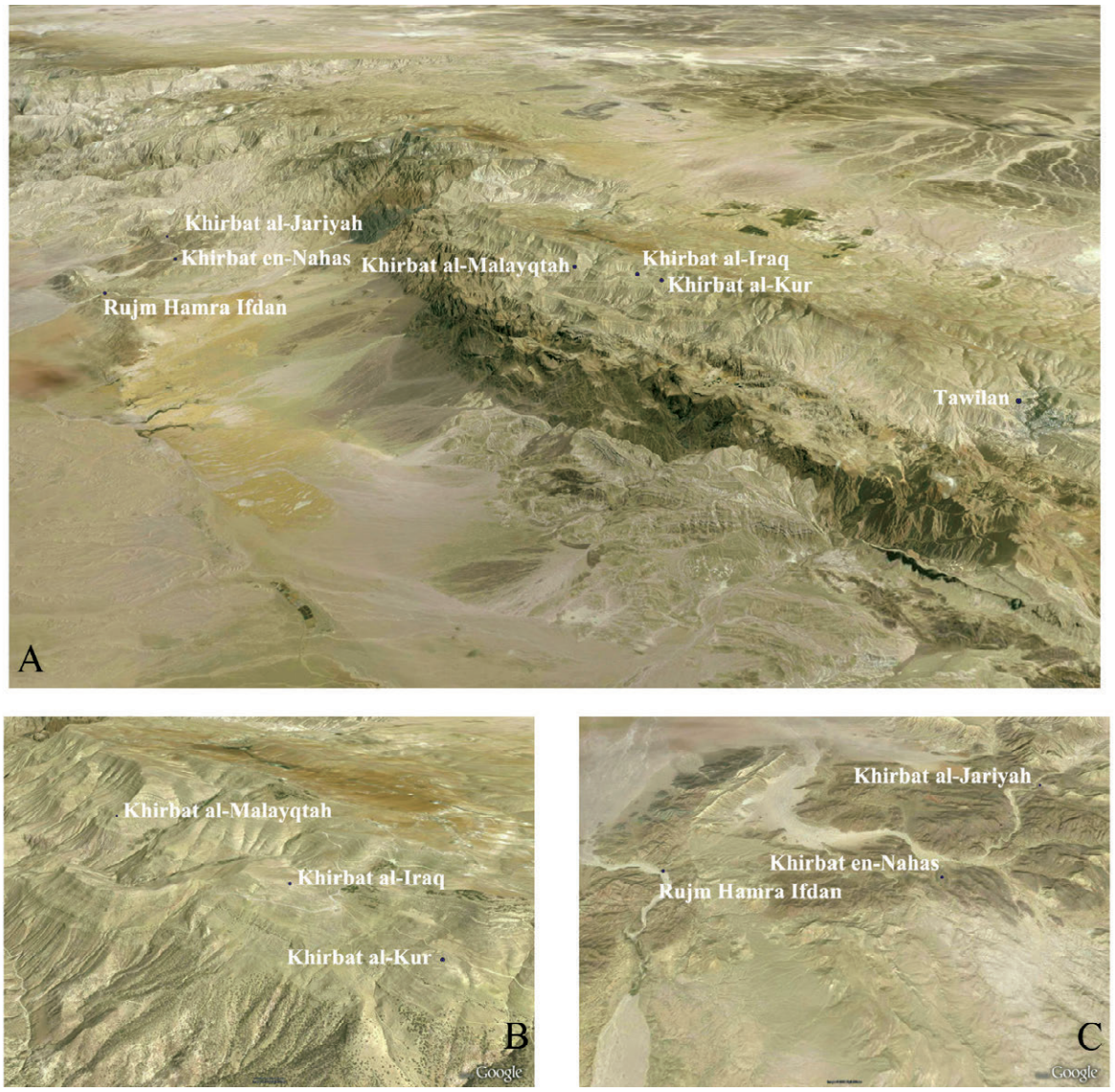

Figure 3.1 (*a*) Aerial Google Earth map of sites studied in the research area. (*b*) Google Earth map of Khirbat al-Malayqtah (KAM), Khirbat al-Iraq (KIS), and Khirbat al-Kur (KIJ) sites studied in the highlands. (*c*) Google Earth map of all sites studied in the lowlands.

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Iron Age villages (Khirbat al-Malayqtah خر ا, Khirbat al-Kur ور خرب ا, and Khirbat al-Iraq العراق خر), located along the western steppe of the modern towns of Showbak. These sites were surveyed in the past by Nelson Glueck (1935), Stephen Hart and Falkner (1985), and George Findlater (2000) but never excavated. Two soundings by the L2HE project were also carried out at Tawilan near Petra. This site was originally excavated by Crystal Bennett (Bennett and Bienkowski 1995) and published by Piotr Bienkowski.[1]

In this chapter, a new body of unpublished archaeological survey and excavation data is presented for the highlands of Edom to lay the groundwork that will help elucidate the processes that led to the evolution of social complexity and associated mechanisms of social formation and identity within Iron Age Edom. Accordingly, first the geographic and environmental boundaries of Edom will be examined to identify differences and similarities between the two subregions (i.e., the lowlands and highlands). Second, several models of Edom's social complexity will be discussed and a methodology presented for investigation in northern Edom. Finally, the new archaeological data recovered from the L2HE project survey and soundings will be presented. These newly excavated sites will be a primary Late Iron Age II material culture source for the following chapters that deal with petrographic and typological analyses of ceramic assemblages from Edom.

The Importance of the Lowland to Highland Edom Approach: Geographic and Environmental Boundaries in Ancient Edom

Geography and environment played an important role in defining the territory and subsistence strategies used by the inhabitants of ancient Edom—a region referred to in Egyptian texts (Kitchen 1992, 2003; Levy and Najjar 2006) and the Hebrew Bible (Avishur 2007; Bartlett 1989). Within the historical, geographic, and environmental boundaries of Edom, there is a highly diversified and unique landscape, which has generated multiple ecosystems requiring different human adaptation strategies for survival. It is these signature landscapes that distinguish Edom from its neighbors and perhaps contributed to the social evolutionary trajectory that occurred in Edom.[2]

The region of Transjordan Edom is traditionally bounded on the west by the Arabah Rift Valley, on the east by a gradual desert transition zone, on the north by Wadi el-Hasa, and on the south by the Gulf of Aqaba and Wadi Hisma region. However, some scholars (Bartlett 1989; Beit-Arieh 1989; Bienkowski 2002; Thareani-Sussely 2008) have suggested, from evidence in the Hebrew Bible and archaeological sites in the Negev desert that contain abundant "Edomite" pottery, that the Edom polity may have also extended further west across the Wadi Arabah into the Negev. This appears especially to be the case for the very Late Iron Age (IIC) period.[3] As the research presented here focuses on the ancient world, the term *Edom* is used.

Within the geographic and environmental boundaries of Edom, three highly diversified and unique geomorphologic/phytogeographic areas have required different human adaptation strategies for survival (Bender 1974). These three areas are described below.

Edom Lowlands

The Edom lowlands refer to the hyper-arid valley bottom (ca. –400 to 300 m above sea level) on the east side of the Wadi Arabah, from the southern tip of the Dead Sea to the northern tip of the Red Sea, and are situated in the western-most portion of the research area (see Chapter 1). From north to south, the lowland is typified by a series of east–west wadi systems that flow down from the highland mountains out to the Wadi Arabah. These wadis cut through volcanic, granitic, and sedimentary rock formations, creating a series of mountain ranges between each wadi, especially in their eastern reaches. It is primarily a marginal Saharo-Arabian desert climate with several natural springs and oases (Bender 1974; Danin 1983; Rudich and Danin 1978). Rainfall between December and March averages 17 mm, while in the summer months from June to September, there is virtually no precipitation (0.0–0.1 mm) (Palmer et al. 2007). The average annual rainfall in the lowlands is less than 100 mm (Centre 2001). Thus, vegetation and agriculture are primarily confined to depressions, seasonally flooded wadis, and springs where runoff systems of irrigation have been constructed from as early as the Iron Age (Barker et al. 2007). Due to the arid nature of the landscape, most sites are located on the banks of wadis near these springs and oases. Tamarisk and acacia trees, native to the area, were used for both house construction, heating, and metallurgical activities. Specifically in the Faynan area, rich copper ore sources are found all along the dolmite-limestone-shale (DLS) rock formations (Ben-Yosef et al. 2009; Hauptmann 2007; Levy et al. 2011).

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Steppe

To the east, the intermediate steppe zone, between the lowlands and highlands, is characterized by a semi-arid climate suitable only for pastoralism unless there is intensive irrigation (Bender 1974; Zohary 1962). The steppe topography contains many large inselbergs and spurs of sandstone cut by seismic activity, wadis, and natural erosion. During the Iron Age and later periods, many of these areas created naturally defensible strongholds that could overlook traversable wadis leading up to the highlands. The easily carved sandstone bedrock enabled inhabitants from the Iron Age and later periods (i.e., Nabatean) to create reservoirs and cisterns for trapping rainfall runoff. The yellow steppe soil has Irano-Turanian vegetation components that include steppe forest, thorny and broom-like brush woods, and dwarf shrub communities (Zohary 1962) with an assortment of wildlife that could also be exploited by the inhabitants. Annual rainfall averages around 100 to 300 mm, enabling this vegetation to grow. As one ascends the steppe, more water-dependent vegetation can grow such as grass and *Artemisia* (Palmer 2007), but further up (ca. 100–600 m), trees such as *Acacia*, *Moringa*, *Juniperus*, *Retama*, and *Phoenix* emerge. At the transition zone between steppe and plateau (ca. 600–1,100 m), trees such as *Juniperas*, *Amygdalus*, *Pistachia*, *Retama* (Barker et al. 2007:38), and *Quercus* can persist.

Highlands of Edom

The highland plateau (ca. 600–1,700 m in elevation) primarily has a Mediterranean climate suitable for agriculture. This Mediterranean band is circumscribed to the western edge of the plateau. The soils are capable of supporting cereals, tomatoes, melons, tobacco, grapes, olives, kernel, and pitted fruits (Bender 1974; Zohary 1962). This zone is an environmentally rich "Mediterranean island" compared with the abutting eastern dessert and steppe region. This subregion is unique to the Levant in being forested with juniper trees, a conifer, along with evergreen oak trees (*Juniperus phoenicea* and *Quercus calliprinos*, respectively) (Zohary 1962:51, 114). The juniper and oak forests, now nearly destroyed, were once a unique element of the Edomite region. Orni and Efrat (1976) have suggested these forests that covered the mountainous terrain may have generated the vivid depictions of Edom in the Hebrew Bible and its association with "Seir," meaning "hairy." However, as Glueck (1940, 1968) points out, most of the juniper forests were cut down prior to World War I by the Turks to construct the Hijaz railroad. It is only in the Dana Reserve and in the south of Showbak, in the area of al-Hisha, where the original grandeur of the forests can still be seen. Further east on the plateau, large grasslands and rolling hills cover the territory. In many areas, such as Showbak, large tracks of this land have been bulldozed and cultivated. Further east, the area returns to a hyper-arid desert environment.

Discussion

The proximity of the lowlands, steppe, and highlands to each other is significant for understanding the trajectory of increasing social complexity in the region of Edom during the Iron Age sequence. The sharp vertical shift in elevation between the lowlands and highlands with traversable wadis makes it possible to travel by foot in one day (Levy 2007; Orni and Efrat 1976; Ozment 1999). Thus, multiple ecological zones can be accessed within Edom by individuals living in the lowlands, steppe, or highlands.[4] Even though Edom was geographically bounded by these natural zones, their proximity meant that Edom and its subregions were always able to participate within a larger interaction sphere. Thus, the ability to traverse these different landscapes would have facilitated increased social complexity in the forms of trade and specialization (see Chapter 1, this volume). As chiefs or elites became involved in interregional trade (Levy 2009; Smith 2009), the potential for harnessing these three ecological zones for financing their own consolidation of power would have become a central concern.

Until the University of California, San Diego research projects in Edom, little archaeological excavation work was carried out in the lowlands of Edom, and most excavation work in the highlands was carried out prior to the 1990s. Thus, one of the goals of this study is to bridge the gap between how scholars view the highlands and lowlands (Bartlett 1989; Bienkowski 1992a, 1992b, 2002; Bienkowski and van der Steen 2001; Knauf 1992; Knauf-Belleri 1995; LaBianca 1999; LaBianca and Younker 1995; Levy 2009; Levy et al. 2003; Levy et al. 2005; Smith 2009; Smith and Levy 2008; Whiting 2007). This will be achieved by comparing the recent archaeological excavations on the plateau with those in the lowlands to determine how they relate chronologically, socially, politically, and economically.

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Considering Settlement Patterns and the Analysis of Social Complexity

One methodological problem this chapter seeks to address in the examination of the southern Edom region is how to more accurately measure the social complexity of a region through an analysis of settlement patterns. While B. Porter (2004), B. Crowell (2004), and others (Knauf 1992; Knauf-Belleri 1995) suggest that Late Iron Age II Edom was a state-level organization, these data are primarily based on the excavations at Busayra (Bienkowski 2002; Bienkowski and Sedman 2001), which revealed a 8.14-ha Iron Age II settlement with monumental architecture and possible ties to Neo-Assyrian influence through artistic styles and construction techniques. In addition, "prestige goods" and other forms of material culture found throughout the region, but predominately at Busayra, have led these scholars to argue that Busayra's elite functioned as a controlling or uniting power under the tutelage of post–ninth-century BCE Assyria over the region through the use of these materials. However, although urban centers, such as Busayra, are frequently associated with archaic states (Marcus and Feinman 1998), a number of variables other than population size and immediate territorial extent play a central role in determining the social complexity of a polity. One variable often not emphasized for understanding social complexity is the number of levels in a settlement hierarchy found within a region, which may help determine how interconnected a large polity may have been within a region with smaller settlements. In this chapter, the survey and soundings conducted in the northern portion of the "Edomite" region, in the vicinity of Showbak and high above the Faynan district, allow us to identify the settlement hierarchy and ultimately the level of social complexity of areas outside the immediate hinterlands of Busayra.

Studying settlement hierarchy (that essentially reflects the organizational principles of social organization) and not simply estimated population size or overall territorial scale avoids the inherent problem of cross-regional studies. Settlement hierarchy is one of the best quantifiable markers for identifying the four tiers of state-level social complexity in the archaeological record (Johnson 1973, 1975, 1977). As many researchers have shown (Adams and Nissen 1972; Feinman 1998; Levy and Alon 1987; Wright and Johnson 1975), by mapping site size from a data set of surveyed and excavated sites, sites can be hierarchically ranked and partitioned into separate tiers. Although size contributes to the understanding of a hierarchical settlement, it is not the only factor that needs to be taken into consideration. When looking at the archaeological record, one must also take into account the social complexity of the buildings found within each site. A three-tiered settlement would have different types of elite public structures used for the supervision of the villages and hamlets under its control, but they would not be at the same scale as that of a top-tiered city, which would include palatial complexes, temples, and administrative centers (Feinman and Marcus 1998). Even if only a few detailed excavations exist for an area, they can help tremendously in defining the four different types of settlement needed to identify a state-level society. What needs to be examined is site size (population, territory) in conjunction with measurements of the degree of integration and complexity of a region.

Several observations should be made concerning Busayra and its northern hinterland in relation to settlement hierarchy. First, there is little doubt that at the end of the Iron Age trajectory in Edom, during the eighth through the sixth century BCE, sedentarism increased, as evidenced by many new sites that emerged on the plateau, especially as has been documented through extensive survey work from Wadi al-Hasa to Busyara (MacDonald 1988, 1992, 2004, 2007). A central question that still requires further study, however, is whether these sites were organized into a more socially complex polity or represented autonomous settlements. Second, the amount of resources required to construct a site such as Busayra in the northern highlands suggests it functioned as a central polity, but the extent of its control and how it maintained its dominance over its hinterlands has not been determined. Third, it must be noted that the settlement patterns in the immediate periphery of Busayra, and the plateau in general, are missing lower tier small towns (ca. 5 ha). Instead, the surveys conducted on the plateau have found only medium-size villages that are a maximum of around 3 ha (cf. Macdonald 2004; MacDonald 1988).[5] Towns represent a key aspect of a state capital's administrative and economic organization. Busayra's size may have enabled it to control the villages within its vicinity; however, beyond its immediate hinterland, without towns it would have been difficult for a single administrative center to maintain its hegemony over more distant settlements. Fourth, a number of "fort" or "watchtowers" ranging

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from .5 to 3 ha have been identified throughout the northern region of Edom with several found near Busayra (MacDonald 2004). It has been suggested that these forts may have reflected a "supra-tribal" form of administration of the hinterlands (cf. LaBianca and Younker 1995). Unfortunately, until now, none of these sites have been excavated to determine their date and whether they functioned as some form of military/administrative control over more distant regions or were in fact local defenses built by the neighboring villages and thus unrelated to a higher tier of organization. In sum, the current data indicate that Busayra may have extended its reach over its Iron Age hinterland, but the lack of small administrative towns makes it difficult to suggest that a four-tier settlement hierarchy existed in the region. In the following sections, the surveys and probes conducted in the southern portion of Edom will be presented for comparison to the northern settlement patterns.

New Iron Age Data for Southern Jordan: L2HE Project

Introduction

In an attempt to understand in greater detail the Late Iron Age II occupation of the northern highlands of Edom in relation to the new work in the lowlands of Faynan, the authors initiated the L2HE. This is an ongoing project that investigates anthropological archaeology issues, such as the nature of social boundaries, trade, copper production, and secondary state formation in the southern Levant—specifically in ancient Edom (southern Jordan) during the Iron Age period (ca. 1200–500 BCE). The first stage of the L2HE project was to conduct a purposive reconnaissance survey[6] of the rarely studied Showbak region to identify significant Iron Age sites for excavation (see Figure 3.1a for the L2HE study area's relation to the Faynan district). In 2006, the project's reconnaissance survey located multiple sites yielding high concentrations of Iron Age pottery with little representation from other periods. Of the 48 sites identified during the survey, 3 were selected for the soundings along with a control sounding at Tawilan in Wadi Musa.[7] The second stage, conducted in 2007, focused on the excavation of four sites in the highlands of Edom, in the region between Showbak and Wadi Musa.[8] The soundings were carried out in two- and three-week intervals from April 4, 2007, to June 14, 2007. As will be presented below, the ceramics, architecture, and material finds from these steppe-zone sites show a high level of intervillage interaction. Although these villages appear to have been self-sufficient in agricultural and domestic production, based on small finds discovered at these sites, they participated in local exchange networks that focused on many goods, possibly including items produced by a larger polity.

The L2HE Steppe and Highland Archaeological Surveys

Survey Methodology: Creation of Lowlands to Highlands of Edom Project

The main purpose of the reconnaissance survey was to revisit key Iron Age highland sites from Dana and Ash-Showbak originally identified by the Dana Archaeological survey (DAS) (Findlater 2000; Findlater et al. 1998)[9] and other projects (Glueck 1934; Hart 1989; Hart and Faulkner 1985). Specific new data were collected (site size, environmental context, and ceramics) from these sites to establish comparable data sets with the ELRAP lowlands project. As this was a highly focused survey aimed at identifying sites suitable for archaeological sounding, regional random sample survey methods were unnecessary.

Site catchment areas 1 km in radius were generated in a Geographic Information System (GIS) around known Iron Age sites to understand the relationship of these sites to their surrounding terrain and undiscovered neighboring sites. The site catchment areas provide a controlled method of documenting the relationship of the larger known Iron Age sites from the plateau survey area to possibly smaller neighboring settlements, associated agricultural activities, paths and trade routes, metallurgical activities, soils, topography, natural springs, vegetation communities, and unique geological formations (Dennell 1980; Flannery 1976; Levy and Alon 1987; Smith and Levy 2008; Vita-Finzi and Higgs 1970). This information enables a reconstruction of the natural environment most important to the ancient site and how the resources there may have been exploited by the Iron Age settlements. Site catchment analysis, as used here, helps yield settlement pattern data needed for understanding the hierarchical structure of the regional settlement landscape.

The GIS was constructed in ArcGIS using satellite/aerial photography (LandSat 7 ETM+ Pan Sharpened images and Royal Jordanian Geographic Center (RJGC) Aerial Photography, 2-m resolution), digital elevation data (USGS ASTER DEM and vectorized 1:25K scale topographic maps), and digitized soil

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and water system maps from the Royal Society for the Conservation of Nature in Jordan. Iron Age sites identified by the DAS and past surveys were imported as point layers into the ArcGIS to understand their location in relation to the other imported imagery sources. One-kilometer site catchment circles were created around each DAS Iron Age site. Additional site catchment circles were created around possible sites identified from high-resolution aerial photography or wadi routes linking one site catchment area to another. A total of 19 site catchment areas were constructed for the survey.

A streamlined version of the GIS database was then uploaded to the field handheld GPS unit running ESRI ArcPad surveying software. The GPS enabled the survey team to quickly locate the specific known site located at the center of each site catchment area. Originally, full transects of each site catchment area were planned, but after the first two days of surveying, this strategy was found to be ineffective. The majority of the survey area consisted of agricultural plains that had been heavily bulldozed and cultivated over the past decades, thus mixing or spreading any original distribution of pottery, lithics, architecture, and other remains within an area. In each cultivated area, stones originally found in the field would be moved to the edge of each area to serve as field dividers or rock piles, and it would be in these areas a larger percentage of pottery sherds were found. However, archaeological sites with architecture were generally avoided by bulldozing and were treated similar to rock piles in that they were bulldozed up to their perimeter. Thus, in each catchment area, one could identify from a distance rock piles either from modern construction or ancient ruins, eliminating the need to traverse the entire catchment area to identify sites with architecture. Each prospective site identified from a distance was then driven to and investigated on foot by smaller, evenly divided 5-m transects. This method allowed a comprehensive coverage of each catchment area of the larger sites and enabled more than one catchment area to be surveyed in a day. A wide range of cultural and environmental variables were recorded for each site. Digital photographs were taken of each site and its architectural remains. Site coordinates, perimeters, and architectural features were recorded using ArcPad software, which was later imported into ArcGIS for spatial analysis.

Since the primary focus of the survey was to identify the period and size, as well as collect a representative assemblage of Iron Age ceramics from these plateau sites for comparison with lowland excavations, only diagnostic pottery and a few exemplary cases of lithics or ground stone tools were collected. The general impression of body sherd density at each site was noted in the field diaries. At the larger sites where buildings and different areas of occupation could be identified, the pottery was collected in separate bags and georeferenced accordingly. Each day after the survey, the pottery was washed and stored in crates for later study. A preliminary ceramic analysis and count was conducted to determine the primary periods: Early Bronze Age, Iron Age, Nabatean, Roman, Byzantine, and Islamic. Where possible, the ceramic analysis sought to determine the dominant period of occupation at the site.

Survey Results

A total of 48 sites were identified during the survey from within the drawn site catchment zones over the previously identified sites (Figure 3.2; Table 3.1). A total of 17 sites discovered within the site catchment areas contained Iron Age ceramics as a dominant or as a component part of the overall collection. Nine sites yielded high concentrations of Iron Age pottery, with little representation from other periods (L2HE: 20, 24, 26, 30, 32, 33, 35, 45, 46, 47, and 48). These sites met the survey's primary goal of identifying key Iron Age sites for further exploration. While additional analyses are needed, the general impression of the recovered Iron Age pottery was that it was Late Iron Age II. Many of the ceramic forms found in the lowlands specific to the Early Iron Age II (see Chapter 4) were not represented in the ceramic assemblages recovered from the steppe region.

Resources and Routes

The territory of Showbak is an agriculturally rich area with springs and open valleys suitable for farming and pasturing. However, the settlement patterns from the survey revealed that the main heartland of Showbak was only sparsely occupied during the Iron Age period. The Roman and Islamic periods appear to have been the primary periods that used the full extent of resources available in the Showbak plains,[10] while the primary Iron Age sites were located along the steppe leading down to the lowlands (L2HE: 8, 19, 20, 45, 46, and 47). There is evidence that some of these structures could also have served defensive roles (e.g., L2HE 45) to control the upper plateau area. It is also significant that there is a modern route in this location that leads from Showbak to Wadi Musa. Due to time constraints,

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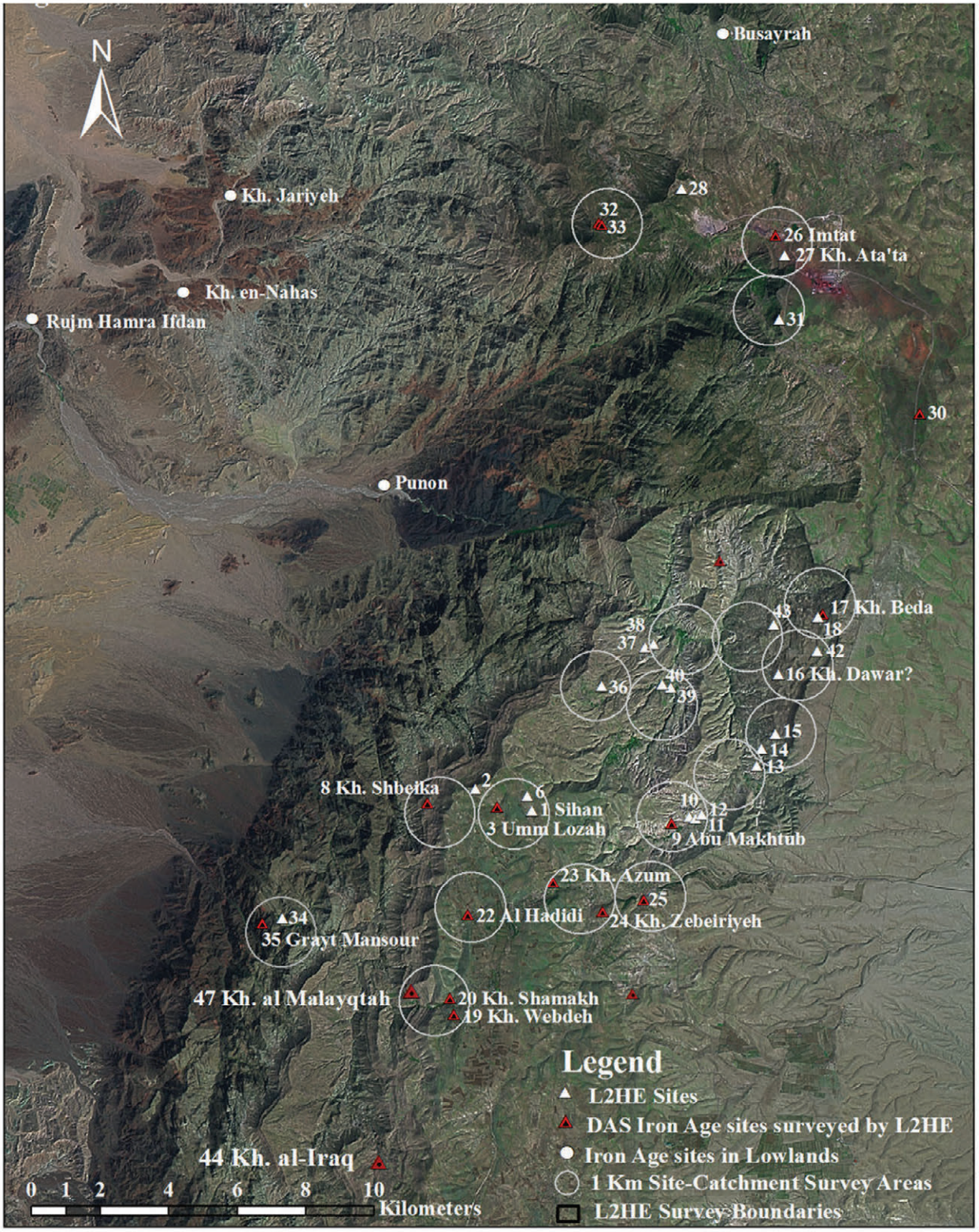

Figure 3.2 L2HE surveyed sites with site catchment zones.

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Table 3.1 Surveyed sites during the Showbak-Dana L2HE survey.

Site	Local Name	Easting	Northing	Elevation	Size (m^2)*	Main Occupation**	Secondary Date	Tertiary Date	Site Type	References
1	Kh. Sihan				62500	Late Islamic	Roman	Iron II	Town/Large Village	Glueck 1935, 89 (Site 152); Hart 1985, 270 (Site); Findlater 2000 (Site 378)
2	Kh. Al-Buweitrah	741912.246	3382152.219	1555.600		EB	Byzantine		Round Structures	Glueck 1935, 94 (Site 174, Khirbat Al-Buweitrah); Findlater 2000 (Site 176)
3	Kh. Umm Lozah	742547.648	3381639.193	1492.900	12500	Late Roman	Iron II		Medium Village	Glueck 1935, 94 (Site 173); Findlater 2000 (Site 175)
4	N/A	N/A	N/A	N/A		Roman			Pottery Scatter	
5	N/A	N/A	N/A	N/A		Roman			Wall Lines	
6	N/A	743422.176	3381951.329	1559.900	9000	Islamic			Small Village	
8	Kh. Shbeika	740514.791	3381738.710	1542.700	25000	Middle Islamic	Iron II	Nabatean	Large Village	Hart 1985, 270 (Site 103); Findlater 2000 (Site 282)
9	Site East of Abu Maktoub	748143.484	3381350.219	1146.100		Islamic	Roman		Terracing	
10	N/A	748131.281	3381233.462	1114.200		Islamic			Stone pile and terracing	
11	N/A	748329.995	3381395.322	114.200		Islamic	Roman		Terracing	
12	N/A	748509.999	3381411.330	1108.200		Islamic	Roman		Terracing	
13	N/A	750121.403	3382835.336	1081.700		?			Wall Lines	
14	N/A	750262.571	3383324.306	1104.600		?			Circular Stones	
15	N/A	750650.644	3383756.514	1137.700		Modern			Circular Structure and terracing	
16	N/A	750752.214	3385494.058	1123.600		Islamic	Iron II		Hamlet with rectangular structures	
17	Upper Beda (Top section)	752044.434	3387264.726	1178.800	52500	Middle Islamic	Early Islamic/Byzantine	Iron II	Town	Findlater 2000 (Site 293)
18	Upper Beda (Lower section)	751903.758	3387172.137	1149.800					Large Village	
19	Kh. Al-Webdah	741225.543	3375587.360	1457.300	20000	Roman	Modern		Large Village	Glueck 1935, 93 (Site 163); Hart 1985, 270 (Site 89); Findlater 2000 (Site 291)
20	Kh. Shamakh	741166.675	3376038.063	1375.100	12500	Iron II	Early Islamic	Modern	Medium Village	Glueck 1935, 93 (Site 167); Hart 1985, 270 (Site 94); Findlater 2000 (Site 289)
22	al hadidi	741680.396	3378485.408	1495.100	600	Nabatean/Late Roman	Iron II (none found by L2HE)		Hamlet	
23	Kh. Azum	744314.000	3379431.000	1426.900	15000	Nabatean/Late Roman	Iron II		Medium Village	Glueck 1935, 93 (Site 170); Hart 1985, 270 (Site 104); Findlater 2000 (Site 172)
24	Kh. Zubariya	745617.149	3378590.501	1424.900	14400	Roman and Other classification	Iron II (Dominant in NE area)		Cistern/Medium Village	Glueck 1935, 92 (Site 156); Findlater 2000 (Site 171)
25	Kh. Wamiya	746810.872	3378917.355	1382.700		Iron II	EB/Roman		Watchtower	
26	Imtat	750666.722	3398321.685	1528.200		Iron II			Bulldozed	Glueck 1934, 77 (Site 19); Findlater 2000 (Site 159)
27	N/A	750931.247	3397736.754	1536.500		Roman			Hamlet	Findlater 2000 (Site 110)
28	N/A	747915.059	3399678.718	1450.500		Roman	Iron II		Rectangular Structures	
29	Gameh	751410.000	3394905.000	1554.000	600	Roman	Iron II	Islamic	Watchtower	Findlater 2000 (Site 3)
30	N/A	754871.702	3393124.912	1402.200	2025	Iron II	Nabatean		Hamlet	Findlater 2000 (Site 366)
31	Atata	750764.042	3395855.079	1620.800	3400	Roman	Iron II		Fort	Glueck 1934, 77 (Site 17); Finlayson & Baird 1995; Hart and Falkner (Hart 1985: 270; Site 111)
32	N/A	745515.830	3398711.562	1278.600	1200	Iron II	Roman		Hamlet	Finlayson & Baird 1995; Findlater 2000 (Site 43)
33	N/A	745515.830	3398711.562	1278.600		Iron II			Hamlet	
34	N/A	736274.527	3378373.237	725.000	15000	Roman	Iron		Caravanserai	
35	Grayt Mansur	735690.180	3378232.382	731.600	37500	Iron II	Middle/Late Islamic		Large Village/Outpost	Findlater 2000 (Site 263)
36	Tel Axdar	745593.924	3385161.744	1165.100		Roman/Byzantine			Stone piles and wall lines	
37	N/A	746813.171	3386354.503	749.400		Roman			Hamlet	
38	Rujm Aragib	747113.313	3386372.834	846.000		Roman	36		Tower	Findlater 2000 (Site 130)
39	Nwayja	747606.714	3385113.801	868.500	22500	Islamic			Large Village	
40	Ain jerab	747341.253	3385203.530	889.300		Islamic			Terracing	
42	N/A	751882.254	3386174.699	1174.300		Roman			Rectangular Structures	
43	lower beda	750618.220	3386937.708	1057.800	22500	Roman	Nabatean		Large Village	
44	N/A	750618.220	3386937.708	1057.800		Roman			Hamlet	
45	Kh. Al-Iraq	738836.000	3373219.000	1428.000	624	Iron II	Islamic		Tower/Fort	Glueck 1935, 88 (Site 141); Hart 1985, 270 (Site 88); Findlater 2000 (Site 286)
46	Kh. Jeneinah	739748.000	3374238.000	1291.000	1250	Iron II	Roman/Byzantine	Islamic	Pottery Scatter	Glueck 1935, 88 (Site 142); Findlater 2000 (Site 280)
47	Kh. Am-Malayqtah	739930.000	3376360.000	1238.000	10500	Iron II	Late Roman/Early Byzantine		Medium Village	Findlater 2000 (Site 281)
48	Kh. Al-Kur	739907.040	3372036.000	1441.000	11250	Iron II			Medium Village	Findlater 2000 (Site 277)

*It was decided to keep the same site size for sites recoreded by the Dana Survey except in cases where the survey found an extreme difference (possibly due to the differing approach)

** Although multiple site periods can be identified for a site generally one period in both pottery and architecture tended to dominate at a site; secondary and tertiary dates were deteremined based on the frequency

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the area between L2HE 47 and further north along the steppe was not surveyed, although satellite imagery indicates evidence that more sites are present.

The other primary location where Iron Age sites were found is along the bend of the King's highway leading through the modern Showbak town. This area was and is still used for agriculture and one of the few areas in southern Jordan that is semi-forested. It is also significant that the four Iron Age sites (L2HE: 22–25) are located on the edges of what is traditionally known as the King's highway from the Roman period (Findlater 2000). Possibly, L2HE 17 (Upper Beda), also located near the King's highway further north, may have served as a key node for connecting the north–south and east–west traffic coming from Wadi Bustan and Wadi Ghwayr. Unfortunately, the heavy occupation during the Islamic period at this site masks the actual extent of the original Iron Age occupation. In Showbak, strategic locations for trade or agriculture during the Iron Age were also ideal locales during the Nabatean, Roman, and Islamic periods, making it difficult to gauge the size of the original Iron Age sites. In addition, the recent practice in the Showbak area of bulldozing fields and dumping all debris in rock piles has made identification of ancient agricultural activities very difficult. An attempt was made early in the survey around L2HE 3 (Umm-Lozah) to gauge the presence of pottery in the bulldozed rock piles, but this resulted in the recovery of only stray sherds dating to the Roman period. L2HE 9 (Abu Maktoub), also located in the plains of Showbak, presented a similar problem in that much of the area was covered by Islamic pottery and construction. L2HE 36 (Tel 'Akhdar), originally surveyed by Nelson Glueck (1934) and identified as Iron Age, yielded no Iron Age pottery but was also heavily bulldozed and converted into an olive tree orchard.

In Dana, L2HE 32 and 33, located on Rumana mountain, would have been suitable locations for agricultural activities as the mountaintop provides fertile level ground. Evidence of Roman period terracing is evident; however, the primary occupation period was Iron Age at these sites. The location of these two sites also may have been on a strategic route leading up from the lowlands via Wadi Dana. L2HE 31, a possible fort, is located on the southern route leading up from Dana Village and may have also served as a strategic control point along routes coming from north–south and east–west. Its location on the level plateau would have also been ideal for agricultural activities.

Defensive and Economic Factors in the Highland Site Location During the Iron Age

Two intriguing sites may have functioned as defensive sites along the steppe zone. Situated on main trade routes, L2HE 45 and L2HE 31 both have large rectangular structures constructed of very large cut stones. The general impression from surface observation is that these sites had a defensive nature compared to the majority of sites surveyed, which were usually constructed of single-course rounded walls using small stones. Both of these sites appear to be located along main trade routes and probably served as control posts for incoming and outgoing traffic. Without soundings, these general observations cannot be verified. The surface pottery collected here places these sites in the eighth century BCE. Overall, defensive construction in the Showbak and Dana steppe zone did not appear to have been necessary during the Late Iron Age II. Wall lines visible on the surface of many of the sites were generally only one course wide and not built to withstand any form of significant attack. This may reflect peaceful interaction within the area and perhaps lack of external threat. These observations may support Knauf (1992) and others that this was a period of heavy sedentarization that resulted in a decrease of nomadism and exterior stress from contemporary Levantine polities such as Israel or Moab. The DAS survey conducted by Findlater (2000; Finlayson and Baird 1995) found Iron Age materials further east of the L2HE survey grid that Glueck (1934) originally postulated as a network of Iron Age II towers set up as a defense against invading armies or nomads from the east. In future survey and soundings, these sites will be investigated to see whether similar construction as seen at L2HE 45 and 31 occurred at these sites or whether they reflect a later time period such as Nabatean, as suggested by Hart and Falkner (1985).

Summary

The Iron Age settlement pattern data for Showbak and Dana reflect small pockets of villages and hamlets primarily located along traversable routes and near natural springs near the edge of the highland plateau. The evidence of fortified small settlements along these routes may highlight the importance of these roads for the secure transport of commodities; however, their connection to a larger polity cannot be determined by survey alone. The absence of any town or large village of significant size with satellite sites suggests that the inhabitants continued to live in fairly autonomous settings. Archaic state-level control reflecting four tiers of political organization, as

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would be expected using site size hierarchies or central place theory (see above), is not present in the region between Dana and Showbak.

The most promising areas for future excavations to better understand how these settlements may have been interconnected in the Showbak region are sites such as L2HE 45 and 44 along the western steppe route and L2HE 24 along the eastern King's highway (see Figure 3.2). In the north, L2HE 31 may also represent, like L2HE 45, some evidence of resource control or defense of the area. L2HE 32 and 33 may represent both control of a trade route and exploitation of the local agriculture richness of the area.

Overall, the L2HE survey met its goals of identifying key Iron Age sites in the Dana to Showbak region suitable for studying the relationship between Iron Age settlement in the lowlands and highlands of Edom. It became apparent during the survey that many plateau areas between the upper Wadi Dana and Wadi Ghwayr were inaccessible by vehicle and could only be reached by extensive hiking. Previous surveys were never conducted in these areas and so were not a primary focus of the 10-day reconnaissance survey (see Chapter 6, this volume, for the kind of survey needed to connect these areas). Since these areas are primary routes leading up from Wadi Faynan, even a preliminary survey of Iron Age sites in this area would be very helpful for understanding of the archaeology of Iron Age Edom. In the following section, the three steppe zone sites selected from this reconnaissance survey for sampling will be discussed.

Lowlands to Highlands of Edom Archaeological Soundings of the Highlands and Steppe

The soundings conducted on the L2HE project were carried out using the same digital excavation techniques developed in earlier seasons by the ELRAP project (Levy and Smith 2007).[11] The primary objective of these excavations was to acquire controlled stratigraphic soundings of multiple sites for the recovery of ceramic data sets that could be subjected to radiocarbon dating and ceramic analysis. These new data from Iron Age sites on the high plateau of Edom serve as part of a comparative study of the cultural relationships between the lowlands and the highlands of Iron Age Edom and also provide a data set comparable to the several other sites excavated on the plateau. The sites sampled on the plateau are located near the western wadi passages (e.g., Wadi Ghwayr), routes that lead down to the Iron Age sites in the lowlands such as Khirbat en-Nahas, Khirbat al-Jariya, and Rujm Hamra Ifdan (see Chapters 2 and 10, this volume; Ben-Yosef et al. 2010). Below, a preliminary overview is presented for each site sampled for this project.[12]

Khirbat al-Malayqtah (KAM)

The excavations at Khirbat al-Malayqtah (KAM) (30.495586 and 35.499579 degrees, ca. 1,150 m above sea level; see Figures 3.3–3.11) were conducted from April 4 to 28, 2007. Khirbat al-Malayqtah (KAM) is located on a spur overlooking the Wadi Faydh. It is 200 m north from the Ain Shimmakh spring. As part of the Shera mountain system, the soils support an Irano-Turanian vegetation and are ideal for terraced farming. A modern dirt road splits through the middle of the site. This site was identified during the L2HE reconnaissance survey and other surveys (cf. Findlater 2000; Hart 1989). Two probes were excavated in 2007 (see Figure 3.5). The first sounding (KAM Area A), located on the western side of the road, directly on the edge of the spur, consists of two squares in total, measuring 5 x 10 m. The smaller 5 x 5–m probe (KAM Area B) was located on the top of a small hill to the east of the road. The second probe was opened after a week of excavation to investigate the function and purpose of the upper hill that appeared to also date to the Iron Age and preserved a large perimeter wall running along the uppermost contour.

Area A

Two 5 x 5–m squares (set to 117 degrees from north) were opened using the total station (Figure 3.5a). This alignment was selected to follow the natural contours of the lower area of the site and to directly target two rooms identified on the surface from preserved wall lines. After the removal of topsoil, two rooms were clearly delineated. The western room was assigned Square B4, and its adjacent eastern room was Square C4.

Phasing

(1) Topsoil (L3001–3004, L3010)
(2) Hard brown fill with wall collapse (L3005–3014, L3020)
(3) Soft ashy sediment (L3016—only in eastern room)
(4) Hard ash sediment mixed with patches of compacted sediment (L3026, L3027)
(5) Floor over bedrock (L3028, L3032, L3033)
(6) Bedrock with foundation stones of wall dug into (L3036)

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Figure 3.3 Overview of Khirbat al-Malayqtah. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

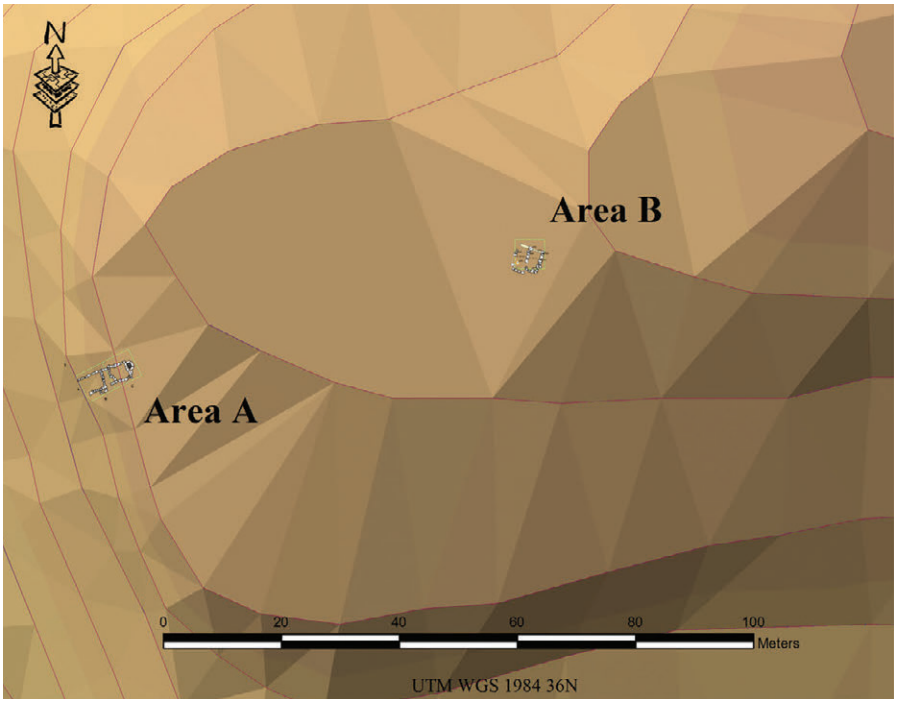

Figure 3.4 Topographic map of Khirbat al-Malayqtah showing soundings A and B, 2007 excavations.

Western Room: Square B4 (Figures 3.5a, 3.7a)

The western room was preserved with only three courses of its surrounding walls. Bedrock was reached after around 80 cm of excavation from the surface. This room, as well as the eastern room, represents a single-occupation period that was sealed by a decomposed mud brick fill and wall collapse (L3008, L3013) due to later depositional processes. Approximately 10 cm prior to reaching bedrock in the eastern room, a compact surface (L3028) was exposed that relates to the original occupation level of the site. This surface was discovered with a high concentration of pottery and one large storage jug in situ at the western end of the room. Besides the high concentration of ceramics, the room was primarily devoid of other forms of material culture or installations that might relate the function of the room. Based on these finds, the room seems to have functioned as a domestic storage facility.

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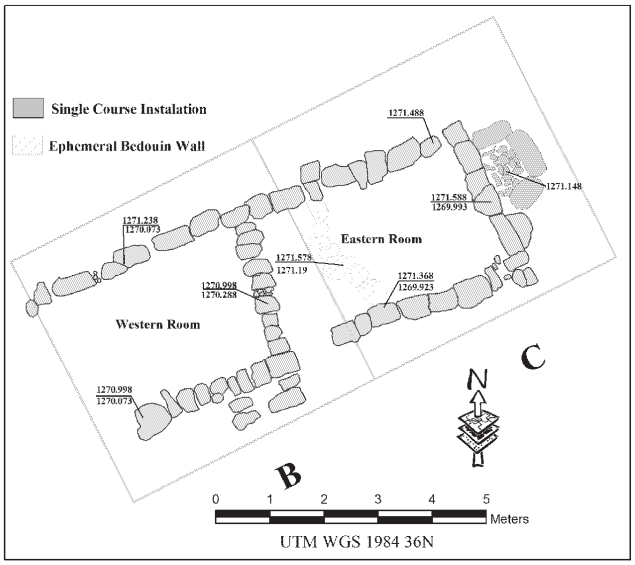
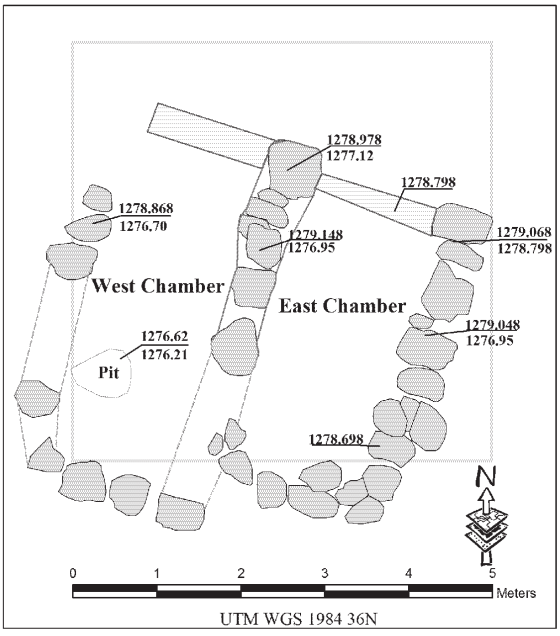


A. Sounding A.



B. Sounding B.

Figure 3.5 Excavations at Khirbat al-Malayqtah, (*a*) domestic architecture of Area A; (*b*) architecture from Area B.

Eastern Room: Square C4
(Figures 3.5a, 3.7b, 3.8a)

The eastern room was divided into two sections by an ephemeral wall found resting on topsoil (see Figure 3.6). This poorly constructed wall resembles walls constructed by Bedouin found at many other sites; it was only one course thick. We decided to preserve this wall by assigning the depositional layers below it as a bulk. In the western portion of this room (part of Square C4), the fill consisted primarily of hard compacted sediment and significant wall collapse. A small installation (L3015) outside of the room abutting the eastern wall contained a stone paving and several broken sherds resting on the paving. At this level, the walls were only one course high. This may represent a later ephemeral phase. Ceramics were found in the installation in small amounts. Following the removal of the hard compacted sediment, hard gray ashy sediment in patches and more of the yellow compacted surface with gravel were found on the western side of the bulk (L3026). On the eastern side, soft ashy sediment (L3016) around 30 cm in depth was removed that rested on similar hard ashy sediment (L3027), as found in L3026. These loci (L3026, L3027) had a higher concentration of pottery and ground stone artifacts than the loci above them. Stone collapse still occurred in these loci but was less frequent. After another 20 cm of fill, the bedrock floor of the structure was found (L3032, L3033). The floor, which took advantage of the natural bedrock, had a high concentration of more complete in situ ceramic vessels, often imbedded in the hard yellow bedrock. Besides the high concentration of pottery and grinding slabs found in the room, two incised "spindle whorls" (cf. Figure 3.10a,b) were found. These spindle whorls are very similar to those found at Busayra (Sedman 2002:pls. 10.166–178) and Tawilan (Bennett and Bienkowski 1995). In addition, several examples of worked bone spatulas (cf. Figure 3.10c) common at Busayra and Tawilan were found. The similarity of these finds serves as further evidence that the single-period occupation at KAM was contemporaneous with the other known larger-scale "Edomite" sites. A probe into the hard yellow bedrock (L3036) demonstrated that the foundation stones of the walls were dug into the basement rock.

Area B (Figures 3.5b, 3.8b)

It was important to open Area B at KAM because it would allow us to investigate the elevated area at the site that appeared to serve a defensive purpose.

Phasing

The stratigraphy of KAM Area B is defined as follows (Figure 3.6):

(1) Topsoil (L3018)
(2) Bright red clumpy sediment fill with large stones from collapsed fill (L3021, L3023–L3025, L3030, L3031, L3034)
(3) Intruding decayed sandstone (L3022)

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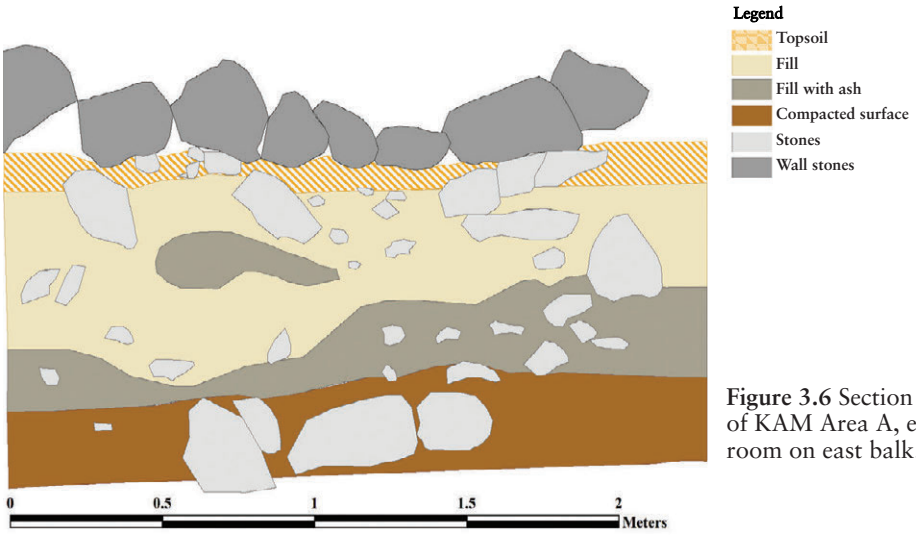

Figure 3.6 Section drawing of KAM Area A, eastern room on east balk.





Figure 3.7 (*a*) KAM Area A, western room floor, view northeast and (*b*) KAM Area A, eastern room floor with western balk, view southwest. *Photos: N.G. Smith, UC San Diego Levantine Archaeology Laboratory.*

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(4) Dark ash layer in the eastern section of the probe (L3029)
(5) More ash with burnt wood over beaten floor (L3035, L3037, L3038, L3039)
(6) Pit dug into bedrock (L3041)
(6) Sterile soil and foundation stones of wall (L3040, L3042)

Area B consisted of one 5 x 5–m square probe located on top of a hill to the east of Area A. A large surrounding wall was delineated along the uppermost elevation of the hill, and Area B probed the southwestern quadrant of the structure. Area B was extremely difficult to excavate as much of the exterior and internal walls had collapsed into the rooms, creating a fill full of large boulder-size wall stones that could only be moved by breaking with a sledgehammer. The probe was excavated to bedrock around 2.5 m below, revealing an exceptionally well-preserved architecture. Two internal walls were delineated running north to south attached to the larger southern wall of the building. This wall was preserved to 2.02 m. Both walls end after around 1 to 2 m, thus serving as partitions to create narrow inner chambers and a hallway. The base of the threshold or step was preserved at the entrance to each chamber. The phasing of the probe was fairly straightforward with a deep fill of sediment and wall collapse. Once the fill was



Figure 3.8 (*a*) KAM Area A, west area divided by balk (view southeast) and (*b*) KAM Area B, view south. *Photos: N.G. Smith, UC San Diego Levantine Archaeology Laboratory.*

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Figure 3.9 (*a*) KAM Area B, L3035, pottery scatter on floor; (*b*) KAM Area B, L3034, burnt wood beam on floor; and (*c*) KAM Area B, L3041, pit with loom weights and pottery. *Photos: N.G. Smith, UC San Diego Levantine Archaeology Laboratory.*

removed, a layer of ash (L3035, L3037, L3038, L3039) was found throughout the probe just above the bedrock floor with an earlier higher concentration in the southeastern corner (L3029). L3035 and L3034 contained ash sediment just above the floor mixed with sherd scatters, loom weights, ground stone, bones, and large wood charcoal beams (Figure 3.9a,b). A cache of olive pits was found in a niche in L3035 abutting the main dividing wall and was used for radiocarbon dating (cf. Figure 3.11a,b).

In the southern end of the chamber, a pit was found cut into the sterile soil (L3041; Figure 3.9c). The pit contained a number of near-complete ceramic vessels, including a juglet (Figure 3.10h), and an apparent stockpile of 15 loom weights (Figure 3.9c). In the upper 10 cm of the pit fill, three of these items were found, including one decorated example. These loom weights differed from the others found at the site in that they were very fragile, perhaps not fired, and appeared to be made of a high concentration of organic material, possibly chaff mixed with dung. The function of Area B appears to have been for storage.

Radiocarbon Sample Results: KAM Areas A and B

Two radiocarbon samples were taken from a collection of olive pits found on the floor of Area A (L3032) and submitted for AMS dating at the Oxford Radiocarbon Accelerator Unit (see Figure 3.11a,b; Table 3.2). L3032 was a compacted yellow-brown hard surface that contained numerous broken or semi-complete (25 percent) sherds in situ. Virgin soil was reached below this floor. This locus appeared to be the best context from which to date Area A at KAM. Both results were found highly consistent. They reveal that this floor can be dated to the Late Iron Age II sequence. As seen in Figure 3.11a and Table 3.2, at 95.4 percent probability, sample OxA-18322 dates from 810 to 578 BCE and OxA-18323 (Figure 3.11b, Table 3.2) at 95.4 percent probability to 820 to 612 BCE. Due to the fluctuations in the calibration curve, a more definitive dating cannot be achieved. While these high-precision dates fall slightly into the very end of the ninth century BCE and the end of the seventh century BCE, they are centered in the eighth to sixth centuries BCE.

A third radiocarbon sample collected from a cache of olive pits from L3035 at Area B was submitted for accelerator mass spectrometry (AMS) dating (see Figure 3.11c). L3035 represents a sample from the floor of the east chamber of the probe in Area B. This floor contained a scatter of pottery sherds resting on very dark gray ashy sediment. Large burnt wood pieces (possibly originating from wood beams that collapsed from the roof) and collapsed wall stones sealed this layer. The radiocarbon sample comes

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Figure 3.10 L2HE 2007 special finds from KAM: (*a*) spindle whorl with incised design (B10109, L3016), (*b*) spindle whorl with incised design (B10217, L3032), (*c*) worked bone spatula (B10284, L3032), (*d*) copper earring (B10233, L3034), (*e*) copper earring (B10089, L3022), (*f*) flint blade (B10269, L3038), (*g*) iron object (B10230, L3033), and (*h*) juglet (B10306, L3041). *Photos: N.G. Smith, UC San Diego Levantine Archaeology Laboratory.*

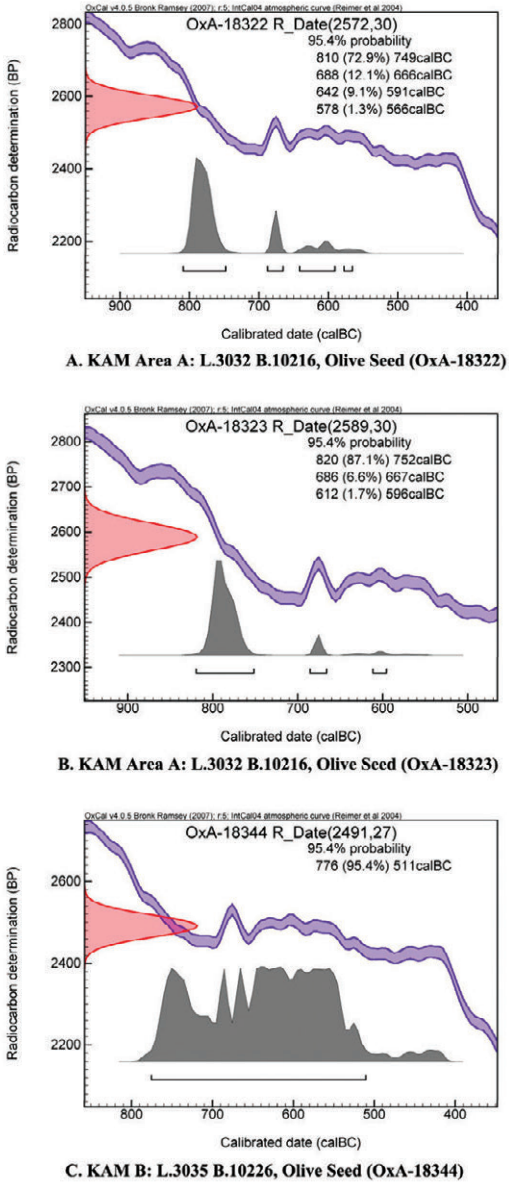

Figure 3.11 L2HE accelerator mass spectrometry radiocarbon results from KAM: (*a*) KAM Area A: L3032, B10216, olive pit (OxA-18322); (*b*) KAM Area A: L3032, B10216, olive pit (OxA-18323); (*c*) KAM Area B: L3035, B10226, olive pit (OxA-18344).

from one sample taken from a collection of olive pits adjacent to the western wall. At 95.4 percent probability, OxA-18344 dates from 776 to 511 BCE and is situated in the eighth through sixth centuries BCE (Figure 3.11c; Table 3.2). Taken together, there is little doubt that the steppe site of KAM was occupied during the eighth to sixth centuries BCE. Due to the fluctuations in the calibration curve, a more definitive dating cannot be achieved. Based on the ceramic study in Chapter 4, KAM should be viewed as a small village settlement contemporary with the period of occupation at the other L2HE sites, Tawilan and Busayra—the largest Late IA II site on the highland plateau.

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Table 3.2 Radiocarbon dates and calibrations for the L2HE sites.

OxA	Site Name	Sample	Material	d l3C	BP Date
OxA-18322	Khirbat al-Malayqtah	L2HE_KAM_A_B.10216_L.3032, seeds, olive	Charred Seeds	dl3C=-21.92	2572± 30
OxA-18323	Khirbat al-Malayqtah	L2HE_KAM_A_B.10216 L.3032, seeds, olive	Charred Seeds	dl3C=-22.30	2589 ± 30
OxA-18344	Khirbat al-Malayqtah	L2HE_KAM_B_B.10226_L.3035, seeds, olive	Charred Seeds	dl3C=-21.09	2491 ± 27
OxA-18345	Khirbat al-Kur	L2HE_KIJ_C_B.11085_L.4006, seeds, Lentils?	Charred Seeds	dl3C=-22.43	2539 ± 30
OxA-18346	Tawilan	L2HE_TW_J_B.l3176_L.6026, seeds	Charred Seeds	dl3C=-22.87	2642± 28
P20943	Khirbat al-Iraq South	L2HE_KIS_D_B.12084_L.5013, seeds,lentils?	Charred Seeds	FAILED due to no yield	N/A
P20945	Tawilan	L2HE_TW_K_B.13206_L.6027, seeds	Charred Seeds	FAILED due to no yield	N/A

Khirbat al-Kur (KIJ)
(Also Known as Khirbat al-Iraq Junubiya)

Khirbat al-Kur (KIJ) (30.456615 and 35.498551 degrees, ca. 1,400 m above sea level; see Figures 3.12–3.18) is situated on a small hill on a spur of the steppe zone. KIJ is located in one of the few areas in the Showbak area that was not completely stripped of its tree cover during the late Ottoman period (see above). Wild oak and pine are densest just south (ca. 0.5 km) of KIJ in an area known as Al-Hisha. KIJ has an excellent nearby water source that in the Roman period was converted into a well and cistern. This site was identified during the L2HE reconnaissance survey based on earlier surveys in the region (cf. Findlater 2000; Hart 1989). The name was changed after excavations to Khirbat Al-Kur after discussion with the local villagers, who suggested this was the more common name.[13]

At the top of the hill, a 5 x 5–m probe was opened where clear wall lines were detected on the surface. The probe was situated on the eastern slope of the site. Excavations revealed that the walls in the excavation continued underneath the southern stone pile. To the west, a depression in the hill is directly noticed and may have represented a past cistern. This pile of stone was no doubt related to the subsurface Iron Age structure described below. Excavations revealed a single-phase occupation with three adjacent rooms. The main room had a pillar perhaps for roof support located in the center of the structure.

Phasing

The following stratigraphy was defined at KIJ (Figure 2.14):

(1) Topsoil (L4000)
(2) Deep moist brown fill (L4001–L4004)
(3) Ceramic scatter fill just over surface (L4005, L4007, L4008, L4009)
(4) Compacted surface and plaster flooring (L4006, L4010, L4011, L4013)
(5) Wall structure built over bedrock (wall L4016–L4019)
(6) Limestone bedrock with pits and installations

Room 1: Main Room (Figures 3.13, 3.15)

The southwest quadrant of the probe exposed a large room that continued south into the balk. The depositional phasing was similar to the other rooms excavated. A large number of hammer stones and other ground stone tools were found in the fill (L4001, L4008). In the southern portion of this room, a complete small juglet was found (L4008; Figure 3.17a). Ceramics were found in the fill but in very small quantities. This room also had many large stones that had collapsed from the walls and perhaps contributed to the destruction of any ceramics left during the abandonment process.

A large two-course pillar stood in the middle of the southern section of the room. The probe was extended further south to fully expose all sides of the pillar. The

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pillar consisted of two very large cut stones with tiny stones used as wedges to level and support it on the bedrock. The upper stone had mason marks, demonstrating that it was cut to have five sides, creating a pentagonal shape (see Figure 3.15a).

The fill in this room was excavated down to a thin plaster surface that overlaid the bedrock. A large pit/cistern around 1 m in diameter was located in the northwestern corner of the room (Figure 3.15b). The narrow pit/cistern opened up in a bell shape similar to cisterns found in Cisjordan (cf. Negev and Gibson 2005). The pit/cistern was excavated for 2 m before it became too dangerous to excavate further. The pit contained a fill mixed with small ceramic sherds and several hammer stones. In the southeastern portion of this room, a cylindrical mortar hole (.30 m) was found carved into the bedrock near the corner of two walls connected to the pillar (Figure 3.15b). The mortar hole was filled with very dark ash sediment that was collected for later flotation and study.

Room 2: Storage Room (Figures 3.13, 3.16)

This room most clearly represents a single period of occupation for this portion of the site. This small room (ca. 1.5 x 3.0 m), bounded on all four sides by stone foundation walls, had a dense scatter of restorable pottery (L4006) inside the room. The ceramic scatter consisted primarily of large broken storage jars; however, other ceramic vessel families (bowls, jugs) were found (Figure 3.16). Many hammer stones, pestles, and mortars were also discovered in this room. One flint blade and several short-life radiocarbon (RC) samples were collected. The cluster of ceramic sherds was imbedded in a soft, light brown matrix just above the plaster and limestone bedrock floor. The depositional nature of the ceramic scatter suggests it represents a remnant of vessels left during abandonment of the site and later natural formation processes of windblown sediment filled the room in two stages. In contrast to the other rooms at the site, there were much fewer wall stones collapsed in this room, and this may explain the



Figure 3.12 Overview of KIJ showing sounding with N. Smith and son, Elijah.
Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.

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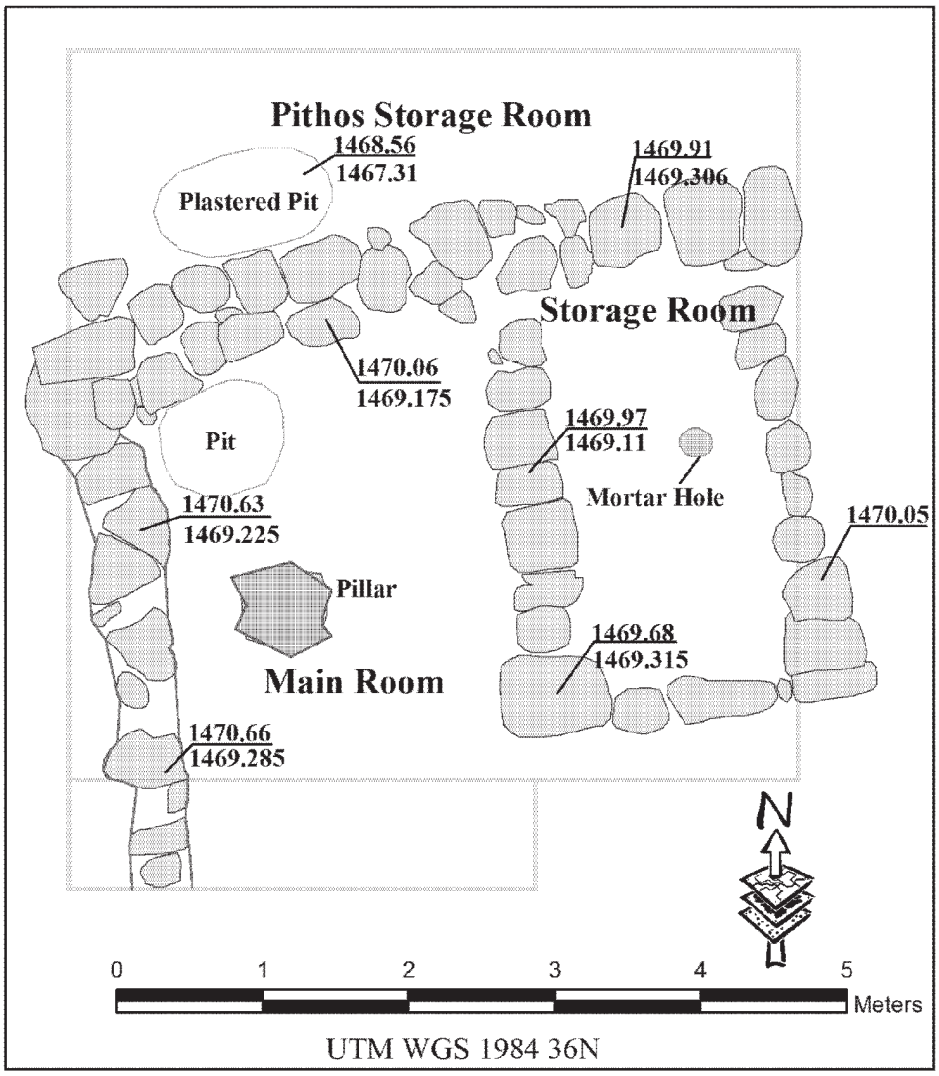

Figure 3.13 Architectural plan from sounding at KIJ.

better preservation of vessels found here. A cylindrical mortar hole was found located in the middle of the room abutting the eastern wall that was dug into the limestone. Since this pit was not sealed by the floor debris but contained a similar fill, it could not be determined whether these mortar holes predated the construction of the walls. A second possible mortar hole was found in the northwestern corner of the room that was shallower and more poorly shaped. Based on the exposure of the probe, Room 2 appears to be enclosed on all four sides; however, the southern wall was preserved only to one course, and further delineation was not possible because the structure to the south was concealed by the southern balk. The small size of Room 2, as well as the fact that it was closed from all sides without a doorway, suggests it was used primarily for storage and accessed from above. However, the presence of mortar holes indicates that at a certain point in time, perhaps earlier than the construction of the walls or the use of the room as storage, minor domestic activities occurred here. It is not unreasonable to suggest these mortar holes would have been used for crushing of acorns from the oak trees or other locally acquirable native plant products in the area.

Room 3: Pithos Storage Room (Figures 3.13, 3.16)

Room 3 represents the northern rectangular quadrant of the probe bounded by a wall on the south and the balks on the north of the probe. In the eastern section of Room 3, after the removal of topsoil, L4010 was opened to record the main fill in this room. Within this locus, a small wall not seen on the surface (L4019) was preserved to one course and found lying directly on bedrock surface running parallel with the larger wall (L4018). This small wall continues east into the

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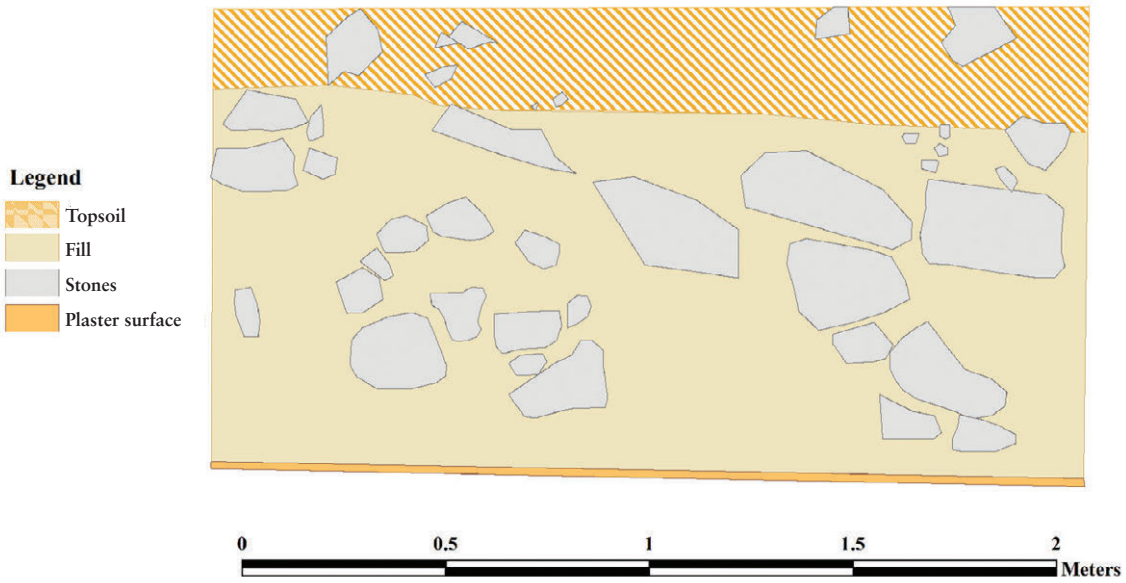

Figure 3.14 Section drawing of KIJ Room 1, southern balk.

northern and eastern balk. The relation of this wall to the primary building is not clear. The gap between the walls yielded nothing of significance besides the typical fill found throughout the probe. There is a possibility that this wall may be associated with an earlier settlement (linked with the bedrock mortars); however, both walls were built directly on the original bedrock. Additional excavation to the north and east of the probe appears the only solution to more clearly understand the relationship of this wall to the main structure.

A large stoneroller was found in situ, reused as part of a small one-course wall in the middle of L4010 (see Figure 3.16, upper left corner). It lies directly on the bedrock on the edge of the storage jar installation pit. Although it is clear that this probe represents a single period of occupation, the discovery of the reused roller may be another source of evidence indicating that there may be an earlier phase of occupation in other areas of the sites. As shown below, a similar roller was found at Tawilan Area K; also compare with earlier excavations at Tawilan (Bennett and Bienkowski 1995:pl. 10.152).

L4012 was opened to sample the western half of L4010 that continued to be excavated below the bedrock level (in antiquity, a large area had been dug into the bedrock, creating a large pit/cistern). A higher quantity of broken pottery mixed in the typical site fill was found just above two in situ pithoi (Figure 3.16). The in situ measurements of these vessels were around 1.5 m in circumference and around 1 m in height. These are remarkably large vessels that, until now, only rims have been found at other sites in Edom (cf. Chapter 4, this volume, concerning pithoi). The pithoi were placed in the pit/cistern after it had been plastered along an east–west axis. They were situated next to but not touching each other. The vessels were complete except for broken rims. A portion of the rim of the second pithos was found broken and lying behind the neck of the vessel. It is a triple-ridged upright rim (see Chapter 4, this volume, PT 20). Pieces of other broken vessels and fill were found in both pithoi (PT). Inside the first PT, a smaller storage jar fragment too large to fit through the neck was found with other vessels. To understand the context of these ceramics, consideration of site formation processes is crucial (Schiffer 2010). Four handles were attached to the shoulder of the second pithos that had an inscribed cross decoration on each handle. The presence of plastering on the installation that held the jars and the large size of these storage vessels indicates they were used for the permanent storage of liquids in Room 3. The storage of the vessels in a subsurface installation inside the bedrock foundation allowed the liquids to remain cool even during higher temperatures. This observation was confirmed during our excavations when summer temperatures outside of the installation were over 40°C but water stored in this facility was still cool and refreshing inside the room.

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Figure 3.15 *(a)* KIJ Room 1, view south, and *(b)* KIJ Room 1, bell-shape cistern and mortar, view south. *Photos: N.G. Smith, UC San Diego Levantine Archaeology Laboratory.*

Radiocarbon Sample Results: KIJ

A lentil seed found on the floor of L4006 in Room 2 was submitted for AMS dating at the Oxford Radiocarbon Accelerator Laboratory (see Figure 3.18; Table 3.2). L4006 consisted of a dense scatter of broken ceramic vessels that rested on the floor of the eastern structure, which has been interpreted as a storage room. The seed was found below the scatter of sherds that rested on the floor. At 95.4 percent probability, OxA-18345 dates to 799 to 545 BCE. Thus, the calibrated AMS date indicates that KIJ belongs to the Late Iron Age II sequence (ca. eighth to sixth centuries BCE). Due to the fluctuations in the calibration curve, a more precise dating cannot be achieved.

Khirbat al-Iraq Shmaliya (KIS)

Khirbat al-Iraq Shmaliya (KIS) (30.467283 and 35.499118 degrees, ca. 1,410 m above sea level; see Figures 3.19–2.25) was clearly connected with the nearby site of KIJ (ca. 0.5 km to the southwest). KIS is located within a kilometer of the modern village of Hawwali.

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Figure 3.16 L2HE 2007, images from KIJ Rooms 2 to 3: top left—Room 2 with pottery scatter; top right—Room 2 with plaster floor; bottom left—Room 3 showing pithos, roller, and secondary wall; bottom right—close-up of pithoi found in Room 3 plastered pit. *Photos: N.G. Smith, UC San Diego Levantine Archaeology Laboratory.*

The site is north of a large limestone outcrop and occupies the highest area of an extensive modern agricultural field. For reasons noted above, the well-preserved surface architectural features at this site were preserved due to the difficulty of bulldozing them. A small building belonging to the local villagers from Hawwali was built using the Iron Age building materials to the south of the area sounded for this project. It is clear that the foundation stones for this building come from the IA occupation of the site. This site was identified during the L2HE reconnaissance survey and other surveys (cf. Findlater 2000; Hart 1989; above). The sounding at KIS consisted of a 3 x 7–m probe specifically targeted to excavate three rooms identifiable by wall lines on the site surface. Of the four sites excavated for the L2HE project, this site proved to be the best preserved, with each room containing plaster floors accompanied with numerous complete vessels, including large reconstructable kraters, cooking pots, and storage jars. The stratigraphy of the site is described below and illustrated in Figure 3.21.

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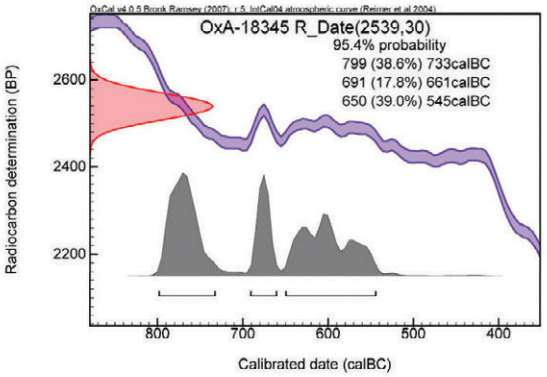
A



B

Figure 3.17 *(a)* Juglet (B11049, L4008) and *(b)* flint blade (B11040, L4003). *Photos: N.G. Smith, UC San Diego Levantine Archaeology Laboratory.*



D. KIJ: L.4006 B.11085, Lentil Seed (OxA-18345)

Figure 3.18 KIJ: L4006, B11085, lentil seed (OxA-18345).

Phasing

(1) Topsoil (L5000)
(2) General fill with minor wall collapse (L5001–L5003)
(3) Hard light yellow compacted sediment (L5004–L5006)
(4) Pottery scatter above floor (L5009–L5011)
(5) In situ pottery on floor (L5012, L5013, L5014, L5017)
(6) Bedrock with pits

Room 1: Eastern Room (Figures 3.20, 3.22c)

The eastern room (No. 1) has large limestone blocks (ca. 75–1 m) incorporated in the walls that are preserved to four courses. The wall courses differ in size from higher to lower, even though it is clear stratigraphically that there is only a single phase represented. It is strange that many of the higher courses in the walls of Room 1 are larger in size than the lowermost courses. Below the topsoil (L5001) and underlying a soft fill (L5006) was found a cluster of large semi-reconstructable storage jars and other vessels throughout the room (L5009). The northeast and southeast corners of the room had the highest concentration of vessels. The broken pottery sherds were imbedded in a hard compacted sediment fill that probably represents decayed mud brick. Some 30 cm of hard compacted sediment was excavated below the assemblage. As this fill was excavated, further patches of ashy fill were found. Many large broken but reconstructable vessels were found in the northern section of the room along with a few complete vessels. Underneath the first scatter of pottery, the upper portion of a very large grinding slab was uncovered (see Figure 3.22c). At the elevation of the top of the grinding slab, L5014 was arbitrarily opened to represent this final stage of fill that continued to the original floor. The fill continued to be a mix of hard decayed mud brick/plaster, softer ashy fill, and many restorable pottery sherds. This locus was kept open until reaching bedrock, since many of the ceramic remains found at the upper elevation of the locus were found to join with those found resting on the final floor. In fact, sherds found in L5001 at the beginning of the excavation of the room were found to join with those found on the floor in L5014, which provides strong evidence that the deposition of the site represented one occupational phase.

Exposure of the floor revealed good evidence for the original organization and use of the room. The large grinding slab was installed in the northwestern corner of the room as part of a crop-processing complex (Figure 3.22c). An elongated flat basalt "mono" or "rubber" was found in situ on top of the large grinding slab. Dark black ash covered the entire grinding slab and was collected for

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later study. This ash deposit may represent the burnt plant remains that were ground at the time of the abandonment of KIS. To the south of the grinding slab, a plastered depression was preserved that was associated with the grinding installation. Plaster was also found on the western wall near the grinding slab. By plastering the area around the installation, ground grain could have been easily collected in a relatively clean setting. To the east of the grinding slab, a narrow channel was constructed with a small single-course wall running north–south, approximately 20 cm from the grinding slab installation. A pestle and hammer stone were found in situ in this channel, which may have served as a storage area for grinding tools. Running east–west perpendicular to the north–south wall is another single-course wall that connects with a smaller grinding slab that was slightly rotated due to later disturbances after abandonment of the site but is still approximately in the same location. Three hammer stones were found in situ abutting the east–west wall that also appears to have been placed there purposely for later use. In the southeastern corner of the room, a small stone mortar was found in situ and associated with a pottery scatter surrounding it (Figure 3.23b). To the west, a cylindrical bedrock mortar hole was found. Overall, the



Figure 3.19 Overview of KIS as seen from KIJ. The steppe setting of the site is seen here. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

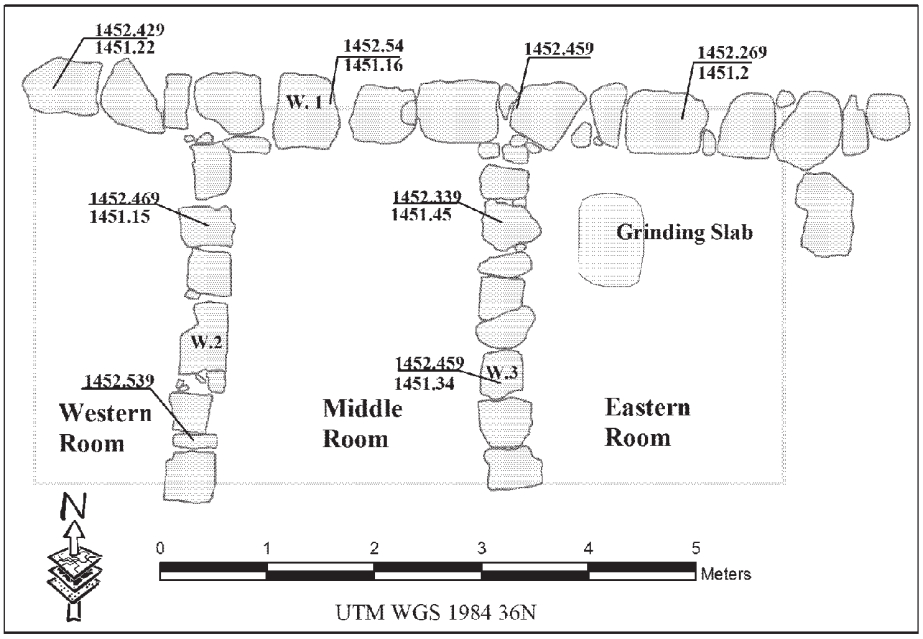

Figure 3.20 Architectural plan of soundings at KIS.

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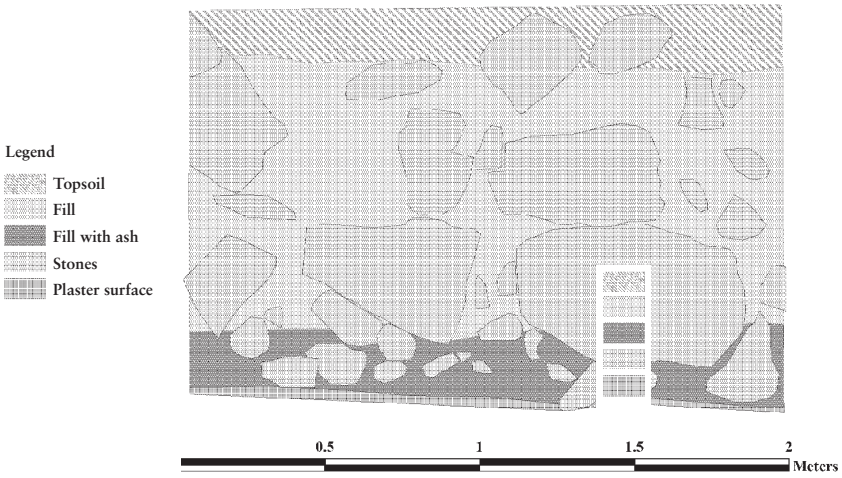
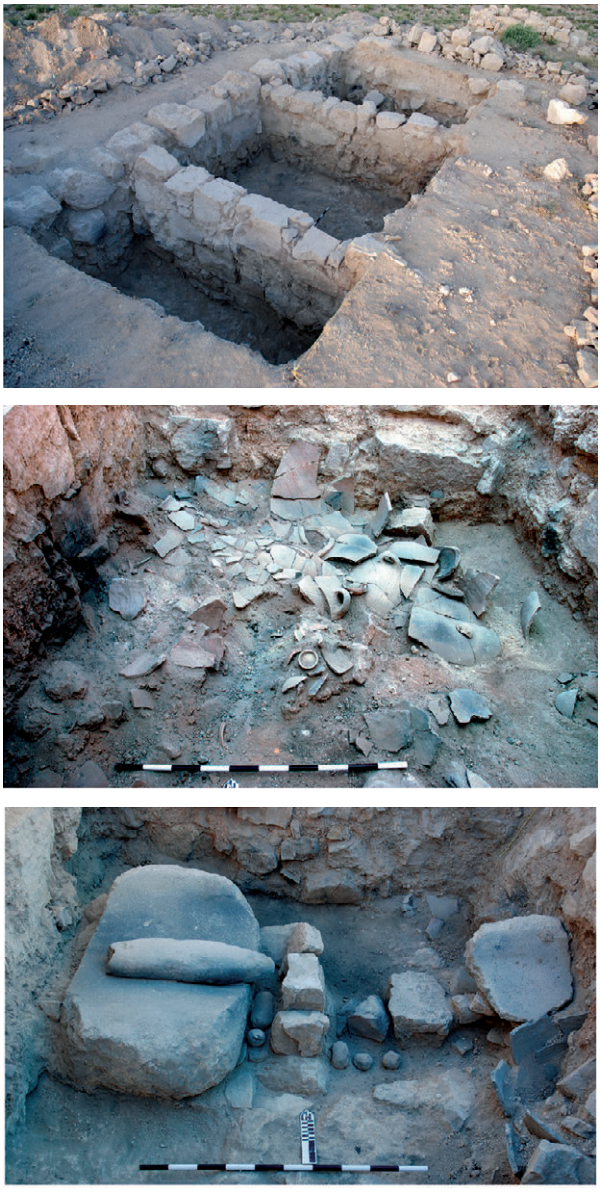


Figure 3.21 Section drawing of KIS Room 1, south balk.



preservation of the room presents a rare picture of Late Iron Age II domestic activities in the steppe zone of Edom. Exposure to the south of the room in 2010 revealed that this room belonged to an organized processing system at the site.

Room 2: Central Room (Figures 3.20, 3.22b)

Below the topsoil, the central room also contained a very hard light yellow compact sediment layer similar to the other rooms. Small ceramic sherds were found imbedded in this layer. Below was an ashy fill (L5010) consisting of patches of this hard material but gradually transitioned into a hard gray ashy sediment in the northern half of the room and a softer reddish brown sediment in the southern half. Directly in the center of the locus, a complete cooking pot was found upside down and lying on top of a carinated bowl that was also upside down. These vessels were imbedded in a patch of the compacted pise surface. As the fill was slowly removed, a large storage jar was exposed that was broken in a radial fashion in the northern half of the room with many other smaller vessels that were either half complete or broken (Figure 3.23a). To the south of the scatter, a cache of over 50 lentil seeds was found concentrated in the fill (B12084). A stamp seal impression on the handle of one of the storage jars was also found (cf. Figure 3.24j). An artificial division was made (L5017) from L5013 because this was the last level of ceramic scatter directly sitting on the floor of the room. Many more ceramic vessels were found

Figure 3.22 *(a)* KIS, view northeast; *(b)* pottery scatter in center of room (L5013), KIS; *(c)* installation and large grinding slab with in situ ground stones in eastern room (L5014). *Photos: N.G. Smith, UC San Diego Levantine Archaeology Laboratory.*

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A



B



C



D

Figure 3.23 L2HE 2007 images of KIS: *(a)* close-up of pottery scatter (L5013), *(b)* two in situ jugs and stone bowl found on surface (L5014), *(c)* exposed surface in L5013 with several vessels found in situ resting on the surface, and *(d)* in situ stacked bowls and small cooking bowls and small cooking pot found on the surface of L5013. *N.G. Smith, UC San Diego Levantine Archaeology Laboratory*

in situ resting directly on the floor at this level. In a number of cases, evidence of purposeful stacking of the vessels was found (Figure 3.23c,d). The floor of this room also contained a dozen hammer stones and pestles. In the northwestern corner of the room, an installation consisting of two small rectangular stones was placed at right angles on the floor surface. In the corner of these stones, a limestone cosmetic dish was found directly on the floor (Figure 3.25g; compare with those found at Busayra [Bienkowski 2002:Pl. 10.1115] and Tawilan [Bennett and Bienkowski 1995:Figure 9.15]). At a higher elevation, an anamorphic palette (Figure 2.25b) was found similar to those published at Tawilan (Bennett and Bienkowski 1995:Figures 9.15, 9.19, 9.60; see also Sease and Reese 1994 for parallels and discussion of these palettes in Edom). An annular rhyton that attached to a bowl was also found amid the ceramic assemblage in Room 2 (Figure 3.25h; Dever 2001). The stacked vessels and another small carinated bowl were all found around these arranged stones. In the center of the room, a mortar hole was found. The preservation of the artifacts in this room is especially good and provides another rare look at domestic life during Late Iron Age II in the steppe zone of Edom. The fact that so many in situ objects were found in Rooms 1 and 2 indicates that this part of KIS was abandoned in haste.

Room 3: Western Room

Only a small portion of the western Room 3 was exposed due to the limits of the size of the excavation probe. The general depositional phasing found in the other two rooms was the same for this room. After the removal of topsoil, an ashy fill with patches of decayed mud brick was exposed (L5011), similar to what was found in Rooms 1 and 2. A small complete torpedo jar was uncovered in this fill in the middle of the room. In the southern area abutting the balk, a large in situ burnt beam was found. After removing the torpedo jar, L5012 was opened. This locus follows the pattern

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of the other rooms; it represents a fill associated with the original floor. However, the composition of artifacts was very different in this room compared with its neighbors. Very few restorable vessels were found on the occupational surface. Instead, this room contained an important assemblage of metal objects. A total of five copper and iron arrowheads, a copper bracelet, flint blade, and unworked shell were found (see Figure 3.25). Due to the small exposure of this room, the exact function is unknown. However, this room contained more metal objects (some with military functions) than any other site the L2HE project sampled in the highlands of Edom.[14]

Radiocarbon Sample Results: KIS

A seed from a cache of lentil seeds found on the floor of Room 2 in L5026 at Khirbat al-Iraq Shmaliya was submitted for AMS dating at the Oxford Radiocarbon Accelerator Lab. Unfortunately, due to the small size of the lentil and possible contamination, the ^{14}C yield was too low and the AMS dating failed. However, as will be argued in Chapter 4, KIS's ceramic assemblage is near identical to the other sites in the steppe and highland that yielded successful radiocarbon dates. There is no evidence to suggest KIS should be dated differently than the other steppe sites. Therefore, KIS should be considered as belonging to the Late Iron Age II sequence.



A. Bowl (B. 12124 L.5017)
B. Bowl (B. 12123 L.5017)
C. Bowl (B. 12140 L.5017)
D. Tripod strainer bowl (B. 12103 L.5013)
E. Strainer bowl (B. 12045 L.5009)
F. Cooking pot (B. 12123 L.5017)
G. Platter (B. 12130 L.5017)
H. Bowl (B. 12073 L.5013)
I. Jug (B. 12133 L.5012)
J. Handle with potter's mark, and detail (B. 12081 L.5013)
K. Handle with potter's mark, and detail (B. 12102 L.5013)

Figure 3.24 L2HE 2007 special finds from KIS. *Photos: N.G. Smith, UC San Diego Levantine Archaeology Laboratory.*

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A. Oil lamp (B.12144 L.5017)
B. Stone object (B.12006 L.5003)
C. Copper bracelet (B.12069 L.5013)
D. Iron arrowhead (B.12100 L.5012)
E. Hematite weight (B.12092 L.5013)
F. Iron arrowhead (B.12071 L.5012)
G. Cosmetic dish (B.12127 L.5017)
H. Ram's head figurine on ceramic rim(B. 12121 L.5017)

Figure 3.25 L2HE 2007 special finds from KIS. *Photos: N.G. Smith, UC San Diego Levantine Archaeology Laboratory.*

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Tawilan

To investigate the relationship between the lowland and highland sites of Edom, we decided to revisit one of the key highland excavation projects carried out by Crystal Bennett on the basis of which the traditional dating scheme for the region was established. Thus, in 2007, as part of the L2HE project, N. Smith, T. Levy, and M. Najjar initiated work at Tawilan (30.330964 and 35.484981 degrees, ca. 1,415 m above sea level; see Figures 3.26–3.37) by carrying out two soundings to reexamine the stratigraphy at the site that was originally excavated by Bennett (Bennett and Bienkowski 1995) and obtain additional radiometric and ceramic data. Specific goals included procuring well-documented radiocarbon samples and ceramic data from the site for comparative analysis with Iron Age sites from the plateau and lowlands. In contrast to the central site of Busayra (Bienkowski 2002), a large town over 5 ha in size with large outer perimeter walls, Tawilan is a medium-size open village around 0.9 ha in size (see Bennett and Bienkowski 1995 for a discussion on the smaller size of the site than originally described by Glueck). Tawilan is located 0.95 km northeast of ʻAin Musa in the highland area of Petra. The site's gentle sloping terrain made it an ideal location for terrace farming. While the material culture is typical of the Late Iron Age II sites located on the plateau of Edom, it is not situated in the inaccessible settings characteristic of other locales from this IA II period such as the Edomite stronghold sites of Ba'ja III, Umm al-Biyara, Jabal al-Qseir, and others (cf. Lindner 1992; Lindner, Knauf, and Zeitler 1996; Lindner, Knauf, Zeitler, and Hubel 1996; Lindner and Knauf 1997; Lindner et al. 1997; Lindner et al. 1998; Lindner and Farajat 1987). Tawilan is characterized by a more open setting and provided an excellent agrarian setting for the highland inhabitants of Iron Age Edom.

Significance of Tawilan in Archaeological Literature

Tawilan was discovered during Glueck's (1934:13–14, 1935:82–83) first survey in the region of Transjordanian Edom. Glueck identified two enclosure walls on the surface—an outer one encompassing around 2 ha of the Iron Age settlement and an inner wall enclosing around 0.9 ha of the site. Glueck dated Tawilan from the thirteenth to sixth centuries BCE. The earlier date was established primarily by the presence of Negebite ware found on the sites surface (Bennett and Bienkowski 1995:50). On the basis of the site name, date, and presumed large fortification wall, Glueck argued that Tawilan was biblical Teman. R. de Vaux (1969) rejected this identification after arguing that Teman was not a particular site but rather a region of Edom. When Bennett first excavated the site in 1968, she probed two sections of Glueck's outer wall (Areas IV and VI; see Figure 2.27). However, this wall lacked evidence of an Iron Age date. Based on the ceramics and other artifacts found associated with the wall, it was dated to the first century CE during the Roman period (Bennett and Bienkowski 1995:51).



Figure 3.26 New excavations at Tawilan (Area K) with modern village in the background. Note the open setting of this highland site. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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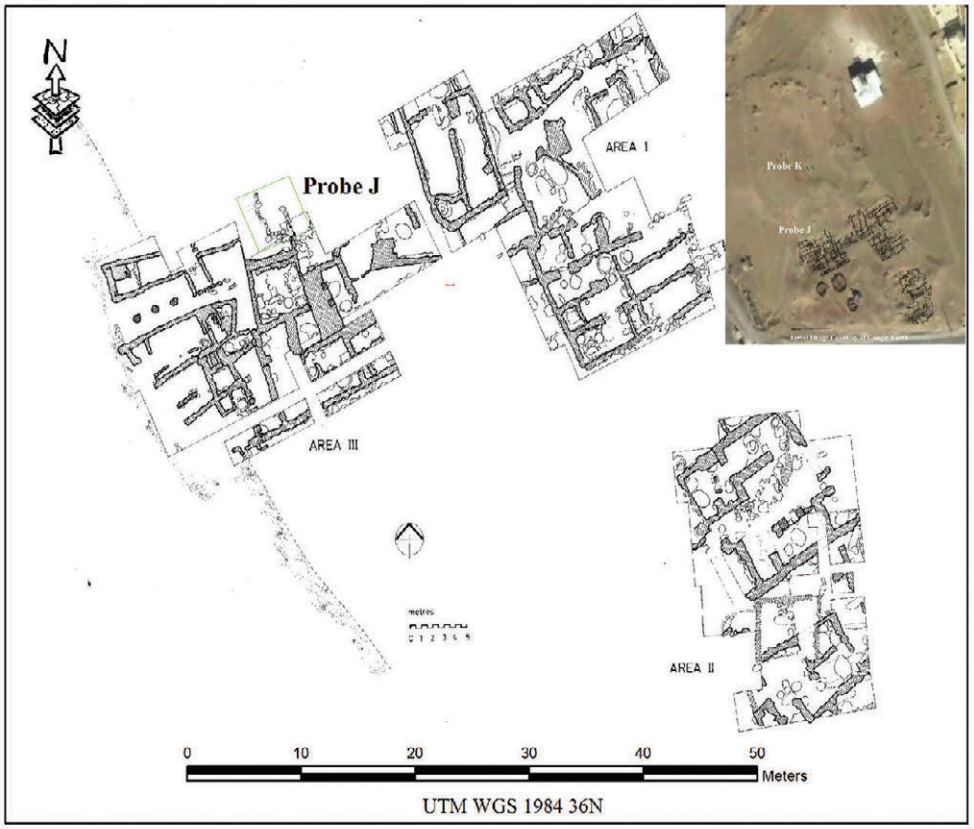

Figure 3.27 L2HE excavations at Tawilan in relation to past excavations (map after Bennett and Bienkowski 1995).

Besides the test probes, Bennett opened three large areas (Areas I, II, and III; see Figure 3.27) in the southern portion of the site. These excavations revealed domestic architecture consisting primarily of rectangular buildings made with dry stone masonry. The size of the stones used and quality of construction was found to differ between the main areas that Bennett's team excavated (Bennett and Bienkowski 1995:101). In a number of the rooms, pits were found dug into the bedrock. All three areas underwent an initial building phase and a second phase of restructuring where the original buildings apparently continued in use until they were destroyed or abandoned at sometime during the end of the Iron Age IIC. Based on this phasing, Tawilan can be considered primarily as a single Iron Age phase site dating between the late eighth and sixth centuries BCE with only minor modifications to the architecture over the duration of its use.[15] While the final monograph publication appeared in 1995, much of the site remains unexcavated. In addition, problematic aspects of the reports concerning Bennett's excavation have obscured a more comprehensive understanding of the site (Bennett and Bienkowski 1995:16–17). Thus, Tawilan was probed by the L2HE project in order to try to resolve a number of these issues, in addition to retrieving a quantitative sample of ceramics and short-life radiocarbon samples for dating. Currently, the site remains in danger of destruction by modern village construction and encroachment by village shepherds.

The New Excavations

The two L2HE 5 x 5–m soundings serve as a control for comparing quantitative data concerning the ceramic assemblage from Tawilan with those at other newly excavated IA II sites on the plateau described above. It was hoped that with radiocarbon dates and a comprehensive collection of diagnostic sherds from each subphase of the site, a more detailed examination of the site chronology would be possible.

Area J (Figures 3.28a, 3.31, 3.32)

The first sounding (Probe J) was made directly north of Bennett's Area III East (Figure 3.18). Bennett (Bennett and Bienkowski 1995) interpreted Area III East as a domestic area. Thus, it was important for us to resample this area because of its similar architectural design and material culture as found at the L2HE sites sounded in Showbak. We placed Probe J in direct proximity to

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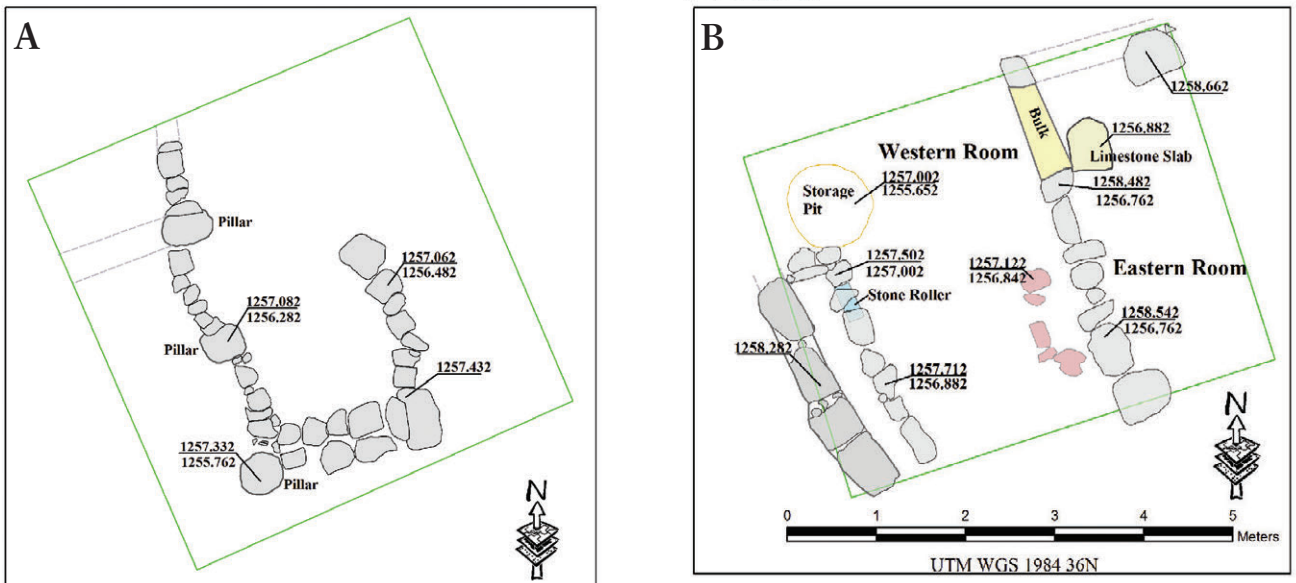

Figure 3.28 Architectural plan from L2HE soundings at Tawilan: *(a)* Probe J and *(b)* Probe K.

the walls and balk from Bennett's excavations in Area III, making it possible to connect the new probe with the stratigraphy of the past excavation. This particular area was selected because the general stratigraphy of Area III East was problematic, and the poor recording of the excavations prevented a clear understanding of this key portion of the site (cf. Bennett and Bienkowski 1995:45). Thus, the new Probe J sounding allows us to directly compare the new data with the stratigraphy defined by Bennett and Bienkowski (1995). The phasing for Area J is summarized below (for stratigraphic profile, see Figure 3.29)

Phasing

(1) Topsoil (L6002)
(2) Stony ashy light brown sediment (L6005)
(3) Powdery, light gray ash sediment (L6008, L6013)
(4) Crudely plastered surface (L6017, L6021, L6022)
(5) Medium-hardness clay sediment and fill with second plaster surface in southern end (L6026)
(6) Bedrock

An initial 5 x 15–m probe was opened directly north of Wall XXXII (cf. Bennett and Bienkowski 1995:Figure 4.1), where another possible room appeared to exist. The initial topsoil (L6002) and fill below it (L6005, L6006) was densely filled with stones and a very high concentration of pottery sherds and ground stones. The description of a "loose brown soil and stones" from the original excavations by Bennett at Tawilan (Locus 75.6 from Figure 4.18) mirrors our excavation of this area. Many of the sherds found within this fill were rounded through erosion, suggesting that the material culture mixed within the fill may have been transplanted from another area or underwent a series of post-depositional processes. The pottery and ground stone artifacts from these loci were collected and counted, but the former were not included in the quantitative ceramic study (see Chapter 4, this volume), which focused on the more secure loci in Probe J. The remaining excavation of the probe was reduced to the western 4 x 5–m area where wall lines were clearly identified. During the excavation, it became clear that the area east of this section was primarily an Iron Age dump that continued for another meter and lacked any evidence of architectural remains. However, in the western 4 x 5–m area at the bottom of L6005, sporadic small (ca. 1–2 cm) patches of a hard compact yellow sediment were found, perhaps relating to similar floor material described by Bennett and Bienkowski (1995:39–47) in a number of the sections in Area III. We identified a general transition throughout this area of the probe to a soft powdery light gray ash sediment (L6008, L6013—the lower portion of the layer). The ashy sediment followed the general stratigraphic description for the profiles abutting Probe J as recorded by Bennett (e.g., S24, S25, S28). Like Bennett's excavations, this ashy fill in Probe J represented the bottom 0.5 to 1 m of cultural

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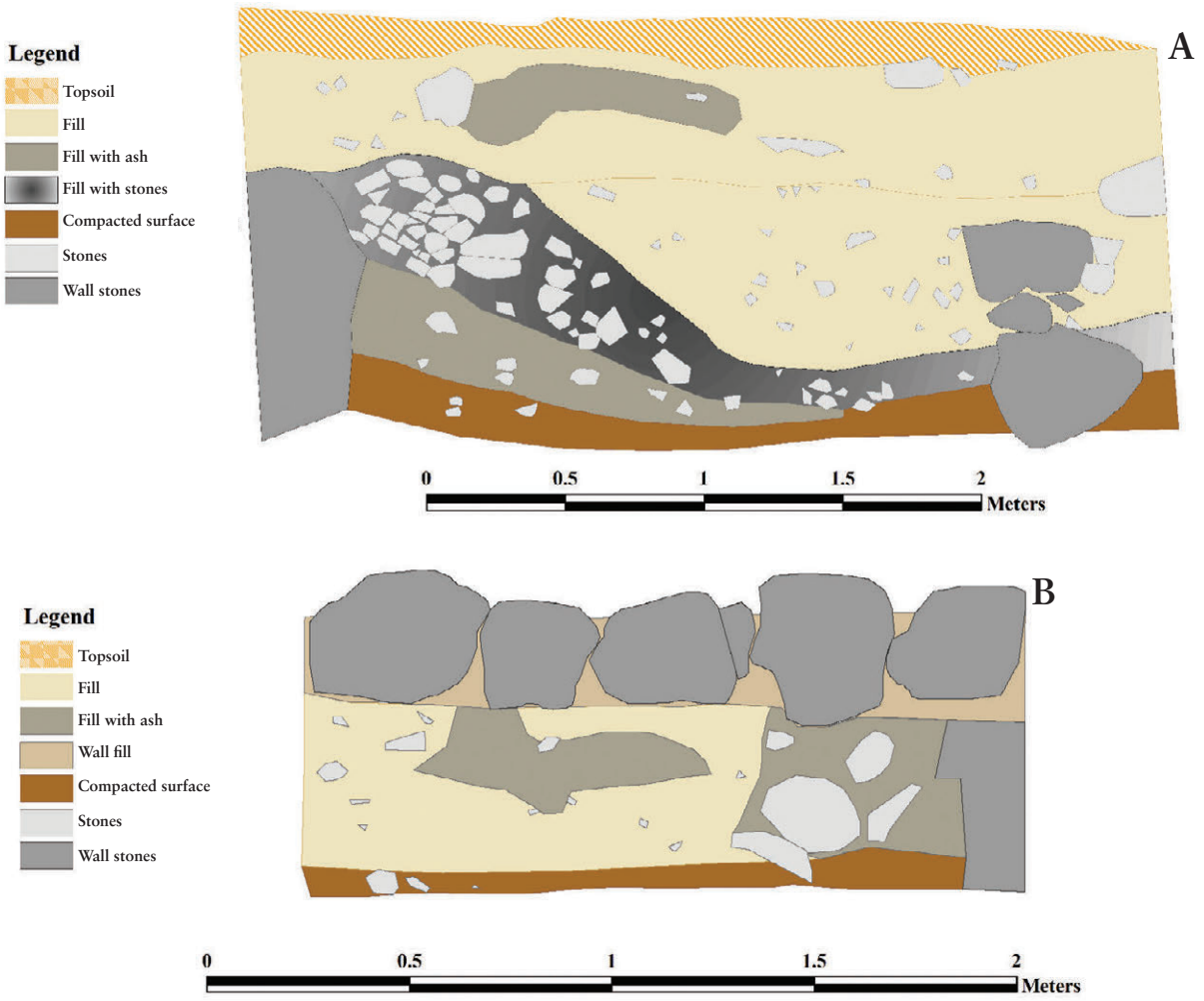

Figure 3.29 *(a)* Tawilan Area J, northern balk section, and *(b)* Tawilan Area J, southern balk section with one-course wall.

deposition before reaching a floor and then bedrock (cf. Figure 2.29). Bienkowski (1995:41–42, 46) relates this deposit to Phase III—the latest Iron Age occupation of the site as identified by Bennett. In Probe J, one complete bowl (Figure 3.36m) was found resting just above a white plaster surface (L6021, L6022) at the bottom of L6013. Virgin soil was reached below this surface in the northern portion of the room. In the southern portion of the room (L6026), we removed the surface exposing pottery sherds (n = 71) and a second surface around 10 cm below the first (Figure 3.32a,b). Below this second surface, the bedrock was reached. This earlier surface could be related to Bennett's first construction phase (II) at the site. However, it is clear from the small buildup of debris over the earliest phase that it was only occupied for a short period before a new surface was built and changes were made to the architecture.

A central pillared wall was found in Probe J resting on bedrock (Figure 3.31a,b). The construction of this wall is similar to other walls found in Bennett's excavations in Areas I to III (e.g., Walls XLIX and XIV and Pillars 1–23). The pillars were created with large irregularly shaped stones. The pillars were then connected together by smaller loosely stacked stone courses as seen for both Walls XLIX and XIV in Area III of Bennett's excavations. The pillars and connecting stone wall were associated with the earliest phase in Probe J as they rested on bedrock below the first and second plaster surfaces. A second wall preserved to three courses (ca. 0.5 m in height) ran parallel to the pillared wall (Figure 3.32b); however, this wall rested on the later plaster surface and bounded the eastern section of the probe where the virgin sediment was higher and also had evidence of plaster. The general

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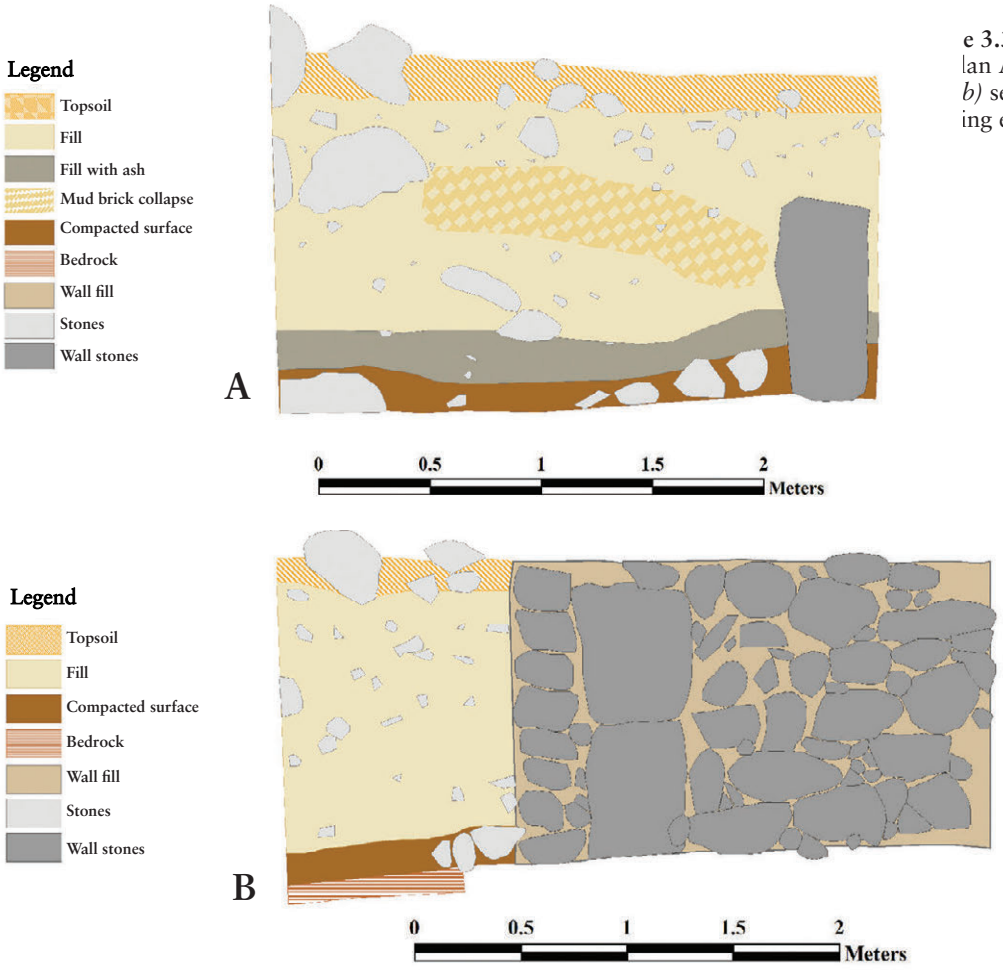

e 3.30 Section drawings from lan Area K: *(a)* southern balk *b)* section of wall and balk ing east and west rooms.

function of this wall is unclear as it does not appear to have been used as a primary support wall as seen with the pillared wall described earlier. However, it is similar to other walls identified in other rooms in Tawilan by Bennett such as F.4 and Wall LVI, which functioned to section off the room directly south of Probe J.

In general, Probe J confirms Bennett and Bienkowski's (1995:47) observations that Tawilan Area III was a single-period occupation with minor phasing during the Late Iron Age II period. The function of the Probe J room beyond domestic activities is undetermined. The large quantity of pottery, bone, and ground stone artifacts in the fills appears to be a result of intense occupation in Probe J and not related to natural formation processes such as runoff found in the topsoil deposits or the eastern dumping areas. Probe J can be linked stratigraphically and by material culture to Bennett's Area III East. The excavations confirmed the original findings by Bennett and Bienkowski (1995) that there is indeed narrow subphasing at the site representing a relatively short occupation period that incorporated use of bedrock surfaces that should be dated to Late Iron Age II. The pottery (to be discussed further in Chapter 4, this volume) and many of the other small finds (cf. Figure 3.36) parallel what was found in the previous excavations at Tawilan. The ELRAP field collection methods (no artifacts were discarded), controlled reporting of the loci, and the collection of samples for radiocarbon dating provide a new set of quantitative data for linking the previous excavations at Tawilan and the several other probes conducted by the L2HE project for further research as presented in Chapters 4 and 5.

Area K

The second probe (Area K) was opened 35 m north of Bennett's excavations in Area III to better understand the chronological relationship between the different areas of the site (Figure 3.18). In this area, a series of rooms could be identified on the site surface that were divided by large well-built walls. The Area K probe provides a useful control for reexamining Bennett's Tawilan excavations that focused primarily on the southern

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Figure 3.31 L2HE 2007 site photographs, Tawilan Area J: (*a*) Area J, view west, and (*b*) Area J, pillared wall with final plastered surface above bedrock, view southwest. *Photos: N.G. Smith, UC San Diego Levantine Archaeology Laboratory.*

portion of the site but left this architecture-rich area untouched. By probing this unexplored area, it would be possible to determine the full range of Iron Age occupation phases at the site. By the end of the excavation season, the 5 x 5–m probe exposed portions of two rooms that have been labeled here as the western and eastern rooms. The excavations and phasing observed in these rooms is summarized below (see Figure 3.30).

Phasing

(1) Topsoil (L6010)
(2) Hard sediment accumulation with stone wall collapse (L6012, L6014)
(3) Brown clumpy moist sediment with some stone wall debris
(4) Hard compacted sediment and patches of gray ash (L6018, L6019)
(5) Hard clay surface with patches of plaster and sporadic stone paving (L6024, L6025)
(6) Softer white ashy surface patches and gray clay surface (L6027)
(7) Pit dug into bedrock
(8) Bedrock

Western Room (Figures 3.28b, 3.33, 3.34)

Immediately below topsoil (L6010), the top course of a middle dividing wall could be identified that separated two well-built rooms. The larger western portion of the probe (3 5m) was labeled the western room. Below the topsoil (L6012), stone collapse and a hard light brown fill sediment was reached. As the stone collapse was removed, the sediment below consisted of a moist brown clumpy sediment (L6015, L6018—continuation of sediment). These loci contained only a few examples of

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Figure 3.32 L2HE 2007 Tawilan site photographs: (*a*) Area J, final plaster surface with possible later wall preserved to one course, view south, and (*b*) Area J, final plaster surface with three-course wall resting on intact surface, view southeast. *Photos: N.G. Smith, UC San Diego Levantine Archaeology Laboratory.*

pottery and animal bone. L6018 was opened with the first appearance of a smaller stone-built wall running north–south that was separated around 30 cm from the larger north–south wall. After 30 cm of excavation, L6018 was closed at the appearance of surface L6024. From topsoil to surface (L6024), 1.3 m of fill was excavated. This hard clay surface could be identified throughout the southern portion of the room; in the northwest and northeast corners, the soft brown fill sediment continued (later being determined to be a pit and cavity for a storage jar, respectively). Patches of ash were found sporadically in different sections of L6024. Only small amounts of pottery were found in comparison to Probe J. In the southeast corner of this room, several flat stones were found imbedded in the clay sediment (resting on the original bedrock), indicating they may have served as paving stones. L6027 was opened to remove the debris and expose artifacts in this clay sediment. Bedrock was reached 10 cm after chipping away at the clay sediment. This locus (L6027) consisted of hard compact clay with patches of softer white ashy sediment. It contained the highest quantity of pottery and cowry shells in the room. Near the several flat stones in the southeastern room corner, concentrations of black ash, ground stone artifacts, animal bones, and ceramics were found. In the northeastern corner, a complete storage jar was found resting on its side immediately on the bedrock and abutting the corner of the middle dividing wall (Figure 3.35a). There was a concave depression in the bedrock allowing the vessel to lie securely on its side. The small north–south wall also rested on the bedrock. This wall was three courses high and ran up to the pit edge. It was also noticed that a stone roller similar to one found at KIJ was reused in the construction of the wall (see Figure 3.34a). Finally, in the northwestern corner, a large 1.5-m diameter pit was discovered. The pit was cut into the bedrock and contained four complete storage

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Figure 3.33 L2HE 2007 Tawilan site photographs: *(a)* Area K, view west, and *(b)* Area K, western room, view south. *Photos: N.G. Smith, UC San Diego Levantine Archaeology Laboratory.*

jars and a decorated jug (cf. Figures 3.33a, 3.35b; see also discussion of pits at KIJ above). Numerous large storage pits were found during Bennett's excavations at Tawilan in Area III (see Bennett and Bienkowski 1995:Figure 4.1), and a similar pattern has been found in the new soundings at the site. During the eighth to seventh centuries BCE, this storage practice seems to have been common as it was also detected in our steppe excavations at KAM and KIJ. It is clear the pit was used as a storage area for various vessels until the final abandonment of the room. The purpose of the hard clay surface found 10 cm above the bedrock in the remainder of the room appears to have been to level off the floor. Whether this occurred contemporaneously with the construction of the room or after is not fully clear from the western room. It is hoped that this problem can be resolved by expanding the excavation to fully expose the two western walls.

Eastern Room (Figures 3.28b, 3.34b)

This room was bounded on the west by the middle dividing wall and the eastern bulk, making it quite narrow. The room was accessed from the northern end of the western room where the dividing wall ends. The phasing mirrors that found in the western room where the fill consists of clumpy brown sediment and stone collapse (L6016, L6019). L6019 was opened with the appearance of a large limestone slab located in the northern portion of the room. At the base of the limestone slab (ca. 20 cm below), a dense pottery scatter was found resting on a clay surface/floor (L6025). Like the western room, this pottery scatter was different from the locus (L6019) above, which contained very little pottery. The stone slab rested on smaller stones touching the bedrock that may have been used for leveling and was just above the level at which the pottery scatter was found. Below the ceramic scatter (L6028),

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Figure 3.34 L2HE Tawilan photographs: (*a*) Area K, inner storage wall with roller, view west, and (*b*) Area K, eastern room, view north. *Photos: N.G. Smith, UC San Diego Levantine Archaeology Laboratory.*

only small amounts of pottery were found before reaching bedrock.

In sum, there appears to be two stratigraphic phases in Probe K, similar to what was observed in the southern area of the site (Probe J). The earliest phase represents Iron Age occupation on the bedrock when a pit was dug in the northwest corner and several walls, paving stones, and a limestone slab were established. The pottery found in the western room was concentrated in ash and hard clay sediment just above the bedrock. At a later stage, a clay surface around 10 cm above bedrock was built. In the eastern room, a pottery scatter resting on this surface was found. However, in the western room, almost no pottery was found lying on this clay surface. Rather, in the northern section, several storage jars were found in situ. At the abandonment of the site, the storage jars were left and the rooms were gradually filled in with windblown sediment and subsequent stone collapse. The fill above the surfaces in both rooms was almost devoid of cultural remains, which is in stark contrast to Area J, where the fills contained high quantities of pottery. Area K was excavated around 2 m from surface to bedrock and, like the southern excavations in Area J, represents a single main occupation of the site that resulted in minor alterations to the settlement plan during its use. The probes provide a general picture of the whole site being primarily a domestic village established only in the Late Iron Age II.

Radiocarbon Sample Results: Tawilan

Two radiocarbon samples were submitted for AMS dating from Tawilan. The sample collected from Area K failed to yield significant results (see ^{14}C discussion for KIS above for explanation). The other sample (OxA-18346; see Figure 3.37 and Table 3.2) was collected

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Figure 3.35 L2HE 2007 Tawilan site photographs: (*a*) Area K, semi-complete storage jar in northwest corner of the western room, and (*b*) Area K, pit with multiple storage jars in northeast corner of western room. *Photos: N.G. Smith, UC San Diego Levantine Archaeology Laboratory.*

from Area J in L6026. This locus represents the earliest occupation in Area J below (ca. 10 cm) the later crudely plastered floor (L6017, L6021, L6022). At 95.4 percent probability, the new sounding at Tawilan shows that the basal occupation floor dates to 890 to 785 BCE and spans the ninth to early eighth centuries BCE. Therefore, this portion of the Tawilan site was occupied between the end of the Early Iron Age II and the Late Iron Age II phase. This is the only example on the plateau where the possibility of a late ninth-century BCE occupation can be entertained. Taking into consideration that this is only one sample and that the calibration curves are not as precise after the ninth century BCE, additional radiocarbon dates are needed from Tawilan and the highland sites to better clarify the absolute Iron Age setting of the highlands in Edom.

Summary

When the new archaeological data presented here are combined with the social model of settlement patterns developed above, a picture of Late Iron Age II Edom's social complexity can be more clearly delineated. The field data retrieved from the survey and soundings described here for the steppe and highland zones provide new insights concerning the relationship and history of settlement of Transjordanian Edom—from the lowlands

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A. Spindle whorl with incised design (B.13214 L.6027)
B. Scarab seals (B.13069 L.6012)
C. Scarab seals (B.13012 L.6003)
D. Bone spatula with pointed end (B.13150 L.6018)
E. Arrowhead (B.13014 L.6003)
F. Iron artifact (B.13200 L.6027)
G. Tridachna shell (B.12028 L.6006)
H. Cosmetic dish with incised design, and detail (B.15001)
I. Zoomorphic figurine head (B.13051 L.6006)
J. Jug (B.13221 L.6030)
K. Handle with potter's mark, and detail (B.13011 L.6004)
L. Figurine head (B.13122 L.6013(
M. Bowl (B.13131 L.6013)

Figure 3.36 L2HE special finds from Tawilan 2007. *Photos: N.G. Smith, UC San Diego Levantine Archaeology Laboratory.*

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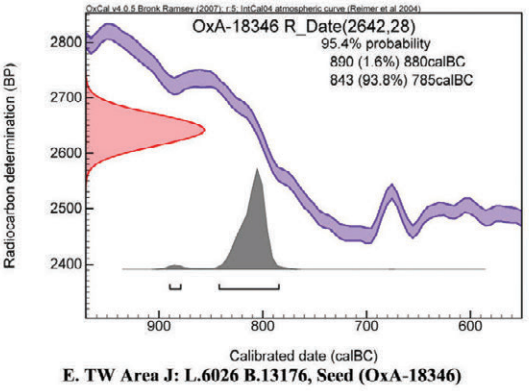

Figure 3.37 Tawilan Area J: L6026, B13176, seed (OxA-18346).

to highlands. The remaining sections describe how these new field data refine our understanding of Iron Age Edom in relation to the earlier research in the area.

Radiometric Results and Dating of the Highlands

Although only a small number of radiometric dates have now been processed for the highlands of Edom, when the AMS radiocarbon results presented here are considered critically, Iron Age occupation at these sites clusters during the beginning of the eighth century BCE. The date from Tawilan suggests that this site was occupied as early as the ninth century BCE. The fluctuations in the radiocarbon calibration curve during the eighth to seventh centuries BCE is a well-known problem (Bronk Ramsey 2005), making any definitive conclusions concerning absolute dating impossible at present. However, according to the results presented here, a significant early eighth-century BCE occupation came to fruition in the steppe and high plateau region of Edom during the Late Iron Age II. More important, the primary occupation phases at Tawilan should not be dated to the sixth century BCE as Hart (1989:44–47) argued (see also Bennett and Bienkowski 1995:102). It is hoped that as more Iron Age excavations in the highlands are conducted, AMS radiocarbon dating will be employed as standard practice so that a clearer picture of the absolute dating of Edom's plateau can be achieved.

The dating of these sites to the Late Iron Age II is further corroborated by a strong similarity in material culture with previously surveyed or excavated contemporaneous sites. Artifacts such as decorated spindle whorls, loom weights, bone spatulas, stone palettes, and clay anthropomorphic masks recovered from the new L2HE excavations share similar stylistic characteristics to what has been documented at Tawilan and Busayra. Moreover, similar construction practices are also evident such as pillared walls, plastering of limestone bedrock, and excavation of pits in bedrock for the use of storage jars. Finally, the Iron Age ceramics (to be discussed in more detail in Chapter 4, this volume) are highly characteristic of this period. All of this evidence points to the majority of plateau sites in northern Edom as belonging to the Late Iron Age.

When the attributes of the Late Iron Age II occupation on the plateau is compared to the earlier occupation of the lowlands of Edom where copper metallurgy, widespread mortuary evidence (see Chapter 8, this volume), and semi-nomadism predominated (Levy 2009), it is clear that a transformation in lifestyle and culture occurred in the later periods of Edom's history—especially in the highlands. The settlement in the lowlands during the Late Iron Age II continued, as seen at Rujm Hamrat Ifdan (RHI) (Chapter 10, this volume), but the highland plateau became the new center of a Late Iron Age polity in Transjordanian Edom. Based on the open village settlement pattern identified in the highlands and the sites sounded by the L2HE project, it seems that the importance of copper diminished in the Late Iron Age. Agricultural production and the control of the trans-Arabian trade routes became much more important during the final phases of the Iron Age in this region of the southern Levant.

Conclusion: A Picture of Late Iron Age II Edom (ca. Eighth to Sixth Centuries BCE): Betwixt and Between Chiefdom and State

The L2HE survey and excavations present a recurring picture of agrarian/pastoral-based autonomous villages representing the dominant type of social organization throughout the Late Iron Age II region of southern Edom. The settlement patterns identified by several different survey projects in the highlands demonstrate that the majority of sites are villages or hamlets that exploited the natural resources around them. Besides open-air Iron Age villages on the plateau, small forts or watchtowers are found dispersed throughout the region. These may indicate a form of administrative/military control but not to the same extent seen among hierarchical archaic states. Outside of the more arable areas on the steppe, many "Edomite" strongholds (e.g., Baja III, Es-Sadeh, Jabal Qseir, Grayyet Mansour, etc.; see also Chapter 12, this volume) are found that may also be related to defense from either

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external threats or internal opposition. In comparison to neighboring southern Levantine polities (e.g., Judah, Israel, Philistia, and Phoenicia), if Busayra and its hinterland is taken into consideration, only a three-tiered settlement hierarchy and two levels of decision making seem to have existed in Late Iron Age Edom. Busayra may have functioned more as a ruling town that directly administered a network of second-tier villages within its immediate hinterland. The extent of its influence on southern Edom has not yet been clarified by the soundings and excavations discussed in this chapter—or previous research. In general, the region of Edom remained undeveloped and a place where pastoral nomadism may have played a more formidable role (cf. LaBianca and Younker 1995; Levy 2009).

When the previous archaeological evidence is taken into consideration with the data presented in this chapter, it becomes difficult to pigeonhole Late Iron Age II Edom into the traditional social evolutionary models developed in archaeology, as noted by many of the scholars who have sought to understand the social complexity of Edom (e.g., Bienkowski and van der Steen 2001; LaBianca and Younker 1995; Levy 2009; Porter 2004). Late Iron Age Edom is a polity that does not meet the essential criteria of an archaic state, but at the same time, at its "capital," it is more centralized and internally specialized than polities such as complex Polynesian and other similar chiefdoms (Earle 1987). In many ways, it appears to masquerade as a state. It is more organized than a complex chiefdom, as witnessed by its development of a capital, Busayra, with diversified monumental constructions, social stratification with elite and a dynastic ruler, several lines of evidence for administrative activities (Edomite inscriptions to kings, seals, weights, etc.—see Chapter 11, this volume), and a "possible" loose administrative system reflected by the various forts/watchtowers found dispersed throughout the region. However, Late Iron Age II Edom lacks the evidence that it integrated the region into a four-tier administrative system that could levy the taxes or tribute required to finance a state and its social institutions (cf. D'Altroy and Earle 1985; Earle 1987; Johnson and Earle 2000). In sum, Late Iron Age II Edom follows a social evolutionary trajectory not fully developed in the archaeological literature. As will be argued below, our Edom case study is not alone in being betwixt and between chiefdom and state.

A number of archaeologists working in different regions and time periods have confronted a similar dilemma in defining this kind of social evolutionary trajectory. They often disagree on whether to classify these cases as states, "downgrade" them to chiefdoms, or use qualifiers to name them something in between (see Marcus and Feinman 1998 for Mesoamerica; Yoffee 2005 for Mesopotamia; Savage 1997 for Egypt; Renfrew 1972 for Greece; Levy and van den Brink 2002; Levy 2009 for the southern Levant).

Joyce Marcus (1998, 2003, 2004) has presented a series of arguments suggesting that these complex polities are the devolved remnants of regional states. Marcus and Feinman's main case for these polities representing the dissolution of former states is based on their studies of the Zapotec and Maya in Mesoamerica:

> When those states break down, their former provinces become autonomous polities who for a time lack the power to incorporate their neighbors into a new state. What develops is a kind of standoff between roughly equal small polities. The rulers of those polities may continue to behave like kings (and be addressed as if they were kings), but the territories they control are no larger than a chiefdom and may have no more than two- or three-tiered settlement hierarchy [Marcus and Feinman's 1998:9].

The local rulers of these provinces, perhaps once subordinate lords, are now autonomous and seek to legitimate their power through the same methods practiced by the state. However, this explanation does not fully address the occurrence of these social institutions in the archaeological record. While it is true that most of these polities occur following the emergence of pristine states (Galaty et al. 2007:120; Marcus 2003; Marcus and Feinman 1998), they are not all a result of the breakdown of former pristine or secondary archaic states. For example, after a dark age of over two hundred years, sometime around 800 BCE, Greece underwent a social revival leading to the emergence of many Greek poleis (cf. Fine 1983; Hammond 1986; Snodgrass 1977, 1980). The Greek polis primarily consisted of a walled urbanized city with a monumental temple and a palace with an average of 5,000 male citizens (Fine 1983). The polis also reinstituted many of the innovations of the former Mycenaean kingdom, including writing and a range of craft specializations. Nevertheless, poleis were small, lacking the type of integration found at the scale of archaic states. The average polis size was from 80 km^2 to 1,300 km^2 (Fine 1983). The polis was connected with a few towns and

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villages but had little centralized economic control. Endemic warfare between neighboring poleis occurred but rarely led to prolonged subjection of other groups. Consequently, many opposing alliances were formed instead, such as the Peloponnesian League, Delian League, or later Achaean League (Hammond 1986; Snodgrass 1980). Thus, the formation of these types of complex societies arose much later after the breakdown of former regional states, was a product of specific catalysts of social development, and adapted formerly known socioeconomic institutions in new ways (cf. Snodgrass 1986 for a peer-polity interaction model).

Another example is the case of predynastic Egypt. A number of scholars have suggested a range of theories to explain and identify the different ways and degree of social complexity that arose in predynastic Egypt (cf. Levy and van den Brink 2002; Savage 2001:111–112). In contrast to many earlier studies, Savage (1997:259) has argued that the initial conquest of the Delta by Upper Egypt under the rule of Narmer was "tenuous at best, and there are ample reasons to suggest that it did not immediately result in the formation of the state." Savage's (1997:259–261) main argument for this interpretation is that even after Narmer's unification of the two regions, consolidation was a gradual process replete with instability, until the end of the second dynasty under Khasekhemwy. This argument suggests a period of around 300 years,[16] when Egypt was something "more than a chiefdom something less than a state."[17] Savage (1997:259) notes a similar gradual process in the formation of the iconological canon and state cosmologies of early Egypt. However, throughout this liminal period, there is clear evidence of the establishment of a kingly dynasty, deification and legitimization of the pharaoh, increasing complexity in writing, construction of monumental buildings, and elaboration of religious and secular bureaucracy. Moreover, the evidence of Egyptian trade diasporas in Canaan bespeak of social complexity beyond the chiefdom level even if these may represent competitive factions (cf. Kansa and Levy 2002:203; see also a similar discussion for Mesopotamian colonies in Algaze 2005). Although a product of pristine development, predynastic Egypt is similar to many of the other polities studied here in undergoing a prolonged period of state formation that should not be simply described as a complex chiefdom or archaic state. The social, political, and economic elements are novel developments in comparison to chiefdoms and under the appropriate analytical lens can enlighten our understanding of the social formation of different kinds of archaic states.

Finally, if these complex societies are to be studied as a category for comparative social complexity, the question arises, "What should they be called?" Early on, scholars such as Renfrew (1972:369) suggested the term *principalities*. Other possible names suggested in the past include petty kingdom, proto-kingdom, pseudo state, de facto chiefdom, princely state, stratified society, and balkanized province, to name a few.[18] The problem with these names is that they are highly value laden and sometimes pejorative. Marcus and Feinman (1998:9) have suggested calling them by the local indigenous name (e.g., *hesps*, *altepetl*, *cuchcabalob*, *caciacazgos*, etc.). The only problem with this strategy is that they then become highly specific, losing their value for typological comparison. The other problem is that in some cases, local names may not have existed or been used to describe these polities.[19]

Although not without its own problems, it is suggested here that the term *kingdom* be used when dealing with archaeology in the southern Levant and Near East. A kingdom can be defined as a politically organized community or major territorial unit having a monarchical form of government headed by a ruling king. The term *kingdom* implies that it is led by a *king*—who is functionally different from a paramount chief. It also correlates well with a level of political organization involving the jurisdiction over a definite region. In addition, kingdoms also can connote a palace, government, military, monumental construction, and stratification, but the extent of political hegemony and size is left vague. Hence, many anthropologists, sociologists, and archaeologists have gravitated towards the term *state* or *empire* to describe social organization of exceptional size and complexity. One could argue that the term *kingdom* has also been used to describe state- or chiefdom-level societies, but if we disqualified a term for its abuses and misuses, almost no term used in scholarly literature would suffice. Finally, specifically for the region of the Middle East, it is a literal translation of an extensively used term in textual documents by both local populations and empires to describe these *types* of polities. This term is also immediately understood by scholars working in other areas in contrast to other indigenous names like *cuchcabalob*. There will perhaps never be an agreement on what term should be used in scholarly literature, but for the sake of further discussion and analysis in the Iron Age southern

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Levant, we suggest the term *kingdom* be used in the strictly defined meaning discussed above.

In conclusion, we argue that Late Iron Age II Edom's social complexity should be understood as a product of an alternative social evolutionary trajectory to the typical models presented in archaeology. Specifically, for the Late Iron Age southern Levantine archaeology, we suggest the term *kingdom* be used as an analytical descriptor for examining Edom and other similar polities that developed in response to neighboring secondary states and more distant regional empires. As shown in Chapter 1 (this volume), the predecessor of the Late Iron Age II kingdom on the plateau of Edom was in the copper-rich Faynan region with its network of copper production sites and mining areas in the Early Iron Age II. The archaeological evidence from new surveys and excavations conducted on the plateau of Edom presented in this chapter provides an objective means to gauge the social complexity of this southern Levantine region. Through more archaeological fieldwork in the highlands of Edom and the development of testable anthropological archaeological models, it will be possible to investigate related questions concerning the actual mechanisms that drove Late Iron Age II Edom onto this social evolutionary trajectory.

Notes

1 We are grateful to Piotr Bienkowski for his encouragement to carry out new soundings at Tawilan.

2 A more detailed discussion of the geological setting and soil morphology will be discussed in Chapter 5 (this volume) as these environmental variables contribute directly to understanding the petrographic study presented in that chapter.

3 Today, a modern Jordanian subdistrict administrative organization designates the Faynan region as part of the governorate referred to as Aqaba.

4 The transition area between these ecological systems (e.g., ecotones [Odum 1971:278]) is not fully discussed in the ecological literature for Jordan.

5 If small towns existed, one would expect to find them in the surveys since all of these surveys were able to locate many of the smaller less visible sites. Therefore, the lack of small towns in this region is not a result of missing or poor data.

6 A purposive reconnaissance survey is a survey that relocates sites that have been identified during previous surveys or are known to exist by local inhabitants and resurveys them to determine specific dating of the sites.

7 Soundings are small-scale excavations also referred to in this text as probes. The UCSD ELRAP-L2HE project is grateful to Prof. Piotr Bienkowski for his support and encouragement to sample Tawilan.

8 In 2010, a large-scale excavation of Khirbat al-Iraq was conducted, which is currently being prepared for future publication.

9 G. Findlater kindly provided his appendices of the sites that were surveyed along with their coordinates. C. Whiting's determination of the site periods in this report was also invaluable, and we thank her and G. Findlater for kindly providing us their survey results.

10 See Chapter 6 (this volume) for an in-depth study of roads leading from the lowland copper ore zone of Faynan to the Iron Age capital of Busayra.

11 Funding from an NSF Doctoral Dissertation Improvement Grant (Grant No. 0631220) enabled this project to acquire all the excavation data for the project as well as hire the Bedouin excavation guards and workers. Since these soundings were conducted during an off-season, only sporadic American volunteers living in Jordan participated on the dig. The majority of the excavations were conducted by the author, the department of antiquities representative, and elite trained Bedouin workers. We would like to especially thank Tahani al-Salhi and Haroun al-Amarat from the Department of Antiquities who participated as department representatives, assistant supervisors, and GIS specialists.

12 The figures presented in this chapter were constructed by K. Bobczynski Smith in Adobe PageMaker; we are grateful for all her hard work.

13 Since all of the excavation data were recorded with the abbreviation KIJ, this abbreviation was retained for this study.

14 Upon revisiting the site several weeks after the completion of the excavation, this site was found to be looted, and damage was done to the balks.

15 This conclusion is supported by the recent L2HE soundings on the site. The ceramic assemblage, studied by Hart, was considered homogeneous during all phases, which should be expected. Due to the lack of any sites with Late IA II stratigraphy associated with pottery, it is not possible to determine the duration the site was occupied or at what point within a late eighth- to sixth-century BCE date the site was first constructed.

16 See de Miroschedji (2002) for a detailed chronology of this period.

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17 This quote was used by Renfrew (1972:369) to describe the Mycenaean kingdoms, which did not fit into simple categories of chiefdom or state.

18 *City-state*, the English translation of *polis*, has also been extensively used for these polities, but see footnote 7.

19 This is the case for the southern Levant.

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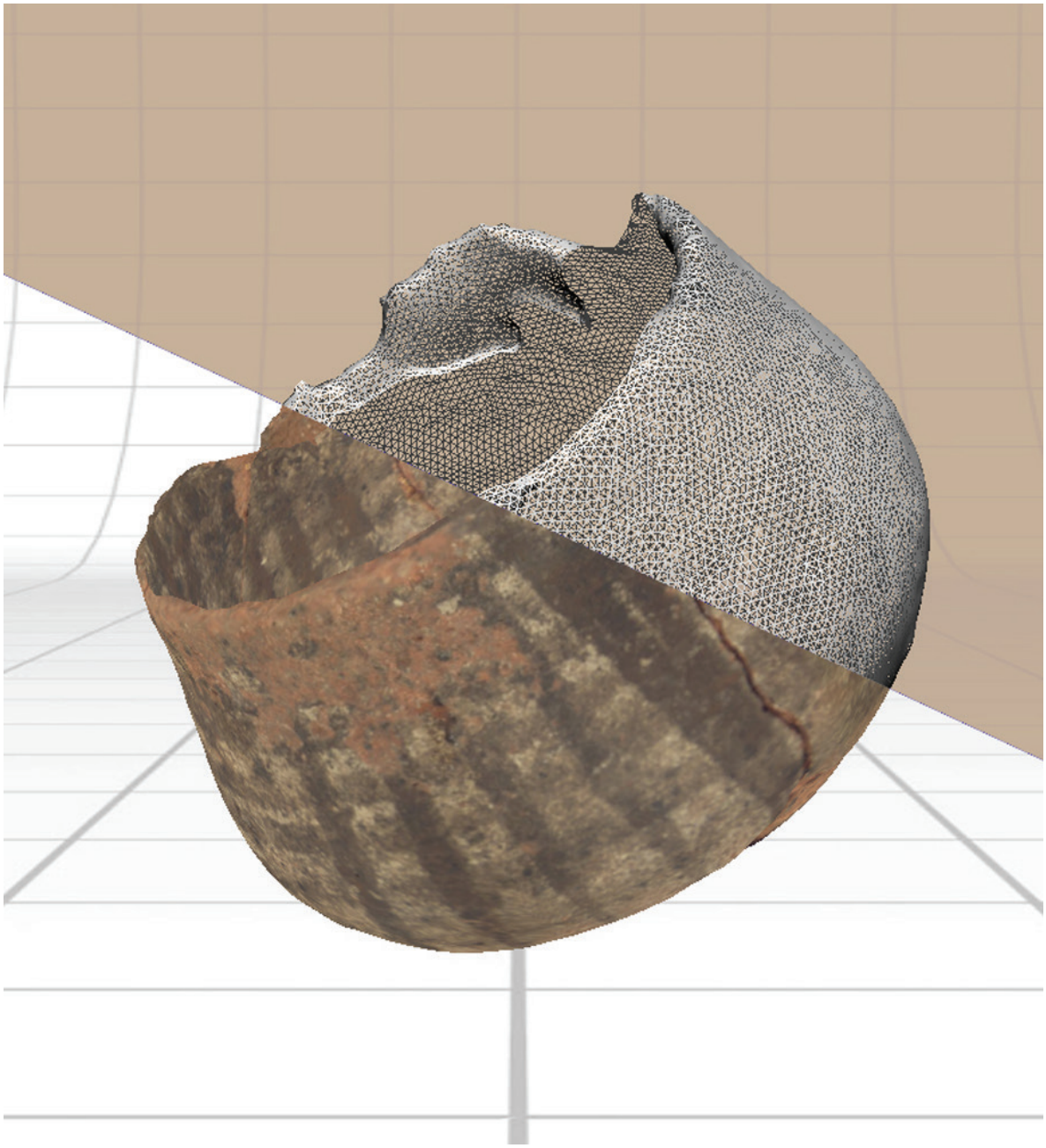

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4 Iron Age Ceramics from Edom
A New Typology

Neil G. Smith and Thomas E. Levy

As one of the most ubiquitous artifacts found in the archaeological record, ceramics play a critical role in addressing dating problems and questions concerning trade, exchange, and social identity. In southern Jordan, prior to the University of California at San Diego (UCSD) Edom Lowlands Regional Archaeology Project (ELRAP) and Lowlands to Highlands (L2HE) projects, Iron Age excavations focused mostly in the highlands of the Edomite plateau, far away from the Faynan copper ore resource zone. The inability to distinguish stratigraphic variation at the highland sites, the decision to not use radiocarbon dating methods, and assumptions about the historicity of the Hebrew Bible based on the assumption that it was codified very late, in the fifth and fourth centuries BCE, led archaeologists to assume that the Iron Age in Edom only began as early as the sixth century BCE. Consequently, researchers assumed that the early history reflected in the Old Testament concerning the earliest Hebrew Kings (David, Solomon) and their neighbors—the Edomites—was pure myth. For the tenth century BCE, it was assumed that no local Levantine complex (kingdom/state level) societies existed. When we began our Iron Age research in Edom, we also subscribed to this theory. However, deep stratigraphic excavations in the Faynan region and in the highlands, coupled with a rigorous application of high-precision radiocarbon dating (see Chapters 2, 3, 10, and 12, this volume), push the Iron Age chronology of Edom back to the twelfth century BCE as is typical of Cisjordan. The ceramic assemblages, described here, play a key role in establishing the new chronology and study of the local ethnic groups (Edomites, Shasu) known to have resided in this region during the Late Bronze and Iron Age from ancient Egyptian texts (cf. Harris and Anastasi papyri) and the Hebrew Bible.

This chapter presents a new typology and quantitative analysis of Iron Age ceramics for the region of Edom in southern Jordan. The research is based on seven excavations carried out by the UCSD ELRAP and L2HE project. The sites include Khirbat en-Nahas, Khirbat al-Jariya, and Rujm Hamra Ifdan in the lowland region of Edom and Khirbat al-Malayqtah, Khirbat al-Kur, Khirbat al-Iraq Shmaliya, and Tawilan in the highlands. This study is the first systematic comparison of the

Opposite: Detail three-dimensional scan of a tenth-century BCE Midianite ceramic vessel found in a monumental building in Area R, Khirbat en-Nahas, Jordan.

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ceramics of Iron Age II (ca. 1000–500 BCE) in Edom based on stratigraphic excavations and radiocarbon dating chronologies (see Chapters 2, 3, and 10, this volume). The ceramic typology developed in this chapter classifies types based on the discovery of similar morphological and petrographic attributes (see Chapter 3, this volume). Among other conclusions, the intersite quantitative and spatial analyses demonstrate the stylistic origin of the Iron Age ceramics found in the highlands to be rooted in the Faynan copper ore district of the Edom lowlands at sites such as Khirbat en-Nahas and Khirbat al-Jariya. These results show the long-term local evolution of Iron Age ceramics in Edom that begins in the lowlands as early as the late thirteenth to twelfth centuries BCE and culminates with widespread ceramic distributions at eighth- to sixth-century BCE sites in the highland zone.

Introduction

The region of ancient Edom in southern Jordan and its Iron Age (ca. 1200–500 BCE) archaeology presents a rich field of study to investigate anthropological models of social change and ethnic identity. In terms of historical archaeology, Edom was one of ancient Israel's most important contemporaries, thus making it a rich source of comparative data for understanding the dynamics of social interaction during the Iron Age between the various polities within the southern Levant. The excavations conducted from 2002 through 2010 in the highlands (Lowlands to Highlands [L2HE] project) and the ongoing excavations in the lowlands (Edom Lowlands Regional Archaeology Project [ELRAP] project) provide new data concerning the social, cultural, and chronological nature of Edom that has been a relatively unexplored region in the southern Levant. As the new fieldwork is rooted in stratigraphic excavations coupled with radiometric dating, the ceramic data from our excavations provide the first objective regional Iron Age framework for establishing a relative ceramic chronology for Edom.

In this chapter, a regional ceramic typology is presented along with a comparative study of the ceramic assemblages from different regions of ancient Edom.[1]

The ceramic typology is based on ceramic data recently collected from stratigraphic excavations conducted by the University of California at San Diego (UCSD) ELRAP and L2HE projects in the lowlands (Khirbat en-Nahas [KEN] and Rujm Hamra Ifdan [RHI]) and highlands (Khirbat al-Malayqtah, Khirbat al-Kur, Khirbat al-Iraq Shmaliya, and Tawilan) of Edom in southern Jordan. The first two sections detail the methodology underlying the ceramic analysis. Then, the theory underpinning the ceramic analysis is described. It will be argued that the combination of a morphological approach coupled with ware analysis is the best method to elucidate ceramic types in the region of the Iron Age southern Levant.

The third section presents the ceramic typology, including descriptions of all vessel types and their attributes, ceramic imports, patterns of surface treatment, and the handmade wares. The last two sections present a series of comparative analyses of the ceramic typology for both regions. It is the goal of these last sections to elucidate chronological relationships between the lowland and highland sites as well as inferences pertaining to complex societies and social/ethnic boundaries for the Iron Age of southern Jordan.

The Organization of the Iron Age Ceramic Analysis for Edom

Introduction

It is important to briefly describe the digitally based collection method used at Khirbat en-Nahas and the several soundings (RHI and L2HE sites) discussed below as this ensured the acquisition of secure stratified ceramic samples. The system has been previously discussed in detail (Levy and Smith 2007; Levy et al. 2010; Smith and Levy 2008). Here only the most recent advancements in computer registration and three-dimensional (3D) scanning are briefly discussed (for a more extensive discussion, see Smith et al. 2012).

Computer Registration

In 2002, a ceramic database was created in Microsoft Access to register every diagnostic vessel sherd with its specific form, color, and fabric details. The database used drop-down menus to collect specific information on rim form, surface treatment, fabric color, sorting,

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roundedness, and inclusions. This system was streamlined over the seasons to focus only on descriptions of vessel family and surface treatment during in-field registration. For this current project, a new registration system was developed that incorporates a server-based structure, html-based input, and barcode scanning, which we call the MasterTable (Smith et al. 2012). The MasterTable is a dynamic table designed to enable high-level users to access all their uploaded data and be able to quickly sort them and make corrections and additions. It directly accesses all the public accessible databases stored on the server and joins them, including personal databases uploaded by a project that may include a detailed ceramic analysis and registration or any other type of table related to the project (e.g., lithics, metallurgy). Since the data are centralized in one place, changes can be made by multiple users from different locations. Any change made immediately alters the database and is saved, but users have the option to undo changes if they make a mistake. All of these features enabled this project to rapidly produce appropriate tables associated with the published figures presented below. This database formed the basis of the initial analyses of Iron Age ceramics from ELRAP (Smith 2009).

Scanning

As in previous seasons, a sample of diagnostic vessel sherds for the ELRAP (KEN 2006 and RHI 2004) project was illustrated by Caroline Hebron. However, to supplement the time-consuming work of hand drawing, approximately half the sherd drawings presented in this chapter were produced from 3D scans using a NextEngine 3D scanner. The 3D scanning of ceramic vessels from both the ELRAP and L2HE projects was initiated in the summer of 2008 in collaboration with A. Shalom and U. Smilansky from the Weizmann Institute and T. E. Levy under the auspices of the California Institute of Telecommunications and Information Technology (Calit2) Center of Interdisciplinary Science for Art, Architecture and Archaeology (CISA3). The goal of the scanning was to try to reduce the expense, time, and subjectivity involved in traditional hand illustration of the sherds (Smith et al. 2012).[2] By scanning in 3D, a highly detailed micron precision model of the ceramic sherd could be recorded that can be used for analysis and digital illustration. A 3-megapixel texture was taken at every angle so that the fabric color associated with the model could be readily visualized.[3] The rotary stage for the scanner was modified to enable scanning of multiple objects (ceramic sherds) at the same time. We found that with this setup, 10 sherds could be scanned and processed in approximately one hour using one scanner. Halfway through this project, a second scanner was donated to the CISA3 Cyber-Archaeology laboratory at UCSD based on our collaboration with NextEngine. This has enabled us to increase the number of sherds scanned to around 20 per hour.[4] Not all pottery types identified during the analysis were illustrated, so some do not have figures. This is mainly the case with types that were low in count or not broken into their own type until long after most sherds were illustrated in the field by hand.

After the digital scan models were cleaned and processed, they were exported into various formats for visualization and publication. The end goal for every scanned diagnostic sherd was importation into MATLAB, the high-level language and interactive environment that enables researchers to perform computationally intensive tasks. Once inside MATLAB, the proper stance of the vessel, its rim diameter, and vessel profile were extracted. This digital profile was then used to automatically draw a digital illustration of the scanned sherd. In this manner, the 3D scanning of sherds has enabled us to double the amount of sherds illustrated in this chapter's figure section. All the L2HE diagnostic sherds and a large portion of those from RHI and KEN are illustrated using the 3D scanning procedure. Most plates presented in this chapter contain these digital sherds, and the plates themselves have been automatically produced using a daughter program, called the PlateMaker (Smith et al. 2012).

Toward an Objective Analytical Ceramic Study of Iron Age Edom: Typology Construction and Parallel Studies

History of Ceramic Typologies in Edom: Problems and Different Approaches

A series of problems associated with past ceramic typologies of Iron Age Edom have necessitated the construction of a new ceramic typology for the region based on stratigraphic excavations and high-precision radiocarbon dating. The first detailed investigation of the southern Jordanian Iron Age pottery assemblages was undertaken by M. Oakeshott (1978), who prepared the first detailed typology of the "Edomite" pottery. To develop a typological series, Oakeshott relied primarily on the ceramic assemblage from Busayra, a site excavated by C. Bennett (1974, 1975, 1977, 1983)

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that, at the time, represented the largest and most extensive collection of Iron Age "Edomite" ceramics. The only other two excavated sites in the region of Edom that were included in this typology were Tawilan (Bennett 1984; Bennett and Bienkowski 1995) and Umm al-Biyara (Bennett 1966)—also excavated by Bennett. Oakeshott's typology was constructed based on the most popular forms found at the site and used an alphanumeric numbering system to delineate the different types. It was standard practice during Bennett's excavations to discard ceramic types that did not fit into the typology that was determined in the field, similar to what was done by Kathleen Kenyon in Cisjordan (cf. Bienkowski 2002; Tappy 1992). Oakeshott's typology did not take into consideration sherds that did not fit into common types. The typology also generalized a number of significant morphological differences within the Iron Age ceramic assemblage that the research presented here has found to be especially problematic. Ware analysis and quantitative determination of clustered types was not extensively handled, which would have helped in constructing a more accurate typology. Equally problematic was the lack of stratigraphic contexts or strong control of the loci at the various sites studied (cf. Bienkowski 2002) that prevented Oakeshott from being able to develop a chronological sequence for the Iron Age pottery of Edom based on stratigraphy. Therefore, the chronological distinctions made by Oakeshott were based solely on typological comparisons with sites outside of Edom in both Transjordan and Cisjordan; a number of these were presumed to be imports from Assyria. Another problem was that Busayra and the other sites used in the typology were treated as contemporaneous, roughly single-period sites and dated to the Late Iron Age IIC period. Thus, the possibility of Iron Age ceramics in Edom extending earlier in time into the Iron Age IIB, IIA, and I periods was not factored into Oakeshott's work. All of these factors are reasons why a new typology needs to be developed, if ceramics are to be used for answering questions in anthropological archaeology as well as historical biblical archaeology. These issues are not taken into account in recent critiques of our Iron Age ceramic research in Edom (e.g., Finkelstein Singer-Avitz 2008, 2009), making these observations of little value.

Until our research, Oakeshott's (1978) typology and classification scheme was the interpretive framework for the comparison and dating of all excavations and surveys in Edom and, thus, in many ways led to distorted chronological assumptions about the dating of the Iron Age in this region. For example, the subsequent ceramic publications by S. Hart and P. Bienkowski followed Oakeshott's typology without significant modification. Hart (1989a) adopted Oakeshott's typological system for several surveyed sites and an excavation conducted at Ghrareh. The only modification to Oakeshott's typology was the combining of Types K (the imitation Assyrian bowls) and M (deep bowl with straight flaring neck) together (cf. Hart 1989a). Although many diagnostic sherds published in this work did not fit Oakeshott's typology, there was no attempt to create new type-names to describe them. In a later study, Hart (1995b) tried to connect Oakeshott's typology with the stratigraphy of Area A at Busayra, but the lack of quantitative data concerning the ceramic assemblage inhibited the extraction of any conclusive chronological information in the study (cf. Bienkowski 2002). Despite this problem, Hart attempted to redate Busayra, Tawilan, Ghrareh, and Umm al-Biyara and a number of his surveyed sites according to this method (cf. Hart 1987a, 1987b, 1989a, 1989b, 1995a, 1995b), essentially lowering the dates to the sixth to fifth centuries BCE. In the final publication of Bennett's excavations at Busayra, a ceramic typology was rewritten by P. Bienkowski (2002). Although the descriptions, formatting, and parallel study were updated, it still followed Oakeshott's typology closely, only deviating where the typology was too specific. Bienkowski rejected a number of Hart's assumptions concerning the chronology of the ceramics and with new information on "Edomite"-style vessels coming from late eighth-century BCE stratigraphic sequences in Tel Arad and Beersheba (e.g., Singer-Avitz 1999, 2002). Consequently, Bienkowski dated Busayra's ceramic assemblage to the Late Iron Age II starting in the late eighth century BCE. Thus, until our study, Oakeshott's typology with its many shortcomings has remained the primary source for understanding Edom's Iron Age ceramic assemblage. A number of the variances between sites and many vessel types not fully distinguished in Oakeshott's typology have remained under the radar of archaeologists working in the region. Thus, below we develop a more comprehensive Iron Age ceramic typology of the region of Edom that accounts for a number of these variances and presents statistically significant types often overlooked.

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Two additional preliminary typologies have been published for the region of Edom by G. Pratico (1993) and J. Zeitler (1992). Although these typologies attempt to address other Iron Age vessel forms, they are not comprehensive enough to account for the chronological and stylistic factors that have been identified and developed in the ELRAP research. First, Pratico's (1993) reexamination of the ceramics from Tell el-Kheleifeh near the Gulf of Aqaba presented a series of organized ceramic plates but without any explanation of the typological system used or a quantitative measure of how many sherds within the ceramic assemblage constituted each figure (ceramic type) presented in the plates. There is thus no documentation concerning the quantities of these vessel forms and no significant attempt at noting parallels to enable other ceramicists to make informed judgments on how representative these types are for Tell el-Kheleifeh—a key Iron Age fortified site near the southern boundary of Edom. Many of the figures parallel those found at other sites, but it cannot be determined whether other significant forms (not paralleled in Oakeshott's typology) were also significant types at the site. Moreover, the published figures represent a mixture of various stratigraphic phases within the site, preventing any interpretation relating the typology to chronological factors. Thus, although Practico's publication of the ceramics from the site typology has detailed descriptions of each published sherd, there is no typological system that enhances our understanding of the site's relation to the region of Edom as a whole. This critique is not meant to diminish the importance of Practico's work, which admirably published the long-awaited results from Nelson Glueck's 1930s excavation, but rather to help move Iron Age ceramic research forward in the 21st century.

Second, based on several surveys and small soundings conducted in the Petra, J. Zeitler (1992:172) developed a preliminary typology. Zeitler's study could not be comprehensive since it depended on a surface survey and two shallow soundings with only small quantities of pottery to define its types rather than material from well-stratified excavations such as those from ELRAP. Nevertheless, Zeitler's typological distinctions are significant especially since they highlight certain forms not identified in Oakeshott's typology. However, the primary limitation of Zeitler's study is that it is a preliminary typology that does not discuss variations within the types, fabric wares, and parallel studies outside the region or describe in detail the ware or quantitative numbers of these different forms. Since there is no significant stratigraphy reported from the limited soundings or radiocarbon dating for Linder's work, the typology is still dependent on Bennett's more extensive excavations to draw conclusions about chronology. It is hoped that in the future, either Zietler or one his colleagues will present a more comprehensive discussion of the Iron Age ceramic types found at these sites.

Due to problems with Oakeshott's (1978) typology and the lack of any other comprehensive typologies for the ceramic assemblages of Edom, this chapter focuses on developing a new Iron Age ceramic typology based on the extensive stratified excavations at KEN (first initiated in Smith 2009; Smith and Levy 2008) and several well-excavated radiocarbon dated sites from the lowlands and highlands of Edom by the UCSD ELRAP and L2HE projects. Since the ceramic assemblages from these sites are stored at the UCSD Levantine Ceramic Laboratory, a detailed quantitative analysis of these various site assemblages and their relations could be conducted. As discussed above, the same techniques for recording and processing were carried out at each site so that a high degree of statistical comparison could be attained. Not only has a similar morphological analysis been performed for all these sites but also comparable analyses of fabric, decoration, and petrography (see also Chapter 3, this volume). Overall, the unique circumstances of the UCSD ELRAP and L2HE projects enable the study presented in this chapter to present the first cross-regional, diachronic typology with the same level of precision often conducted for only a single site.

A New Ceramic Typology for Iron Age Edom: Theoretical Considerations and Methods

Ware vs. Form Typologies

There are a number of approaches to constructing a ceramic typology of a region. Most ceramic typologies tend to emphasize ware or morphology (cf. Adams and Adams 1991; Gifford 1976; Rice 1987). In the region of the southern Levant, morphologically based Iron Age ceramic typologies have predominated, and parallel studies have been made between different sites by their classifications (e.g., Amiran 1969; Dornemann 1983; Gitin 1990; Mazar et al. 2001; Zimhoni 1997). More recently, especially with the increasing use of petrographic, instrumental neutron activation analysis (INAA), and X-ray fluorescence (XRF) studies,

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archaeologists in the southern Levant have taken into consideration ware in their typological constructions (cf. Mazar et al. 2001; Panitz-Cohen and Mazar 2009; Singer-Avitz 1999). In this study, a form-based morphological study predominates, but ware plays a major role in refining the typology and enabling more minute distinctions between sites that appear morphologically to share similar ceramic styles. Thus, an excursus on the methodology and theory behind this ceramic typology is discussed below.

A ceramic typology is defined here as the classification of ceramics into groups (*types*) based on various *attributes* that are observed to cluster together. An *attribute* is a single distinct variable or principal component of a ceramic vessel.[5] For this study, which involves an investigation of technological style that reflects culturally specific variables, an attribute is defined as a single variable of technological style belonging to any choice made within a chain of operations involved in the construction of the vessel (i.e., the *chaînes opératoires*).[6] Some examples of an attribute (technological style) include the type and density of inclusions, petrography, construction method, fabric color, hardness, body shape or size, thickness, form of carination, rim treatment or stance, surface treatment, paint design, functional use, and so on. An *attribute state* represents any possible value or values that describe the nature of that technological style (e.g., "denticulated," "15 cm," "sharp carination," "slag tempered"). Since this study also involves stratigraphy and cross-comparison between Iron Age sites, attributes such as stratigraphic provenience, relation to absolute dating, and intersite/intrasite spatial location are also considered attributes that impinge on typological interpretation.

We also use the concept of *subattributes*, which represent a series of measurable components that define the nature of certain complex attributes (e.g., an attribute such as a rim fold has a specifically associated tangent, length, thickness, precision of completion, and uniformity). Subattributes are quantitative or qualitative measurements of variance that, at the highest degree of precision (e.g., on the micron level, as obtained through 3D scanning), can function as a fingerprint to enable a distinction from one vessel to the next (e.g., the tangent of two nearly identical vessel rims may vary within 0.001 degrees). It is argued here that the clustering of various subattribute of a vessel (e.g., rim fold, vessel body shape, and surface treatment) represents a specific technological style. Every vessel possesses subattributes, but for a potter to repeat consistently these same stylistic patterns over and over requires practice. It is the repeated occurrence of these in several vessels that allows us to distinguish a learned motor habit (i.e., it is habitual) associated with technological style. The measurement of subattributes also enables a more fine-grained approach for investigating craft specialization, since highly standardized subattributes will be very consistent in their measurement and thus most likely indicators of the vessel being produced in the same place and at a mass scale (cf. Arnold and Nieves 1992; Feinman 1991:244–245; Nicholson and Patterson 1992; Renfrew 1977).

A *type* is, thus, a recognizably distinct combination or clustering of *attributes*/technological styles (Gifford 1976:9). Types should not be considered hard-and-fast rules but rather strong associations of attributes and subattributes that possess a limited range of variety and, as a whole, a readily apparent difference between other types. With every season of excavation or survey, the varieties within a type may be expanded to account for ceramics that share the majority of distinctive attribute states but may have distinguishable subattributes or slight deviations in a few of the already established attribute states. Thus, a type should be seen as always in flux and constantly undergoing refinement as its definition becomes more comprehensive (cf. Gifford 1976:9; Spaulding 1960:76).

The ceramic typology constructed here makes no attempt to reconstruct folk classifications (Rice 1987:284) but rather represents a critical, analytically devised classification of ceramic types. Thus, the typological approach presented here takes an *etic* rather than *emic* approach to classification. Types are distinguished based on the attributes and subattributes mentioned above, analytically observed patterns seen among these attributes, and discontinuities between one type and another. Certain attributes take greater precedence or rank over others in the overall classification and distinctions made between the various ceramic types and subtypes. However, a conscious effort is made to inductively discover what attributes are most relevant through an analysis of the ceramic data as a whole. In this manner, the artificially inductive classification made in this chapter may or may not overlap with the original community's folk classifications (cf. Rice 1987:284). Although this study has begun to apply mathematical approximations of vessel morphology and objectively based cluster analyses, at

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the current stage of writing, they have not been applied systematically across the entire collection of ELRAP and L2HE ceramic assemblages. Thus, the construction of the ceramic typology presented here follows many other southern Levantine Iron Age typologies in making informed but subjective analytical inferences of which some attributes have greater weight than others and how or when to split or lump types and subtypes. Other ceramic specialists working within the southern Levant may disagree with either the generalization ("lumping") or specificity ("splitting") of the classifications made below. The positivist approach developed here for the delineation of types should not be mistakenly viewed as the canonical typology of Edomite ceramics as was done in the past with Oakeshott's work and others working in other parts of the world (cf. Adams and Adams 1991:4–5; Chilton 1999:44; Spaulding 1953). The ceramic typology presented in this chapter modifies an earlier publication (e.g., Smith and Levy 2008) in light of new evidence. It is expected that with more extensive excavations at stratified sites in the lowlands and highlands of Edom and insights from future mathematically based analyses, this typology will be amended accordingly. Therefore, a detailed explanation is presented below for every type and subtype to present the reasoning and hypotheses behind each classification and provide grounds for further scholarly discussion.

Perhaps the reason the southern Levant Iron Age ceramic typologies do not emphasize fabric (e.g., Amiran 1969; Bienkowski 2002; Gitin 1990; Zimhoni 1997) is because it is not always possible to easily classify attributes of composition and surface treatment between or within sites. In the Iron Age southern Levant, surface treatments (paint, slip, burnish) or lack thereof and technology (firing technology, wheel-made pottery) are fairly uniform or unelaborated (simple black painted strokes or plain red slip) within and between sites. Surface treatment does not appear to have been as diversified in contrast to Mesoamerica and other New World locations. Similarly, the composition of Iron Age sherds (inclusions, texture, hardness, color) is highly variable within each and every site and thus does not always function as the best tool for distinguishing types across the region. For example, as seen in the petrographic study (Chapter 3, this volume) of Khirbat en-Nahas, most ceramics were created from a single clay source and most likely produced on site; however, there is still a plethora of variation in paste color, sorting, texture, and inclusion size (e.g., see also Mazar et al. 2001). Thus, this diversity in composition is more a product of potting techniques than different ware types exchanged across a region.[7] Taking these factors into consideration, a fabric analysis is not always applicable for the Iron Age southern Levant.

The morphological type system that is commonly used in the southern Levant primarily classifies ceramic assemblages according to attributes of form. A number of techniques have been developed to classify sherds by morphology, such as proportion ratios, vessel contour, geometry, or volume (cf. Rice 1987:215–222). In the southern Levant, morphological type systems classify according to a ranked system of attributes. They start by classifying sherds according to general vessel families (e.g., bowl, jar, jug) generally using proportional ratios of height to diameter and orifice to midsection diameter (cf. Shepard 1965). Vessels that do not fit into these general proportional ratios and have distinctively different sizes, thickness, or morphological features are assigned their own predetermined families (e.g., kraters, pithoi, vats, flasks, pyxides, cups, cooking pots). The determination of these categories can differ between ceramicists who may use slightly different proportions and criteria than others to make the distinction between, for example, a bowl and cup, krater and large bowl, jar and pithos, or jar and cooking pot. Even the delineation between jars and jugs fluctuates, especially in situations where a handle is not present on a fairly closed vessel. Complete vessels are thus generally desired since they can be classified more easily into these families rather than rim sherds.

Once these vessel family classifications are made, types are distinguished by varying attributes of a vessel's anatomy. The body of the vessel (the area between the orifice and base) generally takes first rank in the next stage of classification over rim treatment or other attributes. A number of attribute states and combination of linked attributes are used to classify vessel bodies. These may be geometric attributes (e.g., rounded, flaring, cylindrical, and ovoid) and/or structural attributes (various forms of carination, distance between inflection points, presence/absence of a shoulder or neck). Although in general circumstances, rim treatment follows the classification of the body, in certain cases, it may also be a defining attribute in which various body attributes are linked (e.g., repeated patterns of unique rims treatments on varying body forms). The

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term *rim treatment*, as used in this chapter, refers to all the attributes of the upper portion of a vessel that follows the end of its body or neck. Attributes of rim treatment can be combined to include rim stance, thickening, subsequent folds, grooves, ridges, diameter, attachments, specific treatment of the lip, and so on. Subtypes are generally delineated by specific attributes of rim treatment, certain vessel body variations, or lower ranked attributes (e.g., types of base shapes, handle forms, applied decoration, and surface treatment). The importance at which different attributes take in creating type and subtypes extremely varies between one specialist to another. In this chapter, the typology primarily follows this morphological method of determining types but also seeks to delineate key indicators of technological style.

Methods of Determining Types from Morphological Form and Other Technological Styles for Iron Age Edom

The approach taken in this typology is to primarily classify according to morphological attributes but also seek to integrate ware analysis and petrographic data (thin sections) wherever these attributes reflect a pattern of occurrence. These second-order attributes are analyzed for every vessel but tend to refine the typology into subtypes rather than generate new distinguishable types. The emphasis on morphology placed in this typology is related to one of the inherent research problems of this thesis—specifically, the identification of technological styles that reflect circumscribed social boundaries. A survey of various ethnoarchaeological studies demonstrates that morphological attributes, which often are directly linked with motor habits (technological styles), do not regularly cross social boundaries (see Chapter 3, this volume). In this section, the method for isolating these specific types of technological styles and differentiating them from other styles will be delineated.

Taxonomy Method for Labeling and Discussing Types

The typology presented here uses the alphanumeric system widely used in the southern Levant for ceramic studies (cf. Mazar et al. 2001:11; Zimhoni 1997). This system, in contrast to the type-variety naming system, is more geared toward typologies based on morphology rather than ware. Thus, rather than use of locale and descriptive names of each type, our typology uses an abbreviation of the vessel family (i.e., morphology) and a successive numbering to differentiate types (e.g., BL5b = bowl type 5, subtype "a"). The advantage to this system in the southern Levant is that the typology does not become embroiled in external arguments over the connotation of the use of a morphological term (e.g., collared rim pithos) or the semantics of what morphological forms belong to this name or do not. This naming system is often site specific; therefore, one site's BL5 will not necessarily be the same type as another's BL5. However, comparison between sites can be simply drawn by referring to another site's naming system (e.g., BL5 at KEN parallels B13 at Tel Batash). Since the typology presented in this chapter is developed using multiple sites, diachronic differences in similar morphological forms are distinguished by subtype classifications (e.g., BL3a and BL3b, below).

For each designated type, a description has been written that describes the distinctive attributes of its morphology, ware (fabric, surface treatment), and frequency across the sites. Also, each description is followed by a parallel study where possible. Parallels are presented for the vessel types from excavated assemblages in Transjordan Edom, such as Tawilan, Busayra, Ghrareh, Umm al-Biyara, Tell el-Kheleifeh, and, where possible, sites from the Negev, northern Transjordan, and southern Israel.[8] Comparison of the ceramic assemblages, which is primarily made up of broken rim sherds, to other sites is difficult because one cannot be certain when comparing to complete forms; however, attempts were made here where possible. At a higher level of classification, types are contained under vessel group descriptions that generalize common morphological attributes among several types (e.g., shallow rounded bowls). Detailed descriptions for handmade ware and imports are presented in their own sections.

The figures are separated by site and area. For KEN, each figure is arranged according to the stratigraphic sequence and vessel type from earliest strata to later (see the stratigraphy discussion above respective strata). This approach was chosen to compare and contrast temporal distinctions between the specific vessel types, which, until now, could not be done because of the lack of clearly defined stratigraphic phases at other Iron Age "Edomite" sites in Jordan. For the L2HE plateau soundings (KAM, KIS, KIJ, TW) and single lowland sounding (RHI), the figures will be organized only by vessel type, since they were all shallow single-period sites (with the exception of Area J at Tawilan, which did show phase changes).

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Ceramic Typology by Period and Stratigraphic Level

Introduction

The ceramic typology and analyses discussed below are based on all ELRAP and L2HE diagnostic vessel sherds retrieved with an assignable vessel family (see table in Figure 4.39) from the 2002, 2006, and 2009 excavations at Khirbat en-Nahas (KEN 2002–2006, *N* = 2106; KEN 2009, *N* = 413), the lowland soundings at Rujm Hamra Ifdan (RHI Sounding A, *N* = 96; RHI Sounding B, *N* = 745), and the highland soundings at Khirbat al-Malayqtah (KAM; *N* = 348), Khirbat al-Kur (KIJ; *N* = 124), Khirbat al-Iraq Shmaliya (KIS; *N* = 114), and Tawilan (TW; *N* = 709). Thus, the ceramic data assembled for this chapter represent the first comprehensive typology and quantitative analysis for both the lowland and highland zones of the Iron Age II period in Edom. The total number of identifiable rim sherds (*n* = 4,757) does not include decorated body sherds (with the exception of imports) or miscellaneous ceramic objects (e.g., tokens, lids, spouts, handles). Unlike many of the "classic" Iron Age sites in Cisjordan, sites in Transjordan Edom have generally been poor in the preservation of complete vessels, and the new ELRAP and L2HE excavations are no exception to this (cf. Hart 1989a; Oakeshott 1978).[9] Therefore, the morphological determinations of vessel types presented in this study rely heavily on pottery rim form and assumed curvature of vessel bodies. Accordingly, vessel types distinguished in other studies (Hart 1989a; Oakeshott 1978) by vessel base sherds were not attempted in this study. The typology study was conducted from 2006 to 2009 in the field and at the UCSD Levantine Archaeology Laboratory, where all the ceramic assemblages are stored. The ability to study all of the ceramic assemblages from these different sites in one laboratory greatly facilitated the integration of the different ceramic assemblages into the comprehensive diachronic Iron Age II typology presented here.

Section 4.6 below presents a systematic description of every predominant vessel type identified at each site. The morphologically unique vessel types with low occurrence are not included in this description but are still displayed in the plates where drawn. The new typology includes the ceramics from all the UCSD ELRAP-L2HE excavated sites, but since KEN was the first site to be excavated by the project and studied (Smith and Levy 2008), the typology naming structure begins with forms found at KEN and is followed by forms found at RHI and the L2HE sites. There are some gaps in the typology due to certain types not having significant representation or illustrated examples. Each vessel type description is organized into a brief description of its key attributes followed by a discussion of subtypes, fabric, decoration, and parallels found at other sites. References to published archaeological sites used in the comparative analysis are italicized and refer to a selected bibliography at the end of the chapter.

The ceramic typology presented here aims to compare each dominant vessel type at the subregional level between the seven excavated sites studied here to elucidate chronological, spatial, and cultural differences between the sites. Where early and later Iron Age types appear to share morphological similarities, they are grouped together and assigned to subtypes. These subtypes have then been examined more thoroughly to determine whether significant clustering of subattributes enable a chronological distinction between them. In a number of cases, this has proven to be possible, especially when ware and surface treatment is taken into consideration. The observations discussed within these ceramic descriptions are then addressed by the quantitative studies and concluding discussion in an attempt to relate the inferences made to the models of social boundaries and social change discussed above and other chapters in this volume. Finally, the study seeks to corroborate these observations by comparing the types described here in a regional context with published studies from Edom, northern Transjordan, the Negev, Shephelah, and in specific cases northern Israel.

For Khirbat en-Nahas, the figures are arranged according to excavation area (Areas A, F, S, T, R, and M), stratigraphic sequence (integrated phases), and vessel type from earliest strata to later (see the discussion of the integrated phases for each site in Chapter 2). The sherds for each figure are organized according to vessel family and type (in certain plates, this general pattern had to deviate slightly to accommodate the larger diameter vessels). This approach was chosen to compare and contrast temporal distinctions between the specific vessel types, which, until now, could not be done for Edom because of the lack of clearly defined stratigraphic phases at other Iron Age "Edomite" sites in Jordan. For the soundings, which yielded single-occupation areas (RHI and L2HE sites) with no clearly distinguishable stratigraphy, the figures are organized by site area and vessel type rather than by strata. (For

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example, Figure 4.1 is KEN Area R Integrated Phases V, IV. However, for a site with only one occupation level, it would be presented as Figure 4.37, which is L2HE 07 TW-K.)

Ceramic Descriptions

Platter Bowls: BL1, BL2

BL1: *Platters with flaring sides and simple rounded flat or beveled rims (Figures 4.7:3, 4.10:3, 4.28:1)*

Description: These platters have various rim treatments; see subtype discussion.

Subtypes (*n* = 6): Variation in minute forms has been broken down into six subtypes: BL1a have a straight near-vertical profile to rounded rim, BL1b have rims bent to horizontal 2 cm from the lip and have a flat or beveled rim, BL1c are very large thick (8–10 mm) platters with bent to horizontal rims, BL1e are fine ware platters with inverted vertical stance tapered rims, and BL1f are deeper with an everted to horizontal rim.

Fabric: Ware A1 and B1

Decoration: Black and red concentric lines along the bent section of the rim are common. R161 has two thin black concentric lines separated by white or red paint from the rim to center of the vessel. White slip is found on a few vessels.

Parallels: This type occurs at KEN, KAJ, KAM, TW, and RHI-B (see table in Figure 4.42). In Edom, BL1a parallels *Busayra* (Figure 9.1:10 and possibly Figure 9.4:1–5), *Tawilan* (Figure 6.1:1), and *Tel el-Kheleifeh* (pl. 36:8–10) while many parallels of BL1b are found at *Busayra* (Figure 9.1:1–9) and one example from *Tawilan* (Figure 6.1:9). Parallels in Cisjordan to straight-sided simple rim platters (BL1a) are found at *Tel-Batash* Stratum III (Type BL15; pl. 14:2) and Tel Gezer Stratum VIB, VB/VA (pls. 14:15; 24:8). The stratigraphy suggests they began in the mid-ninth century and became more abundant in the eighth to seventh centuries BCE (cf. Mazar et al. 2001:49).

BL2: *Platters with flaring sides and overhanging rim (Figure 4.28:2)*

Description: These platters all have overhanging flat rims. Some are bent similar to BL1b to create a horizontal section before the rim (e.g., R108, R120, R117). The flat portion of the overhanging rim is grooved or concave. There is only example that preserves a pedestal base.

Subtypes: BL2a are standard bowls with an overhanging rim. BL2b are distinguished by denticulation along the exterior overhang.

Fabric: Ware B1

Decoration: Many are white slipped with black concentric lines on the bent horizontal portion of the rim. Several are more elaborately painted with black, red, and reddish-brown painted bands. The BL2b bowls have black concentric lines circulating the vessel every 1 cm.

Parallels: This type occurs at KAM, KIS, TW, and RHI-B (see table in Figure 4.42). This is a commonly published form at Busayra. BL2a are found at *Busayra* (Figure 9.2:1–10); denticulation (BL2b) also occurs at *Busayra* (Figure 9.2:11–16). *Tawilan* has a couple examples of BL2a (Figure 6.1:7, 11?, 13?, 14) and a couple with denticulation (Figure 6.2:1–4). *Tel el*-Keheleifeh (pl. 36:3) may be a BL2a. In Cisjordan, platters with overhanging rims are found at multiple sites (cf. Mazar et al. 2001:49), but very few have the characteristic groove of BL2a or BL2b's denticulation. A possible parallel of BL2a is found at *Tel Batash* Stratum III (pl. 91:16).

Bowls with Thickened Rims: BL3, BL4, BL5

BL3: *Triangular-section rim bowls (Figures 4.1:1, 18–19; 4.34:1–2; 4.35:1; 4.36:1; 4.37:1–2; 4.4:12–16; 4.10:4, 7; 4.11:13–22; 4.12:1–3; 4.16:15–21; 4.17:1; 4.19:9–11; 4.20:18–21; 4.22:23; 4.26:1–4; 4.27:1; 4.28:3–13; 4.32:1)*

Description: These are small- to large-sized open bowls with a characteristic rim treatment involving folding and flattening of the rim, often creating a triangular section. The formation of the rim varies from one vessel to the next, with most having a triangular section while others tend toward a simpler, flattened profile. The rim stance is generally upright or sloping out. Several of these bowls have rounded sides, but some have soft carnations above mid-body. Bowls with intact base sherds show a disk or ring base and are commonly painted with black concentric circles. White slip on the interior and exterior is common, while burnishing only occurs on a few examples.

Subtypes: BL3 represent the most ubiquitous vessel type. However, there are many varieties among the groups. Divisions of subtypes are broken down according to the size of vessel and then specific rim treatment. BL3a are distinguished from BL3b–d by thickness of vessel and width of the rim. BL3a thickness ranges from 3 to 6 mm, and rim width is less than or equal to 1 cm. All BL3b have thickness starting at 5 mm to 8 mm; however, even though wall thickness may be the same as BL3a, all rim widths are over 1 cm. Rim

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diameter did not prove to be a distinguishing feature as the diameter fluctuated among all classes, although a general trend toward larger diameters is found in BL3b–d as would be expected.

BL3a1 are the most typical bowl of this subtype at KEN. They have the standard triangular section rim that is evenly thickened on the interior and exterior. Rim stance ranges from upright to sloping out. BL3a2 are sloping out and are more thickened on the interior than on the exterior. BL3a3 are upright and more thickened on the exterior. BL3a4 have rims primarily the same as BL3a1 but have attached strap handles with a ridge below the rim. BL3a5 have a thinly cut section (5–7 mm) on the exterior just below the rim, accentuating the exterior thickened portion of the rim and creating a 1-mm protruding ledge at the bottom of the thinned section. The body of the vessel is also much deeper than all other BL3a, which tend to be shallow.

BL3b follow a similar classification. The BL3b1 ware group has a standard triangular rim section. BL3b2 are more thickened on the interior. BL3b3 have an exterior ledge or are more thickened on the exterior. BL3c1 are deep bowls with upright rims but more beveled rim treatments, giving a similar appearance, although with an upright stance. BL3c2 have a more T-shaped rim that is either angled outward or inward. BL3d have a ridge below the rim not associated with a bar handle thinner than BL3a4 and with two examples of handles (R118 loop; R898 strap attached from rim to body).
Fabric: BL3A/B from KEN: The majority have the same fabric, although some have Ware A1/A2. BL3A/B/C from RHI are consistently Ware B1 with few exceptions (n = 2). This clay may have been extracted from the same source as the pithoi (PT) from the later period. BL3b/c from all L2HE sites fluctuate between colors discussed for BL21.
Decoration: Painting is a key defining characteristic of these bowls and consists primarily of black or red horizontal concentric painted bands along the interior of the vessel as well as vertical painted strokes along the rim. Several examples have horizontal bands along the rim with painted vertical strokes. Applied decoration on the exterior in the form of a bar handle is also common. Black strokes on the rim occur often and sometimes crosscut concentric lines on the rim. Several have interchanging black and red strokes on the rim. One example, R1060 (Figure 4.16:16), has irregular red slip on the exterior and uniform red slip on the interior—the thin-section analysis found this to be an import from the western Negev (Imp 1-Loess). BL3a5 have one example with a red band associated with black concentric lines on the interior of the vessel. This is another indicator of it being late. Examples from BL3b1 have black and red strokes on the rim but also red paint between the black concentric line on the interior and also evidence of oblique black lines near the base. BL3c types have white slip, and some are painted similar to BL3a5.
Parallels: This type occurs at KEN, RHI-A, KAM, KIS, TW, and RHI-B (see table in Figure 4.42). This is a common form found throughout the KEN assemblage (tenth- and ninth-century BCE strata) and other "Edomite" sites such as *Busayra* (Figures 9.17:4,5; 9.19:14–16; 9.20:9) and *Tawilan* (Figures 6.5:8,9; 6.7:6). However, the illustrations in the *Busayra* and *Tawilan* publications show that the larger rim treatments (>10 mm) are typical. This pattern should not be considered random as it was found that BL3a dominate the earlier site of KEN but BL3b become the dominant form at all the other later period sites. The smaller BL3a form is only witnessed in a couple examples, such as *Busayra* (Figures 9.17:4,5; 9.19:14–16; 9.20:9) and *Tawilan* (Figures 6.5:8,9;6.7:6). The various forms of the larger BL3b are predominately illustrated in *Busayra* (Figure 9.17), *Tawilan* (pls. 6.4–6.7), *Tell el-Kheleifeh* (pls. 33:6–15; 34; 35:1–6), *Ghrareh* (pls. 3:7–13; 4; 5), and *Umm al-Biyara* (pl. 56:14–17). BL3a1 are found at *Tel Batash* Stratum IV (pl.80:7) and BL3b1 at *Tel Batash* Stratum III (pl. 22:15).

Parallels of BL3 in general are found in the Negev and Judah at *Tell Beit Mirsim III* Stratum A (pls. 22, 23), *Tel Arad* Strata X–VII (pls. 10:B 24; 24:3, 10, 12; see p. 132 for listing), *Beersheba II* Strata VI–II (Figure 26:12–16), *Beersheba I* (pls. 53:2, 5; 54:1, 2; 56:9; 55:5–7; 59:58–71), *Horvat Qitmit* (Figures 4.1:50, 56; 4.2:4–7), *Lachish* Strata V and IV (Zimhoni 1997: Figures 3.11; 3.13:4, 11, 13,14; 3.16:1–4; 3.17:4; Tufnell et al. 1953:pls. 80:70–75, 86; 101), *Gezer III* Stratum VA (pl. 25:7; Type 50c, p. 168), and possibly *Kadesh Barnea* Stratum 3c (pl. 11.27:16) and are similar in rim form to *Tel Batash* Strata IV–II (BL13, p. 39). This vessel type is found at many sites in multiple strata spanning the entire Iron Age II in both Transjordan and Cisjordan from the ninth to sixth centuries BCE. However, the white slip with black concentric lines on the interior of the vessel and stripes along the rim is a decorative style that distinguishes this vessel's appearance from Cisjordan and is characteristic of the region of Edom.

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BL4: *Large bowl with everted rim (Figures 4.36:2; 4.28:14–16)*
Description: These large rounded bowls have an upright everted rim.
Fabric: At RHI, Ware 4 is predominant, but other colors occur apparently with the same fabric. Again, KAM has 2.5YR6/8 light red colors, besides other standard fabrics.
Decoration: R577 has black concentric lines on a white-slipped rim.
Parallels: This type occurs at KAM, TW, and RHI-B (see see table in Figure 4.42).

BL5: *Bowl with upright rounded thickened interior and exterior rim (Figure 4.28:17–18)*
Description: These medium-size bowls with 1-cm-thick walls all have a thickened interior and exterior rim (2 cm wide) that is softly rounded on both the interior and exterior.
Fabric: Ware B1
Decoration: White slip on the rim and black concentric lines and red ring burnish on the interior are common. At Tawilan, several examples have a gray purplish slip on the exterior and rim and red ring burnish on the interior.
Parallels: This type occurs at KAM, TW, and RHI-B (see table in Figure 4.42). These bowls are mixed into the typology by Oakeshott (1978) of Type D bowls. Possible examples based on illustrations include *Tawilan* (Figures 6.5:6; 6.20:4?–5?) and *Busayra* (Figure 9.15:14).

BL7: *Upright slightly thickened rounded rim bowls (Figure 4.8:9)*
Description: These bowls are similar to BL3 but have simple rounded rims that are slightly thicker than the walls of the vessel.
Fabric: Ware A2 (predominant) and Ware A1
Decoration: White slip and black concentric lines on rim and interior. One example (Figure 4.8:9) has knob decoration running horizontally around the vessel below the rim.
Parallels: This type occurs at KEN (see table in Figure 4.42).

BL8: *Rounded bowls with simple upright flattened rims (Figure 4.28:19)*
Description: These rounded bowls have a simple flattened rim that is upright. The rim is no thicker than the walls of the vessel. Decoration is common.
Fabric: Ware A1/A2 for all sherds recovered from KEN. RHI has predominant Ware B4 with few (n = 2) exceptions. L2HE sites have typical B1 ware.
Decoration: The RHI04 versions of these bowls are highly decorated with black, white, red, and reddish brown pigments painted in concentric lines and bands primarily on the interior but also on the exterior and rims of these vessels. The L2HE examples are primarily undecorated.
Parallels: This type occurs at KEN, KAM, KIJ, KIS, TW, and RHI-B (see table in Figure 4.42). This form would be expected to be found at Tawilan, but there are no clear published examples. Perhaps its undecorated generic form on the plateau makes finding published parallels difficult.

BL9: *Flat exterior beveled rim bowls (Figures 4.8:10–11; 4.12:5; 4.17:2; 4.19:12)*
Description: These bowls are beveled from the lip on the exterior. The rim is no thicker than the wall, not folded, and should be related to BL3.
Fabric: Mixture of Ware A2 and A4. R257 was thin sectioned and had a high content of gypsum.
Decoration: R1460 has a black concentric line with vertical strokes on the rim similar to BL3 vessels.
Parallels: This type occurs at KEN (see table in Figure 4.42). See *Busayra* (Figure 9.36:23).

BL10: *Bowl with mid-level stepped carination and tapered or rounded rim (Figures 4.35:2; 4.10:8; 4.12:6)*
Description: This bowl has a mid-level stepped carination with a tapered or rounded rim.
Fabric: R341 (Figure 4.10:8) has a high content of gypsum. R210 (Figure 4.12:6) has a matching fabric to A3 with clear evidence of basalt inclusions.
Decoration: Black concentric lines on interior and exterior.
Parallels: These parallel *Busayra (Figure 9.14:1–7)* and are not found outside Edom.

BL11: *Straight-sided bowl with beveled interior (Figure 4.16:11)*
Description: This straight-sided bowl has a rim beveled from the lip on the interior.
Subtypes: Less pronounced beveled interior bowls are found at RHI, but these also are not as straight sided.
Fabric: Ware A1 and A4
Decoration: R940 from KAJ is slipped (exterior).
Parallels: This type occurs at KEN and KAJ (see table in Figure 4.42). See *Busayra* (Figure 9.36:27).

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BL12: *Thin, round-walled fine-ware bowls with tapered rim (Figures 4.1:20; 4.36:3; 4.12:7; 4.32:2)*
Description: These razor-thin, small rounded bowls are fine-ware vessels with a tapered rim.
Subtypes: BL12b are similar fine-ware bowls but have a straighter body wall. BL12c have a sharply tapered rim that is slightly turned out at the tip and are all found at the Late IA II sites.
Fabric: BL12a and BL12b range from A1 or A2 to a well-sorted very fine A1c. One example (Figure 4.12:7) has a similar morphological form but Arkose-rich (PG2, A7) medium- to fine-ware fabric. The late BL12c are all B1 fabric.
Decoration: These bowls sometimes have bichrome painting, red slip with continuous burnishing on the interior and exterior, or white slip on both the interior and exterior. BL12c have black and red concentric lines and bands—the decoration is the same as BL20.
Parallels: This type occurs at KEN, KAM, KIJ, TW, and RHI-B (see table in Figure 4.42). The characteristic rim treatment of BL12c is found at all the late plateau sites with clear parallels to Oakeshott's (1978) Type J2 vessels (see *Busayra* Figure 9.25:4, 6, 7, 9, 10, 12). BL12a have a similar morphological design to *Busayra* (Figure 9.25:1, 11, 13) but should be considered as a predecessor to these later fine-ware bowls. Other parallels to BL12a/b are found at *Horvat Qitmit* (Figure 4.1:26; 4.9:9), *Tel 'Ira* Stratum VII (Figure 6.89:3), *Tell Beit Mirsim III* Strata A (pl. 24:6–8), *Samaria I* Period III (Figure 4:9), 'Umayri Phase IP3 (*MPP I:* Figure 19.9:1), *Hesban* Strata 16 (Figure 3.11:22), and Dibon (Tushingham 1972:Figure 2:14?). This bowl has parallels in multiple subsequent strata spanning the entire Iron Age II from the ninth to sixth centuries BCE.

BL13: *Carinated bowls with rounded rim sloping up to a tapered lip (Figures 4.4:17–18; 4.8:1, 12; 4.12:8; 4.21:1–2; 4.22:13–15, 22; 4.26:9)*
Description: The two primary characteristics of these bowls are the straight-rim to mid-body carination and a tapered or rounded rim created from a thinning of the thicker interior body of the vessel. Some bowls with thickened interior are very pronounced, while others have a more typical straight rim.
Subtypes: The vessel subtypes are determined by length before carination and overall rim diameter and thickness of the vessel wall. BL13a have approximately 3 to 4 cm from the rim until carination and are the largest examples (>5 mm) in thickness. BL13a2 are identical in form, but the rims are more simply rounded rather than having the slope to taper. BL13b are smaller in diameter and thickness and have around 2 cm before carination. BL13c share similar thickness and diameter as BL13b but have a shorter (1.5 cm) area before carination.
Fabric: Ware A1 and predominately A2
Decoration: Slip and burnish appear on some examples. Ash and soot are also found on many. The majority (>50 percent) are undecorated.
Parallels: This type occurs at KEN and RHI-A (see table in Figure 4.42). In comparison with Busayra, these vessel forms fit within the same class as the Type C vessels designated by Oakeshott (1978); however, the tapered rim and thicker interior are more common at KEN. Moreover, the fabric and lack of decoration make these very different from Type C. The closest example of the thickened interior to taper appears at *Busayra* (Figures 9.13:3, 15). A few parallels are found at Dibon, but they all differ in primarily having a more flat, squared rim and a more shallow body (Tushingham 1972:Figures 2:18–24; 18:11). The Ammonite Citadel/Administrative Complex in Field A at 'Umayri has parallels represented from the ninth to eighth centuries BCE, with a few examples resembling the KEN assemblage (*MPP I*: Figure 19.9:6–9; *MPP II*: Figure 3.14:12–16; *MPP IV*: Area A Phase 8, Figure 3.23:16–17; *MPP V*: Figure 5.20:6). At *Tell Beit Mirsim III* Stratum A (pls. 24–25), a large quantity are present, as found at Busayra and KEN. Examples seen in *Tell Beit Mirsim III* (pls. 24:10, 20, 22–23) are the most common type found at KEN. *Beersheba I* Stratum II (pl. 59:55–57) has a few close parallels with a small disk base. However, at *Tel Arad* Strata XI–IX (Figures 8:3; 28:4; 34:2), the vessel typically has a small-diameter disk base. The ring-base style appears to be unique to Busayra. Unfortunately, the lack of examples with intact bases from the KEN 2002 assemblage prevents any further comparison. See *Gezer III* Stratum VIA (pl. 20:5). The bar-handle design is very common at *Lachish* Strata V–IV (Type B-14, Figures 25.17:2, 3, 5–7; 25.19:14; 25.38:4; 25.50:16; 25.51:2) but also is dominant in Strata III–II (Figures 26.3:8, 9; 26.18:3–5; 26.29:5), where, as at Busayra, ring bases appear. At *Tel Batash* Strata IV–II, a similar form is red slipped and hand burnished and is most dominant in Stratum IV (see pls. 5:16; 7:8; 9:1; 8:12; 13:4, 7; 24:3; 29:15; 41:16–17, 23; 82:5–7; 84:2; 90:3–4; 91:5). Finally, the recent publication at *Kadesh Barnea* Stratum 3a–b also has this vessel (pl. 11.30:3). According to the

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many stratified parallels, this vessel type is relatively long-lasting through the entire Iron Age II period in both Cisjordan and Transjordan.

Medium-Size Rounded Bowls with Plain Rims: BL14, BL15, BL16

BL14: *Round-wall bowl with plain rim (Figures 4.4:1; 4.17:3)*
Description: These are simple, rounded-wall bowls with rounded or tapered rims. The fabric of these vessels is coarse, not well sorted, or rounded. In a few examples, a white slip is applied on the interior and exterior.
Fabric: Ware A1/A2
Decoration: White slip on exterior and interior is found on a couple examples.
Parallels: Found only at KEN in Integrated Phases II–V; generic type lacking published parallels from Edomite sites.

BL15: *Round-sided bowl with groove below rim exterior (Figures 4.1:2, 21; 4.4:19–22; 4.19:13; 4.21:3*
Description: This is a round-sided bowl with a simple, rounded, or tapered rim generally sloping out and a single exterior groove below the rim exterior. Only diagnostic rim sherds have been found, preventing a description of the overall vessel's form and base. BL15 belong in the group of rounded bowls at KEN (e.g., BL14 and BL16); however, the large sample of these bowls with a grooved exterior suggests that it belongs to its own type.
Subtypes: The subtypes are distinguished by groove technique. BL15a have a thin 1-mm groove just below the rim. BL15b have a deep 2- to 3-mm groove. BL15c have two deep grooves below the rim.
Fabric: Three different wares were distinguished under microscope and thin section. Ware A2 is the typical slag-rich local fabric, but also Ware A9 and A10 were common, representing over half the ceramic types examined.
Decoration: Not applicable
Parallels: No Iron Age sites in Edom, with the exception of KEN (cf. Smith and Levy 2008), have any clear published examples of single grooved bowls. See Fritz (1996:Abb. 3:4). Parallels of rounded bowls with a single groove below the rim are uncommon in Cisjordan, but see *Gezer III* Stratum VIA (BL45, pl. 20:1–2), *Lachish* Stratum IVB (Figure 25.28:5), and perhaps the closest parallels at *Kadesh Barnea* Stratum 3c (pl. 11.27:4, 5). The few parallels mentioned here occur in strata variously dated to the tenth to eighth centuries BCE.

BL16: *Fine-ware round-walled bowls with round rim (Figures 4.1:22–23; 4.38:4; 4.4:2, 23–24; 4.10:9; 4.22:16; 4.28:20)*
Description: These round-walled bowls are distinct from BL14 in having finer ware and horizontal burnishing.
Subtypes: BL16a are burnished and red slipped and are possibly all imports from western Negev. BL16b are undecorated with the exception of white slip.
Fabric: One example of BL16a thin sectioned was found to contain loess soil (PG5, I1). The other examples had identical fabric, suggesting they all were imported. BL16b had various local and foreign (PG1, PG4, PG5) fabrics.
Decoration: BL16a have a red uneven horizontal burnishing commonly found at sites in the Negev.
Parallels: This type occurs at KEN, KAJ, TW, and RHI-B (see table in Figure 4.42). BL16a are imports from the western Negev; see *Beersheba II* Stratum VI (Figure 26:18). In general, these are generic types lacking published parallels from Edomite sites.

BL17: *Thin flaring bowl with tapered rim, medium to fine ware (Figures 4.8:13–14; 4.10:4–5; 4.12:9–10; 4.19:14)*
Description: This is a straight-sided flaring bowl with a sharp tapered rim. These bowls are generally medium to fine ware and have a white slip on the interior and exterior. Some examples have a carination leading to the base.
Subtypes: BL17a are the standard type with an average thickness of 3.5 to 4 mm. BL17b are razor thin (<3 mm) and smaller in diameter (cf. BL12b). BL17c are slightly larger and thicker than BL17a, and almost all preserve the lower carination.
Fabric: Ware A1
Decoration: Not applicable
Parallels: This type occurs at KEN and RHI-B (see table in Figure 4.42). Due to the lack of complete profiles containing the lower body and base, associating these vessels with specific parallels is problematic. There are no clear parallels in Edom outside of KEN for these vessels, but similarities are seen in the straight-sided cups found at *Busayra* (Figure 9.30:1–15). In Cisjordan, parallels with a very low carination just before a ring or disk base are found at *Horvat Qitmit* (Figure 4.6:8–10), *Beersheba I* Stratum II (pl.

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59:42, 45), *Tel 'Ira* Strata VIII–VI (Figure 6.60:8), *Lachish* Strata III–II (Figure 26.3:2–5; 26.20:3, 4; 26.33:7), *Tel Arad* Stratum X (Figures 29:15; 32:4; 37:2), *Samaria II* Period VI (Figure 10:11), and *Tell Beit Mirsim III* Stratum A (pl. 24:20, 26). However, other examples, possibly dating to the end of the ninth century BCE and later, are found with the wall continuing to a flat base, such as at *Lachish* Strata IV–III (Figure 25.50:4, 5, 9, 19), *Tel Arad* Strata X–VIII (Figures 30:5–6; 37:3–5), *Samaria I* Period III (Figure 4:8), *Tell Beit Mirsim* Stratum A (pl. 25:1–13), and Beersheba Stratum II (Singer-Avitz 1999:Figure 2:2). The lack of complete profiles at KEN makes assigning this vessel to either the earlier type or later type in the Iron Age II difficult.

BL18: *Small fine-ware carinated bowl with flat rim and incised stanza below rim (Figure 4.38:5–7, 19)*
Description: The small fine-ware carinated bowls or cups have a flat sloping-out rim that leads to a rounded carination. Below the rim and above the carination is an incised triangle patterned stanza. On examples preserved past the carination, evenly spaced knobs are found attached onto the rounded carination.
Fabric: Ware A6
Decoration: Besides applied decoration mentioned above, a white slip is found on the exterior of R394.
Parallels: Found only at KAJ

BL19: *Small carinated bowl with rounded rim (Figure 4.4:25)*
Description: These small bowls (diameters 12–14 cm) have a sloping-out rounded rim that leads to a soft rounded carination.
Fabric: Ware A1
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phases I, III, and V

High Carinated Bowls: BL20, BL21, BL23–BL26, BL28–BL32

BL20: *Fine-ware high carination tiny bowl with globular body (Figures 4.33:1; 4.34:3–4; 4.35:3–13; 4.36:4–5; 4.37:3–6; 4.28:21–26; 4.29:1–15; 4.32:3–5)*
Description: This very fine-ware thin bowl has a globular body with a high sharp carination, creating a very short sloping-out neck. The rim is round or tapered. These are distinguished primarily from BL21 by their delicate thin body profiles and finer surface treatment.
Subtypes: BL20b differ in only having a taller neck by nearly twice the length as that of BL20a. BL20c lack a sharp carination; rather, they have an inverted shoulder that then bends back outward, creating the sloping-out neck.
Fabric: The examples from RHI predominate with the Ware B4 fabric, but there are also a number of examples with a pale red fabric and gray core that is very finely sorted (Ware B5). Similarly, these finer fabric types are also found at the L2HE sites along with a predominant amount of the local Ware B1 fabrics.
Decoration: Many of these bowls but not all are finely slipped and painted with black, white, and/or red concentric bands from below the carination to the lip of the rim. White slip with black or red concentric bands is the most common. Only at KIS are there examples ($n = 5$) of smoothly burnished red slip creating a soapy texture. At TW, two examples with the fine gray cores have a pale brown slip. At KAM, one example has a bar handle attached to the carination. Finally, at RHI, the fine gray core fabric vessels typically have a burgundy red slip and black painted bands (see further discussion on surface treatment below).
Parallels: This type occurs at KAM, KIJ, KIS, TW, and RHI-B (see table in Figure 4.42). These fine-ware vessels are paralleled at many of the sites found in the region of Edom and also the Negev. They were designated by Oakeshott (1978) as Type J and combined with rounded bowls, delineated here as BL12c. These are found at Busayra (Figure 9.23:10–18) and Tawilan (Figure 6.8:1–7); note that Figure 6.8:2–6 are designated here as BL20b and represent a small proportion of overall BL20 at the sites. Possibly Pl.28:7–8 from Tel el-Kheleifeh are also this type, but the illustration makes them look thicker than the typical BL20. In Cisjordan, they are found at several sites, but again their thickness cannot be easily determined. See, for example, *Horvat Qitmit* (see Figures 4.1:33; 4.6:2; 4.9:18; 4.12:4; 4.13:10), *Tel 'Ira* (Figures 6.80:4; 6.90:1; note that they are painted and one example red slipped and burnished), and Tel Arad Stratum VI (Figure 48:3).

BL21: *Wide-necked bowl with globular body and plain rim (Figures 4.1:24; 4.33:2–7; 4.34:5–10; 4.36:6–9; 4.37:7–9; 4.4:8, 26; 4.10:5; 4.12:11–12; 4.17:4; 4.19:1; 4.21:4; 4.29:16–46; 4.30:1; 4.32:6–14)*
Description: This is a deep globular bowl with a carinated, short flaring neck and a rounded or tapered rim. Surface treatment includes white slip on the interior and exterior; painting is rare but occurs as black

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concentric lines around the neck and rim of vessel. **Subtypes:** Variations of BL21 are found throughout the Iron Age II. BL21a1–2 represent this form found at KEN. These bowls are generally small (ca. 10 cm in diameter) with soft rounded carination. Some have loop handles attached. R634 KEN06 is an exception in being much larger (22 cm in diameter) and having a tall neck (3.5 cm). BL21a3 represent the soft carination into later periods. BL21a4 are a single example of a spouted form. BL21b have a sharp carination that creates almost a grooved step at its inflection point. It is noticed that the outer edge of this bowl's carination has a thin flap, possibly created from the tool used to make the carination. Some examples of squat small-diameter cups of this form are found at RHI. BL21b are predominant at RHI but not at the L2HE sites, where only a few (n = 6) examples were found at TW and KAM; these had a light red fabric. These morphological differences and fabric discussed below enable us to distinguish in many cases the lowland from the highland produced vessel style. BL21d are larger and thicker variants of BL21a, while BL21e have a similar carination and diameter to BL21a but have a tall neck. BL21f are cups with handles and distinguished by the perforated holes found along the carination and base of this vessel. **Fabric:** BL21a1–2 are typical B1 ware. BL21a3 and BL21b are representative of the Late IA II periods. The RHI BL21 are almost all Ware B4 fabric with only a few exceptions, similar to the Ware B1 fabrics found at the plateau sites. KAM specifically has a predominant amount of this form in the light red 2.5YR6/8 color but also has light reddish brown examples as well. **Decoration:** Several BL21a1–2s have white slip (interior/exterior), and a few also have black horizontal lines on the neck. BL21a3 are primarily contrasted with earlier forms in lacking white slip. Red slip occurs on several vessels, especially at the L2HE sites. Black and red paint is found on the neck and also just above or below the carination. The BL21b are similar to BL21a1/2 in typically being treated with a white slip and a few examples having black horizontal lines on the neck. **Parallels:** The various types distinguished here are found at the later "Edomite" sites such as *Busayra* (Figures 9.28:9–13; 9.29:1–9), *Tawilan* (Figure 6.10:1–8), *Tell el-Kheleifeh* (pl. 28:1–6), *Ghrareh* (pl. 10:10–16), and *Umm al-Biyara* (pl. 56:10). The sharp carination of BL21b is less frequently illustrated. At *Tell el-Kheleifeh* (pl. 28:2), this forms shares a high degree of similarity to those found at RHI, including the typical very pale brown fabric. One example is depicted at Busayra (Figure 9.28:10). Also, at *Tell el-Kheleifeh* (pl. 29), a whole plate of BL21f is illustrated; however, these forms differ in having two inflection points. These bowls are found at other Transjordanian sites such as 'Umayri Phase IP3 (*MPP I*: Figure 19.8:14–21) and Hesban (Lugenbeal and Sauer 1972:No. 273). These vessels have been identified in small numbers at Judaean sites. An early example is found at *Kadesh Barnea* Substratum 4b (pls. 11.15:2; 11.20:5). Later examples at *Kadesh Barnea* Substrata 3a–b are also similar (pl. 11.31:11–12, 15–16). Pl.11.31:15 is an example of BL21f and P.11.31.15 an example of BL21a4 (compare also BL21e to Pl.11.52:4). A sharply carinated and painted example noted as an Edomite bowl was also found in Stratum 2 at *Kadesh Barnea* (pl. 11.79:7). Other sites with parallels include *Beersheba* Strata III–II (Singer-Avitz 1999:Figures 9:5–7; 10:23), *Tel Arad* Stratum X and VIII (Figures 11:B 31; 35:3), *Horvat Qitmit* (Figures 4.1:33, 36–42; 4.5:4–5; 4.9:17; 4.11:7, 9; 4.12:4–5), *Tel 'Ira* Stratum VI (Figures 6.67:10; 6.70:3; 6.80:5; 6.87:8; 6.89:14; 6.106:6; for BL21b, see Figure 6.89:15 located outside the city wall), and *Tel Masos* Iron Age II strata (pl. 164:8). This vessel is considered Edomite in origin, and its range is limited to Transjordan Edom and the Negev at the Late Iron Age sites (Singer-Avitz 1999, 2007). The carination at KEN is much softer, perhaps reflecting an earlier form of the later more pronounced carination type found at RHI and a few examples from KAM and TW. Painting is also not as common in the parallels and, when present, is monochrome black rather than the bichrome elaborate painting found at Busayra. There appears to be a number of imitation forms at sites such as Tel Beersheva (Figure 9:1–4; note they come from the Shephelah or Judea and are fully slipped) and Tel Arad (Figure 28:5; 37:9) that have high bent carinations with very short necks and surface treatments not commonly seen at the L2HE or RHI sites. Therefore, a chronological distinction needs to be made between the Early IA II ninth-century BCE BL21a and the later BL21b–f, which are paralleled at many sites in Edom and Cisjordan.

BL22: *Shallow sharply carinated bowl with straight, flaring out, tapered, or rounded rim (Figures 4.3:9; 4.12:13–19; 4.16:10; 4.21:5; 4.22:17; 4.33:8; 4.36:10)*
Description: Sharply carinated medium- to fine-ware bowl with low carination and straight-sided, flaring-out

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tapered rim. The carination creates a step between the flaring vessel walls and sharply closing shallow base.

Sub-types: The distinction between the early BL22a and the later supposed "Assyrian imitation–style bowls" must be clarified as several scholars continue to disagree at this point (cf. Finkelstein and Singer-Avitz 2009:210). Figure 4.40 juxtaposes these two different forms for comparison. Although BL22a has a low carination, it should not be mistakenly confused with the carinated "Assyrian imitation–style bowls," here distinguished as BL22b (see also Figures 4.33:8; 4.36:10). First, BL22b has a distinct sharp carination either at mid-body or near the base. The carination sharply bends outward from the upper portion of the vessel and then, at a second rounded inflection point, sharply bends back inward toward the vessel. This carination is a significant elaboration of what is seen consistently in BL22a where the carination is a straight-pointed carination that does not significantly protrude from the vessel. Second, all BL22b's rims are curving outward from the carination and sharply tapered. This is in contrast to BL22a, which consistently has a straight flaring rim. Third, the vessel walls of BL22b are thinner than what is seen among BL22a. Fourth, in comparison to a more medium-ware fabric found in BL22a, BL22b's fabric is finely sorted with almost no visible inclusions and is very hard.[10] Fifth, specifically for the sherds found in Edom, the surface treatment (slip, burnish, and painting) is much more elaborated. Taking these factors into consideration, especially when holding both sherd types side by side in the laboratory, they can be distinguished immediately. Out of the entire ceramic assemblages at TW, KAM, KIS, KIJ, and RHI, no low carinated bowls paralleled BL22a, which is quite common at KEN. As argued below, a parallel study bears out a similar distinction.

Fabric: BL22a are made of local medium to fine ware classified at KEN as Ware A1. This is in contrast to BL22b, which are highly fired, well-sorted, smooth to feel, fine-ware vessels, Ware B1.

Decoration: BL22a: Only one example from Area S was found, and it is the only example that was red slipped with a continuous burnish; it is also thinner and finer than those found at Area A. Two examples from Area A were found with horizontal burnishing without red slip; however, most (12 of 15) have either a white slip or no decoration at all. In contrast, BL22b are slipped, burnished, and painted with black, red, white, or brown bands and strokes. The painting is typical for the later period bowls found at these sites.

Parallels: BL22a are predominately a KEN occurrence. In a previous publication (Smith and Levy 2008), BL22a were lumped together with thicker walled carinated bowls that had a consistent red slip and burnish that have now been separated as BL24 (see below for discussion and parallels). The remaining BL22a, which are thin and fine carinated bowls, have no clear parallels during the tenth to ninth centuries BCE in Cisjordan; however, their morphology is distinctly different from the BL22b form that most likely was influenced by Assyrian styles. BL22a should be seen as an indigenous style originating in the Early Iron II of Edom and should not be lumped together with the clearly later BL22b, as argued above. BL22b represents the so-called late Assyrian imitation–style carinated bowls and paralleled in Transjordan, the Negev, and further north in Cisjordan. The Assyrian forms from which it is assumed BL22b derive have been identified at several Neo-Assyrian Late Iron II sites—see Nimrud (Lines 1954:pl. 37:7–8), Fort Shalmaneser (Oates 1959:pl. 37:59), Tell Sheikh Hassan (Schneider 1999:Abb. 1: Ab: 1–3; Abb. 2: Ac: 1–4), and Nineveh (Lumsden 1999:Figure 8:58). All of these "Assyrian" examples have a similar morphology to BL22b but have no parallels to BL22a. In Transjordan, BL22b are found at *Busayra* (Figure 9.26:12–19), *Tawilan* (Figure 6.8:18–22), *Tell el-Kheleifeh* (pls. 26:7–18; 27:1–6), *Ghrareh* (pl. 9:1–5), and 'Umayri Phase 2 (*MPP I*: Figure 19.16:7; *MPP V*: Figure 5.21:1). Parallels are found throughout Cisjordan at sites such as *Gezer III* Strata VIA–VB (pls. 22:7; 27:19–21), *Samaria II* Period VI–VII (Figure 10:8–10), *Hazor II* Strata VI–Va (II: pls. 67:5; 80:25–26), *Beersheba* Strata III–II (Singer-Avitz 1999:Figure 9:10–12), *Tel Arad* Stratum VII (Figure 10:B15), *Horvat Qitmit* (Figures 4.1:38, 40–41; 4.12:3; 4.6:1; 4.9:13), *Tel 'Ira* Stratum VI (Figure 6.63:5), *Tel Batash* Strata III–II (pls. 14:6; 26:20–22; 57:16; 86:14; 96:4), Aroer (Na'aman and Thareani-Sussely 2006:Figure 3:5; see also Thareani 2010), and *Lachish* Strata IV–III (Figure 25.49:3). For more comprehensive, parallel studies of this vessel, see Singer-Avitz (2007) and Schneider (1999:351–354). Recently, Na'aman and Thareani-Sussely (2006) have argued that this vessel type originated locally in Transjordan, based on the evidence that every petrographic study conducted on these vessels has shown them to be locally produced and common to Transjordan. Singer-Avitz (2007:185, 191) acknowledges that this

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type is locally produced, but its presence throughout Cisjordan and its clear development from Assyrian styles during the eighth and seventh centuries BCE suggest that it may be a product of a "cross-cultural encounter" with Assyria, not simple coincidence. BL22a at KEN are not found after the end of the eighth century BCE in the southern Levant, suggesting that its popularity as a vessel form was superseded by the new BL22b forms (cf. Mazar et al. 2001:43). It is perhaps the indirect influence of the Assyrian ceramic styles that led to the elaboration of the local BL22a toward a more popular "Assyrian-style" carination in their construction of this shallow serving bowl type during the eighth to sixth centuries BCE.

BL23: *Flaring bowl with mid-body carination and tapered or rounded rim, medium to fine ware (Figures 4.12:20–21; 4.19:15–16; 4.21:6; 4.22:18)*
Description: These bowls have a flaring slightly rounded wall to a mid-body carination and typically have tapered or rounded rims. They are medium to fine ware.
Sub-types: BL23a can be distinguished by their medium-ware fabric and lack of decoration. These are finer tapered versions of BL13. They lack preservation of a base but possibly had a disk base (see below). BL23b are much finer well-sorted fabrics, and many are painted or slipped. These also have no bases preserved but most likely had pedestaled or high ring bases. BL23c have a very low carination and may belong with BL17.
Fabric: Ware A1, B1, and B4 at RHI
Decoration: White slip on interior and exterior is common from KEN. The late vessels from RHI and the Plateau sites have bichrome painting in black and red, and some have burnishing and a third painted color (white).
Parallels: BL23b, common at RHI and the L2HE sites, are clearly contemporary with Type C of Oakeshott (1978), with parallels primarily found at *Busayra* (Figures 9.11–9.13) but also at other Edomite sites, where only a few examples are represented at each site—for example, *Tell el-Kheleifeh* (pl. 37:8,10) and *Ghrareh* (pl. 6:19–20). The recent publication of Kadesh Barnea (Cohen et al. 2007) describes this type as an "Edomite" variety. The form found at Kadesh Barnea shares similarities in decoration and form to those found in Edom but lacks evidence of a carination (pl. 11.79:4). In Cisjordan, BL23a, found only at KEN, can be distinguished from BL23b by the formation of the base being either an earlier form with a disk base or a more rare later form with the ring or pedestal base. At *Tel Batash*, the earlier form is well represented with many examples (BL23; see pp. 44–45), with only one example of the later form (BL23b) (pl. 41:22). Parallels to BL23a are also found at *Gezer III* Strata VI–V (Figures 20:4–5; 24:1–2). BL23b have only several other parallels at Samaria. If BL23a do have more simple disk bases, they should be dated to the ninth- to eighth centuries BCE and distinguished from the later predominately "Edomite" form BL23b in the eighth to seventh centuries BCE.

BL24: *Bowl with carination and sloping out rim (Figures 4.1:3, 25–26; 4.10:10; 4.17:5)*
Description: These medium- to fine-ware carinated bowls have a oblique carination similar to BL22 but are much thicker and have sloping-out rims that are either tapered or rounded.
Fabric: BL24a (n = 4) are made of loess soil and should be considered imports from the western Negev. BL24b are a local variation and have standard Ware A1.
Decoration: R781 and R1369 are red slipped and burnished. R781 is evenly burnished while R1369 is burnished on the wheel.
Parallels: These bowls found at KEN, subjected to petrographic analysis, are found at the western Negev sites. For example, four examples of this type from KEN parallel very closely vessels found at *Tel Arad* Stratum XII (Figure 3:1) and *Tel Beersheva* Stratum VI (Figure 26:3). similarities to BL22a in carination, rim treatment, and medium to fine ware are found in Cisjordan at *Beersheba II* Stratum VI (Figure 26:2–3), *Hazor III–IV* Strata X–IX (pls. 208:30; 210:5), *Ain Shems II* Stratum IIb (pl. 31:21), *Gezer III* Stratum VIA (pl. 22:8), *Lachish* Strata V–IV (Figures 25.26:1; 25.28:2), and *Tel Batash* Strata IV–III (pls. 10:9; 22:1; 28:2; 87:10).

BL25: *Bowl with ledges and carination (Figures 4.2:1; 4.4:9; 4.22:19)*
Description: These bowls have two ledges with the second serving as a carination.
Subtypes: BL25a have deep grooves to create ledges. The grooves are red slipped and burnished. The upright rim is thickened on the exterior. BL25b have ledges by oblique cuts or grooves in the body, creating a more stepped look. The second cut creates a carinated look on the exterior. All of these have a white slip on the interior and exterior and are a different fabric from BL25a.

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Fabric: The one example (BL25a) was thin sectioned and was found to be produced from loess soils found in the Negev (Ware I1). One example of BL25b (R101; Area A) was determined after thin sectioning to belong to Ware A10, a more rare fabric possibly originating from south of KEN (see discussion in Chapter 3, this volume). The other two examples of BL25b appear to share the same ware (A10).
Decoration: See above.
Parallels: This type occurs at KEN. A similar design is found at *Tel Batash* Stratum IV–III (pls. 82:11; 23:10;24:13)—this vessel also has a continuous red burnish.

BL26: *Small bowls or drinking cups (Figures 4.2:2–3; 4.4:27; 4.19:2)*
Description: These drinking cups have sloping-in rounded rims that lead to a smooth carination. Rim diameters range from 6 to 10 cm.
Fabric: Ware A1/A2, but a high concentration of calcite was identified during the ware analysis.
Decoration: Four drinking cups found in situ are white slipped with black vertical stripes running around the vessel. Some other examples have white slip on the exterior.
Parallels: This type occurs at KEN and KAJ (see table in Figure 4.42).

BL28: *Large rounded bowl with rounded thickened interior upright rim (Figure 4.1:4; 4.21:7)*
Description: These large round bowls have a thickened interior rim that is rounded and upright.
Fabric: Ware A1
Decoration: Not applicable
Parallels: *Busayra* (Figure 9.35:1) parallels these bowls, but their generic form may suggest they were a popular style for several centuries that underwent only minor variation.

BL29: *Large rounded bowl with thickened interior and groove below rim on exterior (Figures 4.2:4; 4.4:28; 4.21:8)*
Description: This large bowl has a groove below the rim, has treatment on the exterior, and is sloping in with a thickened interior.
Fabric: Although this bowl type was not thin sectioned, the two subtypes have distinctively different fabrics. BL29a core has a pink micaceous clay with no visible shales and resembles Ware A10. BL29b's core is a Ware A9 fabric.
Decoration: White slip on exterior and interior is found on every example.
Parallels: Found only at KEN in Integrated Phases II–III.

BL30: *Small, rounded bowl or chalice with everted rim (Figures 4.12:22–23; 4.30:2–3)*
Description: This is a shallow everted-rim bowl with rounded carination. The angle of the everted rim ranges from horizontal to a 45-degree diagonal. Although many examples of this bowl were found, none of the examples are sufficiently complete to determine the type of base. The low frequency of this form at KEN may represent the beginning of this lowland Iron Age vessel type that evolved to the Type B bowls identified by Oakeshott (Bienkowski 2002; Oakeshott 1978) that are dominant in the later periods in the highlands.
Subtypes: BL30a1 represent the only two bowls of this type found at KEN. These can be distinguished from the other subtypes by a rounded everted rim in contrast to all other types that have a sharp everted rim, creating a ledge at the bend (similar to BL1b and BL2). These may be incomplete chalices without the preservation of their stands, which are common in the Iron Age IIA (e.g., *Tel Batash*: Figure 2). BL30a2 are the later forms with a sharp everted rim and rounded carination. The everted rim is around 2 cm long. BL30a3 are the same as BL30a2, but all have a carination near the base (no profiles with base preserved). BL30b are shallow finer ware thin versions (<6 mm) of this type with the sharp ledge and rounded carination body and rounded or disk base. BL30c have the rounded body, but the rim is angled at 45 degrees rather than near horizontal. BL30d are similar to BL30b in thickness and ware but are deep and carinated, but none have a preserved base.
Fabric: Ware A1 and B1 for later sites
Decoration: Decoration consists of white slip on the interior and exterior, red slip and burnish on the interior, and black painted bands on the rim. BL30b are all plain. BL30d are generally heavy decorated.
Parallels: This type occurs at KEN, RHI-A, KAM, KIJ, KIS, TW, and RHI-A (see table in Figure 4.42). All subtypes of these bowls are well represented at sites in Edom. The rounded carination bowls (BL30a2 and BL30b) have parallels at *Busayra* (Figure 9.8:1–16) and *Tawilan* (Figure 6.3:1–2, 4–5). BL30a3 and BL30d are found at *Busayra* (Figures 9.6:1–18; 9.7:1–8) and *Tawilan* (Figure 6.3:7–8). BL30c occur at *Busayra*

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(Figure 9.10:1–15), *Ghrareh* (pl. 2:3, 8–14), *Tell el-Kheleifeh* (pls. 35:7, 8, 11, 12; 36:1–7), *Tawilan* (Figure 6.3:3, 11, 12), KEN from Fritz (1996:Abb. 3:3), and Feifa (Lapp 1994:Figure 13–2:1). General parallels to BL30 in Cisjordan and Transjordan are dated late: *Tell Beit Mirsim III* Stratum B (pl. 21:8), *Lachish* Stratum III (Figures 26.3:14; 26.36:1; 26.37:10), *Samaria II* Period VII (Figure 11:9, 10), *Tel Arad* Stratum VII (Figure 43:7–8), *Kadesh Barnea* Stratum 3a–b (pl. 11.30:7), and *Dibon* (Figure 2:40, 42).

BL31: *Shallow, rounded bowl with flattened rim (Figure 4.19:3, 7)*
Description: A shallow bowl with flattened rim. This type may be related to BL3. Only one example was found in the 2002 season, in Stratum A3.
Fabric: Ware A1
Decoration: Not applicable
Parallels: No clear parallels outside of KEN, but they may be larger forms of BL3 above.

BL32: *Necked globular bowl with soft carination (Figures 4.12:24; 4.27:2–3)*
Description: This necked bowl is similar to BL21 but has a very soft carination. It may be a predecessor of BL21.
Fabric: Ware A1
Decoration: White slip on exterior with black concentric lines on neck (R396) or body (R122)
Parallels: Found at KEN and RHI; see parallels cited for BL21 for similarities.

Straight-Sided Bowls BL33–BL38, BL40–BL44, BL51–BL57

BL33: *Simple straight-sided bowl with rounded or tapered rim (Figures 4.8:15; 4.12:25)*
Description: These generic straight-sided bowls have a rounded or tapered rim.
Fabric: Ware A1/A2
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phases II–IV

BL34: *Large rounded bowl with thickened, flattened but slightly rounded rim (Figures 4.7:10; 4.13:1)*
Description: These large, thick (1-cm) bowls have upright rims that are thickened by flattening and slight rounding.
Fabric: Ware A2b and A3
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phases II–V

BL35 *Thickened interior rim bowl (Figure 4.21:9)*
Description: Large bowl with sloping-out sides and inverted rim
Parallels: This bowl type is found at *Tel Arad* Strata X–VIII (Figures 25:3–4; 35:1), ʻUmayri *MPPV* Area H Phase 4 (Figure 5.13:7), and *MPPI* Phase IP3 (Figure 19.8:23–25, see p. 305). This vessel appears in the IAIIB (*Tel Arad*) and at ʻUmayri.

BL36: *Large straight-sided bowl with simple rim (Figure 4.22:20)*
Description: These large straight-sided bowls have a simple (flattened) rim.
Fabric: Medium to course A2b ware
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phases I–IV

BL37: *Deep bowls with exterior beveled rim (Figures 4.7:4; 4.8:16; 4.9:14)*
Description: This is a deep bowl with the exterior lip of the rim beveled.
Fabric: Medium to course A2b ware
Decoration: R378 has white slip on the interior and exterior.
Parallels: Found only at KEN in Integrated Phases I–V

BL38: *Shallow bowl with thickened interior rim, creating an interior ledge often grooved below the rim (Figures 4.17:6; 4.19:17)*
Description: This shallow large bowl has a thickened interior that is triangular pointed, creating an interior ledge. A number of these bowls either are grooved or, due to specific folding of the rim, have a small ledge 1 cm below.
Fabric: Although this type was not thin sectioned, it has Ware A10 fabric, suggesting it was produced from somewhere further south than KEN.
Decoration: The two examples have white slip on the interior and exterior.
Frequency: Frequency statistics, stratum, locus, and spatial location
Parallels: Found only at KEN in Integrated Phases I–III

BL40: *Small fine-ware bowl with everted oblique rim (Figure 4.30:4)*
Description: This small fine-ware bowl has an everted rim at an oblique angle.
Fabric: Ware B1

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Decoration: R329 has black concentric lines on exterior body.
Parallels: Found only at RHI Sounding B

BL41: *Bowl with upright flattened rim and two grooves or applied bands on exterior (Figures 4.37:10; 4.32:15)*
Description: These large bowls have an upright flattened rim and two grooves or applied bands below the rim or further down on the body.
Fabric: Ware B4
Decoration: Some have white slip on the exterior and interior. One example (R589) has black concentric lines on the lower portion of its body, and R319 (Figure 4.32:15) has red slip with black concentric lines on the interior.
Parallels: This type occurs at KAM, TW, and RHI-B. R589 parallels nicely *Busayra* (Figure 9.20:13) and has similar three black concentric lines below ridges. Other BL41 have the ridges lower down on the body.

BL42: *Large deep interior beveled bowl (Figure 4.30:5)*
Description: These large bowls have deep upright walls and interior beveled rims.
Fabric: Only R316 belongs to Ware B4; the remaining examples range in color and have a finer fabric.
Decoration: Red slip, white slip red bands along with black concentric lines found on the interior and exterior
Parallels: Found only at RHI-B

BL43: *Bowl with multiple grooved section (Figure 4.30:6–7)*
Description: These rounded or tapered bowls have many grooves (5–7) in a section of the exterior of the body.
Fabric: One example has the local RHI-B4 ware; others vary (Ware B1).
Decoration: R164 has a white slip with a black upside-down triangle painting from the rim to the beginning of the grooved section.
Parallels: Found only at RHI Sounding B

BL44: *Bowl with carination and sloping-out to a thickened, flattened rim with depression (Figure 4.30:8)*
Description: This bowl is carinated at mid-section with the upper portion sloping out to a thickened, flattened rim that has a depression in the middle. R894 has a handle that attaches from the rim to the carination.
Fabric: Both have light red fabric with very fine pink core with several large calcite and quartz inclusions and no visible shales, possibly not local (neither thin sectioned).
Decoration: R894 has red horizontal slip on the rim and interior. R813 has a red to dark red horizontal slip on the interior.
Parallels: Found only at RHI Sounding B. See *Tell el-Kheleifeh* (pl. 33:5).

Large Bowls with Folded Rims: BL51, BL52, BL53, BL54, BL55

BL51: *Large bowl with inverted rim and exterior ledge with groove (Figure 4.33:9–10)*
Description: These large bowls have a sloping-out inverted rim. The rim also has an exterior ledge with a groove just before the ledge.
Fabric: Ware B1
Decoration: R116 has a dark slip on the exterior.
Parallels: This type occurs at KAM and TW (see table in Figure 4.42). This bowl occurs at *Tawilan* (Figure 6.5:3) and *Busayra* (Figure 9.16:16).

BL52: *Everted-rim bowl with sharp carination (Figures 4.34:12; 4.36:11)*
Description: This bowl has an upright-stance everted rim with a sharp carination just below the rim.
Fabric: Ware B1
Decoration: Not applicable
Parallels: This type was found only at the L2HE excavations at Tawilan. It was also published from Bennett and Bienkowski's (1995) excavations of *Tawilan* (Figure 6.6:8).

BL53: *Bowl with inverted turned-over rim (Figures 4.36:12–14; 4.37:11)*
Description: These large bowls have an inverted rim created from turning the clay over on top of itself from the interior to the exterior. The lip of the rim slopes inward, giving a beveled interior look.
Subtypes: BL53a have the interior thickened and sharp fold. BL53b are much shallower bowls; the interior fold is smoothly rounded, and there is a slight ledge on the exterior of the rim created by the completion of the fold. BL53c have a more pronounced exterior ledge on the rim with the groove below the rim.
Fabric: Ware B1
Decoration: Some BL53b have white slip and black concentric lines on the rim. R1028 and R813 have vertical black strokes on the rim.
Parallels: This type occurs at KAM, KIJ, TW, and RHI-B (see table in Figure 4.42). Compare BL53a with *Tawilan* (Figures 6.5:6; 6.6:10). BL53c are similar to *Tawilan* (Figures 6.5:2; 6.7:2, 3).

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BL54: *Large bowl with exterior ridge below rim (Figure 4.36:15)*
Description: These large bowls have an exterior ridge directly below the rim.
Subtypes: No separate subtypes could be distinguished, but each vessel is slightly different in rim form and formation of the ridge.
Fabric: Ware B1
Decoration: R926 has black strokes on the rim and exterior white slip with black cross-hatch painting. R106 has red slip below the interior of the rim and black concentric lines on the interior and exterior.
Parallels: Found only at the L2HE excavations of Tawilan

BL55: *Large bowl with sloping-out inverted turned-over rim with exterior ridge*
Description: This large bowl is sloping out and has an inverted rim with exterior ridge created by folding over the clay from the interior. BL55 are similar in construction to BL53 but slope out more and have a more pronounced exterior ridge.
Fabric: Ware B1
Decoration: White slip, red paint bands, and black concentric lines on rim and interior. T788 has black strokes on the rim also.
Parallels: This type occurs at KAM and TW. A couple parallels found in publications but not considered an important type by Oakeshott (1978). See *Busayra* (Figure 9.36:15) and *Tel el-Kheleifeh* (pls. 34:6–8; 35:2–5). They are also grouped with BL13 at *Tel Batash* Stratum II (pls. 60:7, 9; 64:14–15), where they are more sloped out and almost vertical; they also are red slipped and hand burnished. See also *Tel Gezer* Stratum VIA (pl. 20:20) with a less pronounced exterior ridge, which Gitin (1990) distinguishes from a more common version in Stratum VB/VA (pls. 24:5; 27:24).

BL56: *Thin fine-ware bowl with T-section rim (Figures 4.35:14–16; 4.32:16–17)*
Description: These fine-ware bowls are very thin and have an upright T-section rim. R1180 has a ridge below the rim.
Fabric: Ware B1
Decoration: Not applicable
Parallels: This type occurs at KAM, KIJ, KIS, and TW (see table in Figure 4.42).

BL57: *Thin medium- to fine-ware bowl with exterior ledge (Figures 4.36:16; 4.37:12)*
Description: These medium- to fine-ware bowls have an upright rim with an exterior ledge.
Fabric: Ware B1
Decoration: R901 has a white slip and black concentric line on the rim.
Parallels: Found only at the L2HE excavations of Tawilan in both areas.

Kraters: KR1–KR17, KR19, KR21, KR24–KR25

KR1: *Krater with sloping-in triangular-section rim (Figures 4.4:29; 4.22:24; 4.30:10)*
Description: It is a closed krater with a sloping-in triangular folded rim. The rim is folded on top of itself and shaped to create a sharp triangular ridge. These kraters are large, with a range in rim diameter of 29 to 34 cm.
Subtypes: Several have a straight wall from the neck while others are bent. The RHI example's stance is very different.
Fabric: Ware A1/A2, Ware B4 at RHI
Decoration: Remnants of white (R215, R207) and cream slip (R434) are found on the exterior and rim of the vessels.
Parallels: Found only at KEN in Integrated Phases I–IV; one example with different stance KR1b found at RHI Sounding B

KR2: *Krater with folded-over rim with a rounded ledge (Figures 4.2:9; 4.3:10)*
Description: These kraters' rims are constructed by folding the rim back on top of itself, creating a rounded exterior ledge at the end of the fold. The vessels are sloping in with a hole-mouth orifice. The rim diameters are 24 cm (R860) and 34 cm (R795). These kraters resemble KR15 in design but have much shorter rim folds (e.g., 2 cm).
Subtypes: Only one example is preserved past the rim—it has an approximately 4-cm-long neck before a carinated shoulder. One other example preserves a handled attached to the lower portion of the rim primarily at the ledge.
Fabric: Ware A1/A2
Decoration: R795 has an exterior white slip.
Frequency: Total (n = 2)
Parallels: Found only at KEN in Integrated Phases III–IV

KR3: *Upright, triangular-section rim (Figures 4.2:10–11; 4.4:10, 31; 4.5:1; 4.8:2; 4.13:5–14; 4.17:7; 4.19:18–19; 4.21:10; 4.23:4; 4.27:4)*

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Description: These kraters, with diameters over 25 cm, have upright, thickened, triangular-section rims with no neck between the rim and the body of the vessel.
Subtypes: These kraters can be subdivided into smaller thinner vessel types and much thicker, larger-diameter types. KR3a are typified by having a 2-cm-thick triangular rim and large diameters >29 cm. Some of these vessels have a groove below the rim fold, creating a more distinctive ledge—these have been designated KR3a2 (e.g., R596). KR3b are smaller, more delicate versions of KR3 with triangular rims around 1 cm thick and thin 1-cm-thick bodies. Rim diameters for KR3b range from 17 to 25 cm.
Fabric: Ware A1 and A2. Although calcite, a common inclusion in cooking pots, is present in these vessels as well as KR3b, none of the examples found show any evidence of soot from cooking, as commonly found on cooking pots. All of these kraters share the same ware but can vary in color from pale red to light gray. Calcite and mica are also commonly found in these thin sections.
Decoration: The fabric is often white or there is a white slip applied on the exterior. Several examples have handles attached from the rim to shoulder.
Parallels: This vessel was found at all areas excavated at KEN and one example from RHI-A. At both KEN and RHI-A, the associated layers were radiocarbon dated to the tenth century BCE, suggesting they were common in the area during the Early IA II. The Deutsches Bergbau-Museum team also found samples in their probe at KEN (Fritz 1996:Abb. 3:7–8).

KR4: *Upright, slightly thickened and flattened rim and exterior ledge with neck to carination (Figures 4.13:15; 4.17:8; 4.30:11–12)*
Description: This type has folded-over rims, creating a thickened exterior with ledge. The folded portion of the rim is 1 cm long from the lip in comparison to KR1 and KR2. A short neck (ca. 5 cm) is attached to the shoulder. These resemble conical jars due to the average rim size of 20 cm.
Subtypes: KR4a also have a minor groove on the interior of the vessel at the base of the rim treatment. KR4b resemble KR4a in rim design and stance but lack the carination and the interior groove.
Fabric: One example thin sectioned (R6, Figure 4.13:15) has an arkose-rich fabric with many red wadi stones as inclusions. The other example thin sectioned from KEN06, R1080, has the typical fabric found at the site with possible slag inclusions. The RHI example (R583, Figure 4.30:12) not only resembles morphologically these early forms, but the fabric and inclusions are very similar to R6.
Decoration: Every example has an exterior white slip.
Frequency: Total (n = 3). Only two examples of this vessel were found at KEN, although parallels to this form are common. R583 from RHI is combined with this group but may not be a continuation of the form. The low frequency makes it difficult to understand the seriation of this vessel type.
Parallels: This type occurs at KEN and RHI-B (see table in Figure 4.43). These vessel forms are similar to those found at *Beersheba II* Stratum VI (Figure 27:5, 6), *Lachish* Strata V–IV (B-25: Figure 25.17:26–27), *Hazor* Strata VI–VII (*Hazor II*: pl. 68:7; *Hazor III–IV*: pl. 247:25), *Samaria II* Period IV (Figure 6:15), and *Gezer III* Stratum VA (pl. 28:8). These vessels generally date between the ninth and eighth centuries BCE.

KR5: *Everted rim (Figures 4.2:12; 4.4:4; 4.14:1)*
Description: These kraters are various large open-size, bowl-shaped kraters with an upright long everted rim. Rim diameters range from 28 to 36 cm. Each vessel's everted rim and wall thickness are slightly different from each other.
Subtypes: One example, not depicted here, differs from the other vessels in having a depression along the center of the everted rim; it also has an attached handle.
Fabric: Ware A1
Decoration: Only R847 has a white slip on the interior and exterior.
Frequency: Total (n = 4)
Parallels: Found only at KEN in Integrated Phases II–VI; a variety of forms make comparison outside KEN difficult.

KR6: *Thickened, rounded exterior rim with long, upright, curving neck to shoulder (Figures 4.10:13–14; 4.14:2; 4.21:11)*
Description: This thickened and rounded exterior rim is attached upright to a short neck, leading to the shoulder of the krater. The lack of any examples with more than the beginning of the shoulder makes it difficult to determine the overall profile of the vessel and opens the possibility that they may be very large storage jars. All the diameters measured are over 30 cm and range up to 40 cm, while the thickness of the vessel body remains no more than 1 cm.

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Fabric: Ware A1/A2
Decoration: R734 and R884 have a white slip on the exterior and also on the interior for R734.
Frequency: Total (*n* = 4)
Parallels: Found only at KEN in Strata A2a–A3 and S2a (Integrated Phases II, III–IV).

KR7: *Upright, T-shaped krater bowl (Figure 4.14:3)*
Description: This large open-mouthed krater has a finely constructed upright T-shaped rim. Although the rim diameter is 36 cm, it remains very thin (ca. 0.5 cm). The characteristic design of the vessel warranted its inclusion in the typology in hope of finding parallels in the future.
Fabric: Ware A1/A2
Decoration: White slip on the exterior.
Frequency: Total (*n* = 1)
Parallels: Found only at KEN in Strata A2a (Integrated Phase II, ninth century BCE)

KR8: *Exterior rounded ridge on upright rim, sometimes slightly thickened on interior (Figures 4.2:13; 4.38:8; 4.5:2; 4.19:20–21; 4.23:5–7)*
Description: This large open bowl-like krater (ca. 28–35 cm diameter) has a rim folded outward, creating an exterior ledge. The stance is generally upright, but some examples slope in.
Fabric: All consistently Ware A9, white vitrified fabric
Decoration: White slip or fabric color is common on the interior and exterior, which suggests the color white was preferred for this vessel, resulting in either white fabric to be collected or slip to be applied to nonwhite fabrics.
Parallels: This type occurs at KEN and KAJ (see table in Figure 4.43). Although this krater type shares a similar morphological shape and everted rim treatment to other sites in Cisjordan, the characteristic white fabric is unattested outside KEN. It is found at *Lachish* Strata V–IV, which have red slip and horizontal burnish (Figures 25.20:6) or just the burnishing (Figure 25.21:22); *Gezer III* Stratum VIIA (pl. 11:5); *Samaria I* Period I (Figure 1:11); *Tell Qasile* Strata IX, VIII (Figures 53:6; 54:14); *Kadesh Barnea* Stratum 4 (pl. 11.1:16–17); and *Tel Masos* Area H (pl. 147:3). Tappy (1992:90–91) notes that these kraters have ancestral forms in the Late Bronze and continue through Iron I, ending in Iron II. This vessel type is found in early strata dating to the tenth to ninth centuries BCE.

KR9: *Krater with upright exterior thickened rim and short neck (Figures 4.8:3; 4.14:4; 4.21:12; 4.23:8–9)*
Description: These kraters have a rounded large bowl-type profile but with a short neck. They have simple rounded rims that are slightly thicker than the walls of the vessel. The rim is upright and continues 3 to 4 cm to the rounded shoulder. Some examples have strap handles attached to the rim and below the shoulder of the vessel.
Fabric: Ware A1
Decoration: A thick white slip on the interior and exterior occurs on six of the vessels.
Parallels: A common form (*n* = 20) found only at KEN. It is found in all of the integrated phases (I–VII).

KR10: *Very large bowls with thickened interior rim (Figures 4.2:14; 4.8:19; 4.23:1–2)*
Description: These large, deep bowls have diameters above 30 cm with thickened interior rims (*n* = 11). Also compare to smaller type BL35. This sample was classified as a krater because of its large size. These vessels are classified together according to general morphological form. Rim treatments vary from thickened interior flattened rims to plain flat rims. Many examples have bar or ledge handles attached on or below the rim.
Fabric: Ware A1 and A2
Parallels: This type occurs at KEN, TW, and RHI-B (see table in Figure 4.43). See BL35. A krater is simply a very large bowl; therefore, there are often parallels found between the two.

KR11: *Thickened exterior rim creating rounded exterior ledge and slightly interior ledge (Figures 4.14:5–6; 4.18:2; 4.20:1; 4.23:3)*
Description: This type has a thickened exterior rim flattened on the top with an interior folded ledge (*n* = 19). The rim is upright in stance and attaches to a long neck before reaching a soft carinated shoulder. Rim diameters range from 26 to 38 cm. Strap handles attached on the rim are found on a couple examples. No two examples are exactly alike.
Subtypes: Two subtypes are distinguishable by rim treatment. KR11a have rounded rim treatments with a less pronounced interior ledge, while KR11b are flattened from the exterior ledge to interior ledge, creating an almost pointed triangular appearance. KR11b2 are similar to KR11b but have even longer, more pronounced interior ledges, as well as a sharp bend between the rim and neck, and belong to the plateau site ceramic

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assemblages—these are all grouped together here based on similarities in morphology.
Fabric: KR11a have Ware A1 or A2 fabric. KR11b have Ware A1.
Decoration: This form also appears in white either by fabric or white slip on the interior and exterior.
Parallels: This type occurs at KEN (see table in Figure 4.43). In Edom, KR11b2 are paralleled at *Tawilan* (Figure 6.17:4). Kraters with different decoration and fabric but similar in rim treatment and carination are found at *Tel Batash* Stratum IV (Type KR14b; pls. 3:2, 8, 11; 4:2), *Lachish* Strata V–IV (B-21; Figures 25.3:5; 25.30:6; 25.41:9?), *Gezer III* Stratum VIA but with exterior undercut (pl. 21:6–9), *Hazor II* Stratum VI (pl. 68:4, 11), *Tel 'Ira* Strata VII–VI (Figures 6.68:14; 6.84:11), and *Beersheba* Strata III–II (Herzog and Singer-Avitz 2004:Figure 1:4).

KR12: *Upright, rounded rims, fairly flat on lip handles attached to rim (Figures 4.1:5–6; 4.7:11)*
Description: These large, open kraters have simple rounded or flattened rims. A 5- to 6-cm sloping neck from the rim leads to a rounded shoulder. Half the examples have handles attaching from the rim to shoulder of the vessel. These vessels are created on a wheel but made poorly in comparison to other vessels and have cooking pot fabric. Evidence of burning and soot is also found on the interior and exterior of the vessels. The rim diameters are typically over 30 cm. R632 from our sounding at Tawilan shares many similarities but has an even more crude fabric and a much smaller diameter of 20 cm.
Fabric: Fabric looks like cooking pot fabric and color-ware is standard 2B.
Decoration: Not applicable
Parallels: Found only at KEN (Integrated Phases II–V)

KR13: *Folded thickened interior rim (Figures 4.17:9; 4.21:13)*
Description: This krater has a folded rim that is sloping in, creating a more thickened interior. The rim is attached directly to the shoulder of the krater with a bend. The form is possibly similar to KR3a and resembles later folded rims found on the plateau.
Fabric: 2B/1
Decoration: White slip on interior and exterior occurs on the vessel.
Parallels: Found only at KEN (Integrated Phases I–IV)

KR14: *Thin krater bowl with folded-over rim and interior ledge (Figures 4.14:7; 4.30:13)*
Description: This krater bowl with a diameter over 30 cm has very thin walls (1 cm). The rim is folded over with an interior ridge. Morphologically, it is similar to kraters found at Tawilan that also have been grouped with KR14, but rim treatment and fabric are notably different.
Fabric: Ware A1 and B1
Decoration: Not applicable
Parallels: One possible occurrence is attested at KEN (Stratum A2b) but is primarily found at RHI-B, KAM, and TW.

KR15: *Krater with long folded rim (Figures 4.36:17–20; 4.30:14–17)*
Description: These large open bowl kraters have a long (3–4 cm) folded-over rim that is smoothed into the body on the exterior and bent in on the interior of the vessel (n = 66). The rim diameters of the vessels range from 26 to 45 cm but on average are between 30 and 35 cm. Strap handles are attached from the top of the rim to a lower portion of the body. See subtype discussion below for further details.
Subtypes: These kraters can be broken down into subtypes by rim treatment. KR15a have shorter folds than the other vessels along with less smoothing of the fold into the body and almost no interior bending. KR15a2 share the similarities of KR15a but have a shallow groove just above the ledge of where the fold ends. KR15b have long folds that are smoothed almost completely into the body and the interior is bent in, creating a thickened interior. KR15c are similar to KR15b but are even more significantly bent into where the rim is concave in the interior. KR15d, similar to KR15c, have concave interior bended rims, but the exterior fold is formed as a pronounced ledge; also, all examples of this form have a much thinner profile (<5 cm).
Fabric: All B4 ware at RHI has a consistent very pale brown color. In contrast, all the L2HE sherds are B1, and none have a very pale brown fabric. Instead, colors range from pale red to reddish grey. The fabrics are similar to the L2HE pithoi with abundance of calcite inclusions but few large quartz grains.
Decoration: Sometimes a white slip
Parallels: This type occurs at KAM, KIJ, TW, and RHI-B (see table in Figure 4.43). KR15a are paralleled at *Tawilan* (Figure 6.15:1), *Busayra* (Figure 9.21:8–9), and *Tel el-Kheleifeh* (pl. 22:1–4). KR15b have parallels at *Tawilan* (Figures 6.15:2; 6.16:3; 6.17:1), *Busayra*

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(Figure 9.40:2–5), and *Tel el-Kheleifeh* (pls. 23:1–6; 24:1–2, 4–5). KR15c have similar vessels at *Tawilan* (Figure 6.15:3) and *Tel el-Kheleifeh* (pl. 24:3). At *Tel Batash*, similar rim treatments are found on their kraters in Strata III–II (pls. 15:10; 21:7; 25:5–6; 58:24; 92:3), but these significantly vary in their depth, with smaller rim diameters averaging 25 cm, leading the authors to designate them "krater-jars." The strap handles also are only half attached to the rim and the remainder to vessel wall, while KR15's handles attach only to the rim.

KR16: *Short carinated neck kraters with folded-over rims*
Description: These kraters are more closed with a short neck (2–2.5 cm), leading to a carination. Rim treatment is related to other kraters of this period in being folded over; however, the fold is much shorter (see below for subtype description of varying rim treatment). The walls of these vessels are thin (<5 cm), similar to KR15c and KR17. Strap handles are attached from rim to body below the carination.
Subtypes: Subtypes can be distinguished by rim treatment. KR16a have longer, more pronounced folds that are more flat, creating a T-shaped appearance similar to KR17. KR16b have short folds that are rounded down with a pronounced ledge where the fold ends. KR16c have a short fold that is smoothed into the body. The neck between rim and carination on KR16c is generally shorter (12–16 mm) in comparison to KR16a/b (20–28 mm).
Fabric: Ware B1; fabric is either the same as KR15 or color only differs in being reddish yellow.
Decoration: White slip occurs on some of the vessels.
Parallels: This type occurs at RHI-B (n = 25; see table in Figure 4.43). For KR16a, see *Busayra* (Figures 9.21:12). KR16b are paralleled at *Tawilan* (Figure 6.17:8–9) and *Busayra* (9.22:8). Compare *Busayra* (Figures 9.21:13; 9.22:1) with KR16c.

KR17: *Krater with folded-over rim, T-shaped (Figures 4.30:18; 4.31:1–2; 4.32:18)*
Description: Large open bowl kraters similar to KR15 but with the long folded rim formed to create an interior and exterior ledge that is nearly horizontal (T-shaped) to a 45-degree angle. The rim is created by an inner bend and then a fold over the rim, causing the exterior fold to be horizontal. In some examples, the exterior fold has a pronounced ledge. Rim diameters average 30 cm. Vessel walls are thin (<5 cm). All examples preserve small in diameter strap handles in comparison to KR15 strap handles.
Fabric: Ware B1; all the same fabric, except R825 is reddish yellow. The two types from KAM share similarity in form enough to be typed together but color fabric is pink.
Decoration: White slip occurs on most vessels
Parallels: This type occurs at KAM and RHI-B (see table in Figure 4.43). Similar to *Tawilan* (Figure 6.16:2) and *Busayra* (Figure 9.22:7).

KR19: *Upright, thickened, rounded rims with short neck before shoulder (Figure 4.36:21)*
Description: These kraters have an upright, thickened rim with a short, upright neck before the shoulder, creating a more closed type of krater. Rim treatment varies on each vessel but primarily is not much thicker than the wall of the vessel.
Fabric: Ware B1
Decoration: Not applicable
Parallels: One example was found at L2HE's excavation of Tawilan Area J. Similar types have been found in surveys conducted in the region (MacDonald 1988:Figure 11:14; MacDonald et al. 2004:170:1; 259:1).

KR21: *Krater with thickened and beveled exterior rim (Figure 4.2:15)*
Description: This krater has a thickened exterior rim that is beveled (n = 2). At the base of the rim, it attaches to the body of the vessel with a bend. The only preserved examples are both broken at the bend, limiting further description. Rim diameters are 30 cm (R1213) and 34 cm (R1406).
Fabric: Ware A1 and B1
Decoration: R1213 has a white slip on the interior and exterior.
Parallels: Documented only at KEN, RHI Sounding B, and L2HE sites.

KR24: *Large thick open bowl krater with upright thickened rim and short neck (Figures 4.4:30; 4.17:10)*
Description: These large krater bowls are thick and have an upright thickened exterior rim and a short upright neck that curves outward to the body of the vessel (n = 2). One example (R438) has a strap handle attached from the rim to the body of the vessel.
Fabric: Ware A1
Decoration: White slip on interior and exterior
Parallels: Found only at KEN in the fill of Stratum A1b and Stratum T2a (Integrated Phases I and III).

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KR25: *Krater with upright rim with exterior ridge and sloping-out neck (Figure 4.14:8)*
Description: This more closed krater has a sloping-out neck to the shoulder and a thickened exterior rim that is short.
Fabric: Ware A1
Decoration: Not applicable
Frequency: Total (*n* = 5)
Parallels: Found only at KEN Areas A and R.

Jugs

JG1: *Jug with deep groove along midsection of handle*
Description: Only two examples were found during two different time periods. Only the handle is preserved, which has a characteristic deep groove down the midsection of the handle, splitting it into two halves. The grooves are made slightly different, but handle size and design otherwise are nearly identical.
Fabric: Both examples are made of a white fabric, Ware A9.
Decoration: Not applicable
Parallels: Found at KEN Area A and RHI-B. Compare with *Busayra* (Figure 9.56:16).

JG2: *Jug with folded-over and undercut rim (Figure 4.10:16)*
Description: This large jug has a folded-over rim that has been undercut. The jug has a short neck (5 cm).
Fabric: Ware A1
Decoration: Not applicable
Parallels: Found only at KEN Area A, Stratum A2b and A3 (Integrated Phases II–IV).

JG3: *Jug with ridge below rim (Figures 4.1:7; 4.5:3; 4.9:2; 4.17:11; 4.21:14–15; 4.34:13)*
Description: These medium-size jugs have upright, ridged rims, around 7 to 10 cm in diameter. Many examples are also spouted. The sharpness and size of the ridge vary.
Fabric: JG3 are generally a lighter color, ranging from white to pink to very pale brown. Some examples have white slip on the exterior.
Subtypes: The ridged rim jug continues from IA IIA to later periods, but the distinction in rim treatment and ridge can be distinguished. The JG3a group has rims with the same thickness as their neck's profile, averaging around 7 to 8 mm. JG3a1 have an upright rounded or slightly exterior thickened rim with a pointed ridge below the end or the rim fold. JG3a2 have a rounded upright rim and a less pronounced rounded ridge below. JG3b are similar to JG3a in having a rim with the same thickness as the neck but have a rounded, sloping-out spouted rim with a pronounced rounded ridge below. JG3c have a sloping-in, thickened exterior rounded rim with a low unpronounced rounded ridge. JG3d1 have an upright thickened exterior rim with a rounded ridge at the lower ledge of the fold. JG3d2 are similar to JG3d1 but have a more pronounced pointed ridge. JG3e have a thickened rim with a ridge created by a groove. JG3f have an unpronounced rounded ridge and overhanging ledge on the lip.
Fabric: The predominant ware found at KEN is the white Ware A9. Only one example of JG3a has the standard A1 ware but is vitrified from high firing; the gray and red shales can be seen in the core. The erosion of limestone can be seen from high firing. JG3b are similar to the other groups but are very fine with no large quartz inclusions as found for JG3a. The have a light greenish gray core and exterior. JG3d: R1146 has a large quartz inclusion and limestone-typical 2b. The ware, however, has an olive brown core and exterior.
Decoration: Not applicable
Parallels: This type occurs at KEN, KAM, KIJ, KIS, TW, and RHI-B (see table in Figure 4.43). JG3b are paralleled at *Busayra* (Figure 9.55:3, 5). For JG3d1, compare *Busayra* (Figure 9.54:8–10), *Tawilan* (Figures 6.26:1–2, 4; 6.27:8), and *Tell el-Kheleifeh* (pls. 20:1, 4–5; 21:1.3–4, 6). For JG3d2, compare *Tawilan* (Figures 6.26:3; 6.27:6) and *Tell el-Kheleifeh* (pls. 20:2; 21:5). For JG3f, compare *Tawilan* (Figure 6.27:4). This is a popular jug type in Edom found at *Busayra* (Figures 9.54:8–11; 9.55:1, 3, 5–6), *Tawilan* (Figure 6.26:1–4), *Tell el-Kheleifeh* (pls. 20:1–5; 21:1–8), and *Ghrareh* (pls. 18:1–2; 19:1–7). In Cisjordan, it is found at *Horvat Qitmit* (Figures 4.3:22; 4.5:29; 4.14:2, 8; 4.16:15), *Tel 'Ira* Stratum VII (Figures 6.74:20; 6.87:15; 6.88:16), and *Tel Masos* Stratum II and Late IA II (pls. 135:9; 166:10); see *Tel Arad* Strata IX–VIII (trefoil mouth: Figures 32:14; 35:9; spouted: Figure 38:3), Strata XII–XI (Figures 3:4; 4:4), *Beersheba II* Stratum IX (Figure 19:6), *Beersheba I* Stratum II (pl. 68:18), *Lachish* Stratum III (Figure 26.31:9), and *Tell Beit Mirsim III* (pl. 14:6). For the JG3a group, see *Gezer III* Strata VIB–A (pls. 12:16?, 18; 15:3; 19:6; see discussion of type on pp. 146–147) and *Hazor II* Stratum VIII (pl. 58:14). This rim design is popular throughout the Iron Age, but more precision is needed to clarify significant chronological differences and change over this long period.

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Jugs with Thickened Exterior Rims and Handle Attached at Rim: JG4, JG6, JG9–JG12, JG14–JG18, JG21, JG26–JG29, JG31, JG34, JG36

JG4: *Jug with triangular thickened rim (Figures 4.7:12; 4.10:17–18; 4.14:9–10; 4.23:13)*
Description: These jugs have rims that have been folded over, creating a triangular, thickened exterior rim. Some examples are spouted.
Subtypes: The subtypes JG4a and JG4b have been distinguished by size. JG4a have small triangular rims with an average height of 8 to 12 mm. JG4b are large jugs with triangular rims in the range of 14 to 16 mm. The small and large triangular rims are grouped together for JG4d, which are a spouted version of this type.
Fabric: JG4 typically have Ware A1 fabric, but one thin-section example of JG3d (R467) has visible slag in the core and thin section, Ware A2. JG4A from KIS (R1144) are standard vitrified B1, as seen for JG3d.
Decoration: Not applicable
Parallels: This type occurs at KEN, KAJ, RHI-A, KAM, KIS, TW, and RHI-B (see table in Figure 4.43). For JG4b, see *Tell el-Kheleifeh (pl. 21:9)*, *Tawilan* (Figure 6.28:3, 6), and *Busayra* (Figures 9.55:4; 9.60:11?). R1058 is inverted, creating an external triangular section; compare with *Busayra* (Figure 9.58:2). These jugs are found at *Busayra* (Figure 9.58:1, 2), *Tawilan* (Figure 6.28:6), *Tell el-Kheleifeh* (pl. 21:10), *Ghrareh* (pl. 19:16), Feifa (Lapp 1994:Figure 12–2:10, 11), *Tel 'Ira* Strata VIII–VI (Figures 6.73:3; 6.71:6; 6.84:15; 6.103:4–5), *Tel Masos* Strata II–I (pl. 137:11; 139:6; 152:6), *Tel Arad* Strata XII–XI (Figures 3:2; 3:6:9–10; 9:1), *Lachish* Stratum III (Figure 26.27:5), *Beersheba II* Stratum VI (Figure 28:9), *Beersheba I* Strata V–IV (pls. 53:16; 55:17), and *Kadesh Barnea* Stratum 4b (pl. 11.23:5). This vessel type is found primarily in Iron Age IIA strata but is also found at all the sites on the plateau.

JG6: *Jug with thickened, bent-up exterior rim (Figures 4.10:19–21; 4.11:1; 4.14:11–12; 4.20:2–3)*
Description: These bent-up, slightly thickened rounded exterior rims of medium-size jugs are possible variants of JG4. In contrast to JG4, the exterior is blended into the neck of the vessel.
Subtypes: JG6a are concave on the interior, and the exterior is very unpronounced. JG6b are concave on the interior but more pronounced on the exterior. JG6c have a bent-up appearance with unpronounced exterior. JG6d are JG6a but with evidence of being spouted.
Fabric: Ware A1/A2
Decoration: Not applicable
Parallels: This type occurs at KEN, KAM, KIJ, TW, and RHI-B (see table in Figure 4.43). This jug shares similar rim treatment to *Tel 'Ira* Strata VII–VI (Figure 6.68:16) and *Tel Arad* Stratum XII (Figure 1:6).

JG8: *Thin-walled upright tapered rim jug (Figure 4.23:14)*
Description: These jugs are very thin walled (3–4 mm) with a straight upright rim that has been tapered. The average rim diameter is 8 cm. One example, R191, has a strap handle attached at the rim.
Fabric: Ware A1
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phases I–V.

JG9: *Jugs with handle attached to rim with thickened exterior (Figures 4.2:16; 4.5:4; 4.11:2; 4.23:15–16)*
Description: These are various jugs with strap handles preserved and thickened exterior rims, but generally only the area where the handle attaches to the rim is preserved, making specific identification difficult (compare with JG4 and JG6).
Fabric: Ware A1 and B1 for examples from later sites
Decoration: Not applicable
Parallels: See JG4 and JG6.

JG10: *Spouted jug with turned-out rounded rim and short neck (Figures 4.9:3; 4.21:16)*
Description: These spouted jugs have short necks with a turned-out rim, creating a larger diameter orifice than the diameter of the neck. Rim diameter averages 8 cm. The rim itself is rounded, but the curvature is more flat along the lip than along the sides. All examples are from KEN except R699 from Tawilan, which shares a similar design but has been undercut to create a more defined ledge from where the rim is turned out. All the examples from KEN are simply rounded and turned out.
Fabric: Ware A1 and B1
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phases II–V and possibly Tawilan

JG11: *Upright rounded rim jug with undercuts under the exterior of the rim*
Description: The distinguishing feature of this jug from simple upright rounded rim jugs is the decoration of creating undercuts in the clay at the bottom of the rim and upper portion of the neck. These cuts create many ledges.

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Fabric: Ware A1
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phase III

JG12: *Jug with slightly everted rounded rim and groove below lip (Figures 4.1:8–9; 4.8:4)*
Description: These small-diameter jugs (ca. 6 cm) have slightly everted rims creating a significantly larger orifice than their neck diameter (2–3 cm). A majority are grooved below the everted rim, creating a second ridge nearly horizontal to the oblique position. Each vessel is slightly different in thickness and how the exterior groove is created. R831 has a strap handle attached but preserves only a portion of the rim.
Fabric: Ware A1 and A9
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phases I–III, V

JG14: *Small jug with upright, thin, flat, or rounded rim (Figures 4.2:17; 4.38:18; 4.5:5; 4.11:3; 4.14:13; 4.20:4)*
Description: These are various small jugs with upright, simple, flattened, or rounded rims. These vessels have thin walls (<5 mm). Rim diameter of these jugs ranges from 5 to 7 cm. Small strap handles are attached from jug rim to body.
Fabric: Ware A1 and B1
Decoration: Some jugs have a white slip on the exterior.
Parallels: Found only at KEN in Integrated Phases I–V and KAJ

JG15: *Long neck jug with thin upright, rounded rim (Figures 4.2:18; 4.9:4; 4.14:14; 4.17:12; 4.23:10–11)*
Description: These are medium-size jugs with simple, rounded rims upright or sloping out.
Subtypes: JG15b (R623) is distinguished from JG15a by the presence of a groove 5 mm below rim of the vessel. JG15c are finely painted jugs of this type (see Decoration below).
Fabric: Ware A1
Decoration: Horizontal black stripes are found on the neck of this vessel. A white slip on the exterior is also found on R423.
Parallels: This type occurs at KEN (see table in Figure 4.43). Jug-size types are found at *Busayra* (Figure 9.59:3) but also much earlier at *Tel Arad* Stratum XII (Figure 3:10) and may be related to an earlier form found in the Iron I *Samaria I* Period I (Figure 1:8). This vessel type appears to be early tenth to ninth centuries BCE, but the parallels are limited.

JG16: *Narrow-necked jug with everted carinated rim (Figure 4.5:6)*
Description: The rim is everted and carinated at the lip, with a narrow neck, 3 cm in diameter. Only one example is present in the assemblage; the jug has a white slip on the interior and exterior.
Fabric: Ware A1
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phase III

JG17: *Jug with middle ridge halfway below neck (Figure 4.14:15)*
Description: There are only two partially preserved examples found at KEN. These jugs have around 5 cm below the rim on the neck a pushed-out ridge from where a strap handle is attached (R1121). The examples found at RHI have triangular rims similar to JG4. At KEN, however, the two possible similar examples are both broken at the ridge, making determination difficult between early and late forms. Rim stance differs; R482 is upright while R831 is sloping out.
Fabric: Ware A1
Decoration: R482 has an external white slip.
Frequency: Total (n = 2)
Parallels: See *SIGNAS* (pl. 20:5) as possible parallel with KEN forms. For RHI examples, compare with *Tawilan* (Figure 6.29:7, 8), *Tell el-Kheleifeh* (pl. 32:7?), and *Busayra* (Figure 9.56:1–10) but note rim treatment is different. In Cisjordan, see *Tel Batash* Stratum II (pl. 49:4–5, 6?) and compare with decanters that have a more everted and thickened rim: *Tel Batash* Stratum II (JG14; pl. 59:6; 61:8) and *Gezer* Stratum VIB (pl. 12:21). These jugs are found only in Late Iron Age II contexts.

JG18: *Jug with everted rim and short neck (Figure 4.4:5; 4.19:8)*
Description: The rim is everted on a medium-size jug with the most complete example having a short neck.
Fabric: Ware A1
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phase V

JG21: *Small jug with turned-out rim and large strap handle (Figure 4.7:13)*
Description: This jug is similar to JG18 but has a much smaller diameter, although it has a large handle (2 cm).
Fabric: Ware A1
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phases I, III

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JG26: *Cooking jug with inverted rim and exterior ridge (Figure 4.38:11)*
Description: These jugs have a rim that is inverted, creating an exterior ridge and rounded thickened interior. The sharp bend of the rim creates a small concavity below the rim of the jug on the interior. These jugs are called cooking jugs according to fabric (see below).
Fabric: The fabric of these jugs is commonly associated with cooking pots (A6). The ridge created on the rim also relates it to contemporary cooking pots.
Decoration: Not applicable
Parallels: This type occurs at KEN and KAJ (see table in Figure 4.43).

JG27: *Spouted jug with routed rim (Figure 4.31:3)*
Description: This spouted jug has the upper portion of the thickened rim sliced away, creating a routed look. The closest rim treatment is found in JG3.
Fabric: Ware B1
Decoration: White slip has been applied on the interior and exterior of vessel.
Parallels: Found only at RHI-B (*n* = 1)

JG28: *Large jug with folded-over and rounded exterior rim*
Description: These large jugs with thin walls have a rim that is folded over, and the fold is then rounded, creating a similar bulbous appearance to the rim found on collared rim pithoi.
Fabric: Ware B1
Decoration: Not applicable
Parallels: This type occurs at KIS, TW, and RHI-B (see table in Figure 4.43). Possibly the same as *Tawilan* (Figure 6.28:2), but drawing makes thickened exterior to protrude significantly more than JG28.

JG29: *Small jug with ridge and handle at mid-neck with everted rims*
Description: This small jug (rim diameter 2 cm) has a ridge at mid-neck where a loop handle is attached. Two examples have preserved rims that are everted and thickened.
Fabric: Ware B1
Decoration: White slip applied on exterior is present on R138.
Parallels: Found at RHI-B (*n* = 3). Compare with *Busayra* (Figure 9.57:6–7) and *Tawilan* (Figure 6.29:3–5).

JG31: *Large jug with inverted bent rim*
Description: This large, thick, heavy jug has an inverted bend in the rim that is slightly thickened on the interior. A large strap handle is attached at the rim.
Fabric: Ware A1
Decoration: A white slip is applied on the exterior.
Frequency: Total (*n* = 1). Frequency statistics, stratum, locus, and spatial location.
Parallels: Found only at KEN in Integrated Phase II

JG34: *Small jug with bent-in and thickened interior rim.*
Description: This is a small jug with a rim that is bent in at an angle and then thickened at the lip. The strap handle is attached at the rim and the joint of the bend.
Fabric: Ware A1
Decoration: Heavy white slip on the exterior
Parallels: Found only at KAM (*n* = 1)

JG36: *Jug with sloping-in short neck and folded-over and beveled rim*
Description: This large-mouthed jug (10 cm) has a sloping neck. The rim is folded over and beveled on the exterior.
Fabric: Ware A1
Decoration: Not applicable
Parallels: Found only at KIJ (*n* = 1)

Juglets

JT1: *Juglet with upright rounded rim (Figures 4.1:11; 4.24:4)*
Description: These juglets have upright rounded rims (diameter average 3 cm). Loop handles are attached to a couple examples.
Fabric: One thin section conducted and stan
dard A1 ware. Core has visible shales but well sorted and fine. Exterior color ranges from red to light reddish brown. One small juglet (R31) has a very fine pink core with no visible inclusions.
Decoration: Only one example possesses a white slip. Several are burnished.
Parallels: Found only at KEN in Integrated Phases I–III, V

JT2: *Small juglets with short necks (Figure 4.7:15)*
Description: These juglets have 2-cm rim diameters and short necks.
Subtypes: Only two examples are found at this size and they vary in design.
Fabric: Ware A1

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Decoration: R1252 has red slip and burnish.
Parallels: Found only at KEN in Integrated Phases II–III, V

JT3: *Juglet with short neck and upright rims with strap handles (Figures 4.10:6; 4.15:3; 4.21:17; 4.24:6)*
Description: These jugs have simple upright rounded rims (diameter ranges 4–5 cm). They have short necks (ca. 2.5 cm) and strap handles attaching from rim to shoulder of the vessel. R523 has the only preserved shoulder that suggests these were globular bodied.
Subtypes: The stance and design of each juglet are slightly different.
Fabric: Ware A1
Decoration: Some examples have white slip on the exterior.
Parallels: This type occurs at KEN and RHI-B (see table in Figure 4.44).

JT13: *Spouted juglets with upright rounded rim and short neck (Figure 4.31:4)*
Description: These juglets are spouted with upright rounded rims. The neck is short (4 cm) before the shoulder of the vessel.
Fabric: Ware A1 and B1
Decoration: White slip is found on the exterior or white fabric is common.
Parallels: Found only at KEN in Integrated Phases II–V

JT17: *Juglet with ridge on neck*
Description: This juglet has an upright, thickened exterior rim and lower ridge on the neck at the attachment of the handle.
Fabric: Ware B1
Decoration: Not applicable
Parallels: This juglet, found only at RHI Sounding B, was partially preserved to below the attachment of the handle, making comparison with complete vessels difficult. Juglets that parallel the upper portion are found at *Tel 'Ira* Stratum VII (Figure 6.74:17), *Tel Masos* Stratum I (pls. 139:10; 144:12; 148:4; 161:8), *Tel Arad* Strata XI (Figure 4:8), *Tel Batash* Stratum III (pl. 88:12?), *Lachish* Stratum IV (Figure 25.20:21), *Kadesh Barnea* Stratum 4b (pl. 11.15:12), and *Tell Beit Mirsim III* Stratum A (pl. 16:7). This juglet, with its characteristic rim and ridge on the neck, possibly a single handle attached, appears from the tenth to the mid-eighth centuries BCE.

JT19: *Juglet with dimple base and handle attached at mid-neck (Figures 4.17:13; 4.20:6)*
Description: This juglet has a long, straight, narrow neck and dimple base. The loop handle is attached from the mid-neck to the shoulder. This is the only near-complete example found, but it lacks the black burnish typical of this juglet type (black-burnished sherds belonging to juglets were found at KEN and may belong to the same group).
Fabric: Ware A1
Decoration: Not applicable
Parallels: Found at KEN Areas A, S, an R. See similar juglet form, but black burnished, at *Beersheba II* Stratum VI (Figure 30:6, 7), Lachish Tomb 521 IAIIA (Tufnell et al. 1953:pl. 88:328), *Tel Arad* Stratum XII (Figure 3:5), *Kadesh Barnea* Stratum 4 (pl. 11.2:16), and many other sites (see Amiran 1969:256). It is generally dated to the tenth to ninth centuries BCE.

JT21: *Black burnished juglet (Figure 4.5:9)*
Description: Only small fragments of the body and loop handles of these juglets have been found, but they fit a similar design as the classic black-burnished juglets in Judah.
Fabric: Ware I3, imported from the vicinity of Jerusalem
Decoration: Black burnish
Parallels: Found at KEN Area T Integrated Phase III and Area A Integrated Phase II. See similar juglet form, but black burnished, at *Beersheba II* Stratum VI (Figure 30:6, 7), Lachish Tomb 521 IAIIA (Tufnell et al. 1953:pl. 88:328), *Tel Arad* Stratum XII (Figure 3:5), *Kadesh Barnea* Stratum 4 (pl. 11.2:16), and many other sites (see Amiran 1969:256). It is generally dated to the tenth to ninth centuries BCE. JT21 at KEN is strong evidence that links the trade and social interaction between KEN and the western Cisjordan sites during the tenth to ninth centuries BCE.

JT22: *Cypriot black-on-red (Cypro-Phoenician) juglet (Figures 4.2:20–21; 4.3:11; 4.4:11; 4.5:10; 4.24:5)*
Description: These fragments of black-on-red juglets have very thin, well-fired clay with burnish and black-on-red painting (see discussion below on imports).
Fabric: Ware I4
Decoration: Not applicable
Parallels: These imports to KEN are found at many sites in Cisjordan and elsewhere, dating to the tenth to ninth centuries BCE (cf. Singer-Avitz's [2004] discussion of this vessel for southern Israel). This import is another clear indicator of KEN's interaction with the Cisjordan sites during the Early IA II period.

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JT23: *Trefoil juglet (Figure 4.11:4; 4.20:7)*
Description: This is a trefoil juglet with a long neck and oblong body; not globular.
Fabric: Ware A1
Decoration: Not applicable
Parallels: The trefoil rim (*n* = 3), found at Areas A, S, and T during Integrated Phase III, has many parallels from northern sites and possibly originated from Phoenicia (Tappy 1992:196–197). Similar examples were found at *Samaria I* Period III (Figure 5:5), *Hazor II* Strata VIII and VA (pls. 58:25; 88:2), and *Hazor III–IV* Stratum IXb (pl. 176:1, 3). For globular jugs with a short neck, see *Tell el-Kheleifeh* (pl. 31:9) and *Tel Masos* Stratum I (pl. 160:12). Parallels suggest this is a tenth- to ninth-century BCE vessel type.

JT26: *Juglet with sloping-out rim*
Description: This is a juglet with a rim sloping out from the neck. White slip is common.
Fabric: Ware A1
Decoration: Not applicable
Parallels: This type occurs at KEN and KAJ (see table in Figure 4.44). Somewhat similar juglet forms are found at *Tel 'Ira* Stratum VII (Figure 6.83:16), *Tell Beit Mirsim III* Stratum A (pl. 18:12, 23–29), and *Tell Beit Mirsim II* Stratum B (pl. 51:12) and Stratum A (pl. 68:33–44).

Jars

JR1: *Slightly thickened exterior, rounded rim, with no neck and thin walls (Figures 4.19:5; 4.20:8; 4.23:18)*
Description: This hole-mouth jar has a slightly thickened exterior, rounded rim, and thin walls.
Fabric: Ware A1 and B1
Decoration: Some have white slip on the exterior.
Parallels: This type occurs at KEN (see table in Figure 4.43). Similar to PT10 but much smaller; see parallels above.

JR2: *Jar with folded-over rim and thin ridge at end of fold (Figure 4.1:12)*
Description: This neckless jar has an upright thin folded-over rim that is blended into the body but then has an added thin ridge at the end of the fold.
Fabric: Ware A1 and B1
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phases III, V

JR3: *Neckless jar with upright rounded rim*
Description: This jar has no neck but rather has an upright rounded rim directly attached to the body of the vessel.
Fabric: Ware A1 and B1
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phases II–V

JR4: *Long fold of upper rim; sometimes grooved on folded rim (Figures 4.15:4; 4.21:18)*
Description: This thinner-walled hole-mouth jar has a folded-over rim flattened into the wall and then grooved. The rim treatment parallels the pithos size version (PT19).
Fabric: Ware A1 and B1
Decoration: R788 has a white slip on the exterior and interior.
Parallels: This type occurs at KEN (see table in Figure 4.43). The Edomite examples from the plateau are thicker and more upright; see Busayra (Figure 9.42:1–5), Tawilan (Figures 6.22:1; 6.24:3; 6.25:1), 'Umayri Phase IP3 (MPP I: Figure 19.7:6), Dibon (Tushingham 1972:Figure 1:29–32), and Tel Arad Stratum XI (Figure 4:2).

JR5: *Folded-over phalanged jar (Figure 4.11:5)*
Description: This jar has a unique rim treatment involving a folded-over rim that is then inverted and depressed along the lip, creating a phalange from the lower portion of the exterior fold. It may be a variant of JR6.
Fabric: R682 has a very pale brown fabric similar to what is seen at RHI in kraters. This fabric is the most consistent in this type represented in 10 examples. This example was highly fired with the same color core and slag inclusions. R263 is darker but has a similar fabric with many small slag inclusions. R763 was not thin sectioned but differs from the others in having a red fabric similar to what is found in the jugs (R54). R908 from KAJ has a similar fabric but also has arkose and basalt.
Decoration: White slip on exterior and cream slip/wash on interior. R263 has a black band below the everted rim with vertical strokes spaced every 2 cm around the lower portion of this band.
Parallels: Found only at KEN in Integrated Phases III–IV

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JR6: *Long, everted rim with slight depression in the middle of lip (Figures 54.1:13; 4.38:16; 4.5:11; 4.9:7; 4.15:5)*
Description: This large jar has a characteristic long, everted rim that is then slightly depressed after the fold. Strap handles are attached to the end of the everted rim. These jars vary in thickness of vessel wall, length of everted rim, and depth of the depression.
Fabric: Ware A1 and B1
Decoration: R263 has a black concentric line on the exterior below the everted rim with horizontal strokes spaced every 2 to 3 mm. R763 and R70 have white slips on the exterior.
Parallels: This type occurs at KEN, KAJ, and RHI-A (see table in Figure 4.43). See *Busayra* (Figure 9.52:1), *Tawilan* (Figure 6.32:3), *Kadesh Barnea* Stratum 4b (pl. 11.8:5), and Barqa el-Hetiye (Fritz 1994:Abb. 10:7).

JR7: *Thickened exterior rim with neck before shoulder (Figure 4.15:6–7)*
Description: These are jars with short, upright necks and various subtypes of rim treatment. Rim diameter ranges from 10 to 12 cm—these could possibly be jugs. Figure 13:21 has an upright thickened exterior rim, while Figure 13:20 is less pronounced.
Fabric: Only R351 was thin sectioned, primarily due to its very fine well-sorted high-fired white fabric (see JG3). The later example from Tawilan (R992) has a reddish brown fabric of typical ware (see KR15).
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phases II–III. Compare Figure 13:20 to *Busayra* (Figure 9.50:8–12) for generic jar types found in Edom.

JR8: *Jar with sloping-up short neck and upright flattened exterior ledged rim (Figures 4.4:6; 4.8:5; 4.9:8)*
Description: These small globular jars (R1003) have a short neck that slopes upward to the upright rim that is flattened with a exterior ledge.
Fabric: Ware A1 and B1
Decoration: White slip is found on the exterior of these vessels.
Parallels: Found only at KEN in Integrated Phases II–V

JR9: *Hole-mouth jar with flattened rim and sloppy overhanging ledge*
Description: This hole-mouth jar is possibly mold made and has a flattened rim with excess clay pushed over the exterior of the rim unevenly.
Fabric: This standard 2B fabric color highly varies from pale red to pink and fabric appears brittle.
Decoration: A white slip is found on the exterior.
Parallels: Found only at KEN in Integrated Phase III

JR10: *Hole-mouth wheel-made jar*
Description: These hole-mouth jars have simple rounded rims and are wheel made.
Fabric: Standard ware similar to JG6d and has slag inclusions
Decoration: White and cream slip found on the exterior
Parallels: Found only at KEN in Integrated Phases III, V

JR11: *Thin wheel-made holemouth jar with slightly turned-up rounded rim (Figure 4.7:5)*
Description: These hole-mouth jars are thin, well fired, and wheel made. The rounded rims are slightly turned up
Fabric: R346 has a reddish yellow core and fabric is similar to JG6D, R54.
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phases III–V

JR12: *Hole-mouth jar with two grooves below rim*
Description: This hole-mouth jar has two deep grooves on the shoulder of the jar just below the rim.
Fabric: Ware A1 and B1
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phases II–III

JR13: *Hole-mouth jar with thickened exterior rim and crosshatch painting (Figure 4.5:12)*
Description: This wheel-made hole-mouth jar has a thickened exterior rim that has been folded over. This vessel has a black concentric line on the rim and below the thickened exterior portion of the rim. Black crosshatch follows below the exterior line.
Fabric: Pale red fabric standard 2B
Decoration: Not applicable
Parallels: This type occurs at KEN and RHI-B (see table in Figure 4.43).

JR14: *Hole-mouth jar with long thin folded-over rim and slight depressed lip*
Description: These very thin small-diameter (10-cm) hole-mouth jars have a long, thin folded-over rim that is blended into the body. The lip of the jar depression causes the remaining portion of the folded rim to be thicker than the lip.

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Fabric: Similar fabric to JR6; has slag inclusions. R816 has a black color fabric but core similar.
Decoration: Not applicable
Parallels: This type occurs at KEN (see table in Figure 4.43). Possibly similar to *SIGNAS* (pl. 19:3), but this vessel is much larger and twice as thick as examples.

JR15: *Upright, thickened exterior rims with ridge halfway down on neck (Figure 4.15:8–9)*
Description: These are storage jars with a ridge on the neck that inclines with upright, thickened exterior rims.
Fabric: Standard JG6D fabric with slag inclusions
Decoration: White slip is applied on the exterior of all three examples.
Parallels: This type occurs at KEN and RHI-B (see table in Figure 4.43). Site 159 (KEN in SIGNAS survey) has published this vessel (pl. 18:5). Parallels outside KEN are rare, but see *Gezer III* Stratum VIB (Type 2A pls. 12:4, 5; 14:10) and *HAZOR*. A similar profile but smaller diameter is found at *Busayra* (Figures 9.50:6–7; 9.60:16?).

JR16: *Small jar with upright rim (Figure 4.17:14*
Description: This is a very small (rim diameter 10–12 cm), delicate jar, with an upright thickened exterior rim.
Fabric: R1325 was selected for thin sectioning due to its different-looking fabric. This is a single example of I5 from Phoenicia. The other JR16 looks like it is from local fabric, especially R448, which has visible slag inclusions throughout.
Decoration: R1325 has a dark red slip.
Parallels: Found only at KEN in Integrated Phases I, III–IV, but R1325 should be expected to have parallels in Phoenician sites based on the petrographic analysis (see Chapter 3).

JR17: *Upright, thickened exterior flattened or rounded rims with upright neck leading to shoulder (Figure 4.3:1)*
Description: These jars have thickened and flattened rims with an upright neck curving out to the shoulder
Fabric: S R767 has white fabric A9, distinguishing it from the other JR17. JR17 have standard A1 fabric; neither have slag. R66 has a high limestone content.
Decoration: Not applicable
Parallels: This type occurs only at KEN (see table in Figure 4.43). (Figure 6.30:6)

JR18: *Jar with sloping-in short neck and rolled-over triangular-pointed rim (Figure 4.5:13)*
Description: These jars have sloping-in short necks with a rolled-over rim that is then shaped to create a rounded point or ledge.
Fabric: Ware A1
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phases III, V

JR19: *Jar with short everted rim and depression (Figure 4.21:19)*
Description: This jar is similar to JR6 but has a short upright rim before the body of the vessel and a much shorter everted or thickened exterior rim that has a depression on the midsection of the lip. Handles attach from the edge of the everted rim.
Fabric: Ware A1
Decoration: Not applicable
Parallels: This type occurs at KEN and RHI-B (see table in Figure 4.43).

JR20: *Jar with short upright neck with groove and thickened exterior rim (Figure 4.24:1)*
Description: This jar has a short upright neck with a thin (1-mm) groove at the midsection of the neck. The rim is upright with a thickened exterior with a rounded ledge.
Fabric: Ware A1
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phases I–II, V

JR21: *Hole-mouth jar with exterior triangular-sectioned rim.*
Description: This hole-mouth jar slopes inward and has a thickened triangular-sectioned rim.
Fabric: Ware A1
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phases II, V–VI

JR22: *Jar with long folded-over sloping-in rim*
Description: This jar has a long folded-over rim (3 cm) that is thick at the lip and thins out to the end of the fold. At the end of the fold, the rim attaches with a bend to the body of the vessel. Some examples show horizontal scraping or grooving on the fold.
Fabric: Ware A1
Decoration: White slip is found on the exterior.
Parallels: Found only at KEN in Integrated Phases II–III

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JR24: *Jar with inverted rim.*
Description: This storage jar is created by a fold of the rim up and then inverting it, creating a hole-mouth.
Fabric: Ware A1
Decoration: White slip on the exterior
Parallels: Found only at KEN in Integrated Phases III–IV

JR25: *Jar with upright rolled-over rim and pie crust decoration*
Description: This jar has an upright rolled-over rim that is then scraped near the lip to create an uneven overhanging pie crust appearance.
Fabric: Ware A1
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phase II

JR26: *Neckless upright triangular-sectioned rim storage jar (Figure 4.3:12)*
Description: This neckless storage jar has an upright triangular-sectioned rim.
Fabric: Ware A1
Decoration: R647 has black vertical lines painted on the rim every 1 cm, and on the rim, black radial lines are painted near the shoulder of R647.
Parallels: Found only at KEN in Integrated Phase III

JR27: *Small neckless jar with triangular-sectioned rim*
Description: This is a small delicate neckless jar with an exterior triangular-sectioned rim.
Fabric: Ware A1
Decoration: Not applicable
Parallels: This type occurs at KEN and KAJ (see table in Figure 4.43).

JR28: *Cup spouted jar with attached strap handles (Figure 4.1:14)*
Description: This storage jar has a straight sloping-in neck with a thickened rim and has a cup-like spout attached to the rim. A strap handle attaches to the right side of the cup and connects with the rim.
Fabric: Ware A1
Decoration: Not applicable
Parallels: This type occurs at KEN (see table in Figure 4.43). A parallel is found in the SIGNAS survey (pl. 20:1). See examples from Cisjordan at *Tel Gezer* Stratum VIA (pl. 19:15).

JR30: *Neckless jar rim with triangular-sectioned rim*
Description: These neckless jars have upright rims with a vessel wall from the rim sloping out quickly to near horizontal. Each rim is different; general category.
Fabric: Ware A1
Decoration: Not applicable
Parallels: This type occurs at RHI-A, KAM, TW, and RHI-B (see table in Figure 4.43). Possibly *Busayra* (9.45:1).

JR31: *Jar with short neck before carination and long folded rim*
Description: These jars have a short neck before carination. The rims have long folds and are similar in design to KR15–17 but have small closed diameters. May be related to JR37.
Fabric: Ware A1
Decoration: Not applicable
Parallels: This type occurs at RHI-B (see table in Figure 4.43).

JR32: *Short-neck jar with upright simple rims*
Description: This small, thin (5-mm) short-neck jar has an upright simple rim (serves as a neck).
Fabric: Ware A1
Decoration: Exterior of rims painted with black concentric lines
Parallels: This type occurs at KIS and RHI-B (see table in Figure 4.43). Compare with *Busayra* (Figure 9.51:7).

JR33: *Short-neck jar with upright flattened rim*
Description: This thick (>10-mm) short-neck storage jar has an upright flattened or slightly beveled rim.
Fabric: Ware A1
Decoration: Not applicable
Parallels: This type occurs at KEN, TW, and RHI-B (see table in Figure 4.43). Compare with *Lachish* Old (Figure 3.50:6).

JR34: *Short-neck jar with upright rounded rim slightly thickened on the exterior*
Description: This short-neck jar has an upright slightly thickened exterior rim (rim serves as neck).
Fabric: Ware A1
Decoration: Not applicable
Parallels: This type occurs at KEN and TW (see table in Figure 4.43). Possibly similar to *Busayra* (Figure 6.30:17).

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JR35: *Medium-neck jar with upright flattened rim*
Description: This medium-size necked jar has an upright rim.
Fabric: Ware A1
Decoration: Not applicable
Parallels: This type occurs at KEN, KIS, and TW (see table in Figure 4.43).

JR36: *Medium-neck jar with sloping-out interior beveled rim*
Description: This medium-size neckless jar has a sloping-out flattened or interior beveled rim (rim serves as neck).
Fabric: Ware A1
Decoration: Not applicable
Parallels: This type occurs at KEN, KIS, and TW (see table in Figure 4.43).

JR37: *Jar with thickened exterior triangular-sectioned rim and short neck before carination*
Description: This jar has a short neck before a carination at the shoulder. The rim is triangular through thickening.
Sub-types: JR37b have two grooves on the rim.
Fabric: Ware A1
Decoration: Not applicable
Parallels: This type occurs at KEN, KAM, TW, and RHI-B (see table in Figure 4.43). See *Busayra* (Figure 9.46:5).

JR38: *Neckless jar with upright triangular rim with two grooves on flattened lip*
Description: This medium-size neckless jar has an upright triangular rim with two grooves on the horizontal flattened lip portion of the rim.
Fabric: Ware A1
Decoration: R922 has black concentric lines on the exterior and R130 has remnants of red, black, and white painting.
Parallels: This type occurs at TW and RHI-B (see table in Figure 4.43).

JR39: *Hole-mouth jar with sloping-in, folded-over rim with exterior ledge*
Description: This hole-mouth jar has a sloping-in rim that is folded over, creating an exterior ledge.
Fabric: Ware A1
Decoration: Not applicable
Parallels: This type occurs at KEN, TW, and RHI-B (see table in Figure 4.43). Compare to *Busayra* (Figure 9.46:3–4).

Pithoi

PT2: *Pithos with rolled out rim (Figures 4.15:12; 4.27:5)*
Description: This pithos has a short sloping in neck that leads to a rim that has been turned out to a horizontal position. The tip of the turned-out rim is sharply rounded.
Subtypes: SJ2b share similarities with SJ2a, but the rim is undercut and much thicker.
Fabric: Ware A7 for KEN; the fabric is directly distinguishable from the other pithoi from KEN. The RHI are Ware B4.
Decoration: R106 has a white slip on the exterior.
Parallels: Found only at KEN in Integrated Phase II.

PT3: *Pithos with short upright neck and flattened rim with overhanging exterior ledge (Figures 4.3:2; 4.22:2; 4.27:6; 4.31:5)*
Description: These pithoi have a characteristic short neck (2–3 cm) with a flattened rim that is thickened on the exterior to create an overhanging ledge. There is some variation on PT3 but not enough to create subtypes. Not one example is exactly alike in thickness and rim treatment. The only example from KEN (R834) has a well-formed exterior ledge along with a depression in the center of the flattened rim. R877 found at KEN is different and shares many similarities with examples from RHI (R465/R750), such as being smaller (small storage jar size), and lacks the depression or well-defined ledge. R254, which is pithos size, has a less distinct neck but shares similarity in formation of rim with R465 and R750. Finally, R663 has been classified as PT3c because it has a more triangular-shaped rim than those above.
Fabric: R877 and R834 share KR8 Ware A9 fabric. The RHI examples have typical B4 fabric. The Tawilan examples have the B1 fabric.
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phases II–IV

PT4: *Sloping-out, triangular, thickened exterior rim with short neck (Figure 4.15:13)*
Description: This pithos has an upright, triangular, thickened rim and short neck before the shoulder. Only one example was found during the 2002 excavations. This pithos is a possible variant of PT5 (see below). Two more examples were found in 2006.
Fabric: All have similar gray core with slag inclusions, Ware A2b.

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Decoration: All three examples had a white slip on the exterior and interior.
Frequency: Total (n = 3)
Parallels: Found only at KEN. Compares with WF424 (Barker et al. 1998:Figure 27:6–7).

PT5: *Rounded, thickened, exterior rim, sometimes with a collar on the neck (Figures 4.3:3; 4.5:17–18; 4.7:16; 4.11:7; 4.20:11; 4.22:3–4; 4.24:9)*
Description: This large pithos has a folded, bulbous rim that creates a thickened exterior, which is upright with a short neck. In several examples, a collar is found very high on the shoulder where the neck bends to attach to the shoulder. This vessel type is commonly classified as a collared-rim pithos (see Herr 2001).
Fabric: Ware A2b
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phases I–IV (see table in Figure 4.44). Parallels for this pithos type are found throughout Cisjordan and Transjordan. There is an enormous amount of literature discussing this vessel for Cisjordan (see Faust 2006) and, in more recent scholarship, its appearance in Transjordan (Bienkowski 1992; Finkelstein 1992a, 1992b; Herr 2001). In Cisjordan, the collared-rim pithos was primarily limited to the Iron I and was very rare in the Early Iron IIA. However, in Transjordan, it has a much greater longevity, spanning the whole Iron II. Herr (2001) has presented the most extensive study of its presence in Transjordan, where it continues into the Late Iron IIC. Based on a study of the pithoi in stratigraphic sequence at ʻUmayri, developmental changes can be identified in subsequent periods. This pithos type found at KEN is most similar to the Early Iron II assemblages and vessels found in unstratified contexts presented by Herr (2001:Figures 14.5:1; 14.6:1–2, 5, 7–8). Similar forms are also found at *Busayra* (Figure 9.42:8, 12), *Ghrareh* (pl. 26:18), Barqa el-Hetiye (Fritz 1994:Abb. 11:8–9), *WF424* (Barker et al. 1998:Figure 27:5), *Hesban* Stratum 16 (Figure 3.10:2), ʻUmayri Phase IP2 (*MPP I*: Figure 19.12:11), Field A Phase 5 (*MPP IV*: Figure 3.32:1, 2), *Tel Masos* Stratum I–III (pls. 138:14; 140:12), and *Samaria I* Period III (Figure 4:20). These parallels support a dating of the ninth century BCE for this specific developmental stage found at KEN.

PT6: *Pithos with upright rim and no neck (Figure 4.1:16)*
Description: This pithos has a thick upright rounded rim that directly attaches to the body of the vessel, thus lacking a neck.
Fabric: Ware A2
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phases II–III, V

PT7: *Pithos with upright triangular rim and no neck*
Description: Similar to PT6 but having a thickened triangular-shaped rim. Only one example was found.
Fabric: Ware A2
Decoration: Cream slip applied on the exterior
Parallels: Found only at KEN in Integrated Phases III–IV

PT8: *Thickened and flattened upper rim (Figures 4.10:2; 4.11:8; 4.22:5)*
Description: This is a large pithos with a folded rim that creates a thickened exterior, but the way the rim is pressed and flattened into the body makes it less pronounced than PT5. This pithos is a variant of PT5 but is distinguished primarily by its unique rim treatment popular in Transjordan.
Fabric: Light red exterior, slag rich with red/gray core A2b
Decoration: Some have white slip on the exterior.
Parallels: Found at KEN in Integrated Phases II–V. The pithos found at *Busayra* (Figure 9.43:4) resembles Figure 11:8 but without the upper groove. Other possible parallels are found at *Hesban* Strata 19–18 (Figures 3.4:1; 3.7:9) and *Kadesh Barnea* Stratum 4b (pl. 11.20:16).

PT9: *Folded-over rim with groove slightly inverted (Figure 4.9:11)*
Description: The folded and inverted rim with groove distinguishes this single example from the pithoi mentioned above.
Fabric: Ware A2
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phase II

PT10: *Upright, thickened, rounded, or triangular rims attached directly to the neck (Figures 4.10:1; 4.11:9; 4.15:14–16; 4.17:17; 4.24:7)*
Description: This hole-mouth pithos has a folded, thickened, exterior rim directly attached to the body of the vessel (diameters are ca. 20–24 cm). Similar rim profiles are present with diameters over 25 cm; the lack of complete profiles makes classification of these vessels as pithoi or kraters difficult.
Fabric: Fabric is standard PT A2, but all have well-sorted fabric with only a few large inclusions. Slag is visible within the core. R773 is the exception with large slag inclusions throughout, Ware A2b.

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Decoration: Often thick exterior white slip is applied.
Parallels: This type occurs at KEN and KIS (see table in Figure 4.43). A similar rim profile is noted as a krater at *Tawilan* (Figure 6.17:6). Its rim diameter of 22 cm suggests that it is more likely a pithos similar to those found here. This pithos is common to Cisjordan and Transjordan: Dibon (Tushingham 1972:Figure 1:43, 44), *Horvat Qitmit* (Figure 4.14:45), *Tel 'Ira* Stratum VII (Figure 6.75:2), *Tel Batash* Strata III–II (pl. 63:6), and *Samaria II* Period IV (Figure 7:6). This pithos may possibly be related to sharper-edged forms at Beersheba Stratum II (Singer-Avitz 1999:Figure 3:19), Stratum V (Herzog and Singer-Avitz 2004:Figure 5:1), and *Tell Beit Mirsim III* Stratum A (pl. 13:9).

PT11: *Pithos with upright thickened interior and exterior rim*
Description: This pithos has an upright neck and rim that is thickened evenly on the exterior and interior.
Fabric: Ware A1
Decoration: A white slip is on the interior and exterior.
Frequency: Total (n = 1). Frequency statistics, stratum, locus, and spatial location.
Parallels: Found only at KEN in Integrated Phases II–III

PT12: *Pithos with folded-over and triangular rim that is slightly beveled along exterior ledge (Figure 4.3:4)*
Description: This pithos has a straight neck and uniquely shaped rim that is folded over and made triangular but is beveled along the exterior ledge.
Fabric: Ware A2
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phase IV

PT13: *Pithos with triangular rim and exterior groove between lip and ledge (Figure 4.9:12)*
Description: This pithos has a short neck leading to a thickened triangular rim that has been grooved to accentuate the exterior ledge from the lip of the vessel. Similar but more pronounced than PT12.
Fabric: Ware A3, with large basalt inclusions
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phase II

PT14: *Pithos with thickened exterior rim that has been beveled (Figure 4.9:13)*
Description: This has a neckless upright pithos with a thickened exterior rim that is beveled up to flattened lip of the rim.
Fabric: Ware A7; arkose rich with lower cretaceous shale.
Decoration: Not applicable
Parallels: Found only at KEN in Integrated Phase II

PT15: *Pithos with folded-over flanged rim (Figures 4.34:14–15; 4.5:19; 4.31:6)*
Description: This pithos has a folded-over rim with a pronounced overhanging flanged ledge. A majority of the examples also have a collar at the attachment of the neck to shoulder.
Subtypes: R499 from KEN06 is smaller and more upright and may be a predecessor to this common form in the later periods.
Fabric: RHI fabrics have a high concentration of basalt and are in general a more coarse fabric B3. The L2HE sites, especially KIJ, have high quantities of large quartz inclusions. The one example from KIS, R1151, has basalt inclusions but has a much smoother and sorted fabric similar to the other L2HE sites. R499 from KEN06 is a course fabric that appears to have slag inclusions and possibly also basalt, but a thin section was not made on this sherd.
Decoration: Not applicable
Parallels: This type occurs at KEN, KAM, KIJ, KIS, TW, and RHI-B (see table in Figure 4.44). Similar to *Busayra* (Figure 9.42:7, 9).

PT16: *Pithos with folded-over rim that is smoothed into the body*
Description: This rim is created similar to PT15 but is smoothed into the body of the vessel rather than being pronounced.
Fabric: Course B3 fabric with basalt inclusions similar to PT15
Decoration: Not applicable
Parallels: Found only at RHI-B, possibly similar to *Busayra* (Figure 9.42:15)

PT17: *Pithos with folded-over bulbous rim that is grooved on the interior and exterior*
Description: The pithos has a more rounded folded-over rim than PT15/16 but also has a exterior groove just below the lip of the rim and also on the interior at the bottom of the rim.
Fabric: All slag-rich fabric B2; see PT18
Decoration: Not applicable
Parallels: Found only at RHI-B

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PT18: *Pithos with very large folded-over rim similar to PT15 but with exterior groove below lip (Figures 4.34:16; 4.35:18; 4.37:13; 4.31:7–8; 4.32:19)*
Description: This pithos is a combination of PT15 and PT17 in having the phalanged folded-over rim but also a groove or depression on the exterior just below the lip. Some examples also have an interior groove also found on PT17. R183 preserves a collar as seen on PT15.
Fabric: The examples from RHI have large slag inclusions, making the sherds very course and rough to the feel (B2). All L2HE examples are similar medium course, smooth to the feel, quartz-rich sherds, Ware B1. Many examples also have large calcite inclusions.
Decoration: Not applicable
Parallels: This type occurs at KAM, KIJ, KIS, TW, and RHI-B (see table in Figure 4.44). See *Busayra* (Figure 9.43:4, 9–10, 13).

PT19: *Pithos with thin folded-over rim and hole-mouth orifice with two grooves on exterior (Figures 4.37:14; 4.24:8)*
Description: This pithos has a hole-mouth sloping-in rim that is folded over and flattened into the body, then grooved three times. This type may be related to PT20.
Subtypes: PT19C are similar to above but larger and thicker.
Fabric: Ware A1 and B2
Decoration: Not applicable
Parallels: Two examples were found at KEN Area S, Integrated Phase I. PT19b/c were found at KAM and TW (n = 4).

PT20: *Pithos with upright folded-over rim with two grooves on exterior (Figures 4.37:15; 4.20:12)*
Description: These pithoi have large upright folded-over rims with two grooves over the exterior of the rim. This rim treatment creates this type of three-ridged rim pithoi.
Subtypes: Each pithos is constructed slightly different, with varying depth and size of grooves.
Fabric: Ware A1 and B1b
Decoration: Not applicable
Parallels: This type occurs at KEN, KAM, KIJ, and TW (see table in Figure 4.44). The various forms of this pithos are found at *Busayra* (Figure 9.42:1–6) and *Tawilan* (Figures 6.22:1; 6.24:1–3; 6.25:1).

PT21: *Pithos with sloping in collared neck and thickened grooved rim*
Description: This pithos has a sloping in and bending upward neck that has a collar at the shoulder. The rim is slightly thickened and flattened with two grooves along the lip of the vessel
Fabric: Ware B1b
Decoration: Not applicable
Parallels: Found at KAM, KIS and TW. Compare with *Busayra* (Figure 9.42:11).

PT22: *Pithos with upright short-necked thickened exterior ledge rims*
Description: These pithoi have a short upright neck (4–5 cm) with a thickened exterior ledge on the rim. The rims vary from being rounded or flattened on the lip but all have exterior ledge either triangular shaped, rounded, or undercut.
Fabric: Ware A1 and B1b
Decoration: Not applicable
Parallels: Found only at L2HE sites KAM, KIJ, KIS, and TW.

PT23: *Pithos with sloping-in, folded-over rim and three light grooves*
Description: This pithos has a neck sloping into a folded-over rim with a similar design to PT15 but less pronounced ledge and three light grooves starting from just below the lip.
Fabric: Ware B1b
Decoration: Not applicable
Parallels: Found at KIJ (n = 1) and primarily at TW (n = 7). See *Tawilan* (Figures 6.24:4; 6.25:3?).

PT24: *Pithos with upright folded-over rim rounded and blended into the neck*
Description: This pithos has a sloping-in neck that leads to an upright folded-over rim that is rounded and blended into the neck, making the exterior only slightly thicker than the interior, giving a slight collar-type look to the rim.
Fabric: Ware B1b
Decoration: Not applicable
Parallels: Found at the L2HE excavations of TW. See *Busayra* (Figure 9.43:5).

PT26: *Pithos with everted thickened squared rim*
Description: This pithos has a unique rim treatment where the rim is everted and shaped to create a squared

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exterior thickened section. Only one example was found, but direct parallels found necessitated its publication.
Fabric: Ware B1
Decoration: Not applicable
Parallels: Found at the L2HE excavations of TW. See *Busayra* (Figures 9.42:9; 9.43:7) and *Tawilan* (Figure 6.24:6).

Cooking Pots

A typological study of the cooking pots was conducted only for RHI Sounding B and L2HE sites, since there was not one cooking pot alike found at KEN. However, each individual cooking pot found at KEN was given a type number and was illustrated in the figures for future comparative studies (cf. CP1 [Figures 4.24:11–12]; CP2 [Figures 4.20:13; 4.22:6]; CP3 [Figures 4.8:21; 4.22:7; 4.24:14]; CP4 [Figure 4.3:5]; CP6 [Figure 4.20:14]; CP7 [Figure 4.6:1]; CP8 [Figure 4.6:2]; CP9 [Figure 4.7:16]; CP10 [Figure 4.24:13]; CP11 [Figure 4.1:17]; CP13 [Figure 4.8:22]; CP14 [Figure 4.9:1]; CP15 [Figure 4.27:7–8]; CP16 [Figure 4.27:9]; CP18 [Figure 4.27:10]; CP20 [Figures 4.38:12; 4.7:6–7; 4.23:12]; CP21 [Figure 4.7:8]). All of the cooking pots from KEN share the common treatment of a ridged rim but vary significantly in their attributes. For an attempt at drawing parallels to other sites in Cisjordan, see Smith and Levy (2008). Although these cooking pots are ridged as seen in the later cooking pots found at RHI and the L2HE sites, none show a morphological match as was repeatedly witnessed when comparing the later sites cooking pots together.

CP25: *Small-necked cooking pot with pronounced ridge and simple rim (Figure 4.31:9)*
Description: This small, thin body necked cooking pot has a pronounced ridge on a simple rim. The ridge is created by a fold creating a high ridge (5 mm) but also an internal bend.
Fabric: Ware B6
Decoration: Not applicable
Parallels: Found only at RHI-B

CP30: *Necked cooking pot with ridge and short bend on thickened exterior rim (Figure 4.31:10*
Description: This necked cooking pot has a ridge created by a fold and a minor internal bend. The lip is thickened and pointed on the exterior.
Sub-types: CP30A hole-mouth; CP30b necked
Fabric: Ware B6
Decoration: Not applicable
Parallels: Found at RHI-B; for CP30a, see *Busayra* (Figure 9.38:3, 6), *Tawilan* (Figure 6.34:1), and *Tell el-Kheleifeh* (pls. 17:4; 18:3–6, 10). For CP30b, see *Tell el-Kheleifeh* (pl. 19:4) and *Busayra* (Figure 9.39:6).

CP31: *Necked cooking pot with upright or sloping-in sharp-ridged rim (Figure 4.31:11)*
Description: This necked cooking pot is created from a horizontal bend below the rim and has a sharp ridge on the rim created by bending inward. The lip of the rim is rounded and thickened on the exterior with a sharp exterior edge.
Fabric: Ware B6
Decoration: Not applicable
Parallels: Found at RHI-B; compare with *Busayra* (Figure 9.39:1–2)

CP33: *Necked cooking pot with wide ridge and slightly sloping-in simple rim (Figure 4.31:12–13)*
Description: This neck cooking pot has a slightly sloping-in neck and rim. The ridge is wider (15 mm), taking up most of the neck, while the rim is rounded with no thickening.
Fabric: Ware B6
Decoration: Not applicable
Parallels: Popular at late eighth-century BCE sites in the study (n = 43; see table in Figure 4.43). It is found at RHI-B, KAM, KIJ, KIS, and TW.

CP34: *Necked cooking pot with wide pronounced ridge and slightly sloping-in simple rim (Figure 4.31:14*
Description: This pot is similar to CP33 but has a more pronounced ridge often created by grooving.
Fabric: Ware B6
Decoration: Not applicable
Parallels: RHI; see *Tell el-Kheleifeh* (pl. 19:2), which could be CP33 or more likely CP34.

CP35: *Hole-mouth cooking pot with ridge and thickened exterior ledge rim (Figures 4.33:11; 4.36:23)*
Description: This hole-mouth cooking pot has a thin pointed ridge (ca. 5 mm) on the rim. The lip is thickened on the exterior to create a pointed ridge. The rim has no internal bending in contrast to CP36–38 and is more stubby (ca. 15 mm long) in comparison.
Fabric: Ware B6
Decoration: Not applicable
Parallels: RHI; see *Tell el-Kheleifeh* (pls. 16:4; 17:3–4; 18:4?).

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CP36: *Hole-mouth cooking pot with sharp ridged rim and thickened exterior lip (Figure 4.34:18)*
Description: The hole-mouth cooking pot with sloping-in rim has a ridge created by a sharp bent-in rim. The lip of the rim is thickened on the exterior, creating a sharp exterior ledge.
Fabric: Ware B6
Decoration: Not applicable
Parallels: Found only at KAM, KIJ, and TW (see table in Figure 4.43)

CP37: *Hole-mouth cooking pot with sharp ridged rim and thickened exterior ledge lip (Figures 4.33:12; 4.36:24)*
Description: The hole-mouth cooking pot with sloping-in rim has a ridge created by a sharp bent-in rim. The lip of the rim differs from CP36 in being thickened without a sharp exterior ledge.
Fabric: Ware B6
Decoration: Not applicable
Parallels: RHI; see *Busayra* (Figure 9.38:2, 4). Possibly *Tawilan* (Figure 6.33:4) is the same type but drawing is unclear.

CP38: *Hole-mouth cooking pot with sharp-ridged rim and thickened interior lip (Figure 4.36:25)*
Description: This hole-mouth cooking pot with sloping-in rim has a ridge created by a sharp bent-in rim. The lip of the rim is thickened on the interior.
Fabric: Ware B6
Decoration: Not applicable
Parallels: RHI; see *Busayra* (Figure 9.38:9–10).

CP40: *Hole-mouth cooking pot with upright ridged flattened rim (Figure 4.36:26)*
Description: This hole-mouth cooking pot has a sloping-in ridged rim. The distance from lip to ridge is short (5–6 mm), and the ridge is either rounded or pointed. The flattened lip is the same thickness as the neck and body. This type is the neckless form of CP32.
Fabric: Ware B6
Decoration: Not applicable
Parallels: Found only at Tawilan

CP47: *Medium-neck cooking pot with upright pronounced ridge rim with several grooves on lip (Figure 4.35:19)*
Description: This unique cooking pot has a medium neck (13 mm from body to bottom of rim). The ridge on the upright rim is pronounced and the ledge is turned up. On the lip, several grooves occur. A strap handle attaches to a ridge on the shoulder and lower down on the mid-body.
Fabric: Ware B6
Decoration: Not applicable
Parallels: Found only at KIS; one example illustrated

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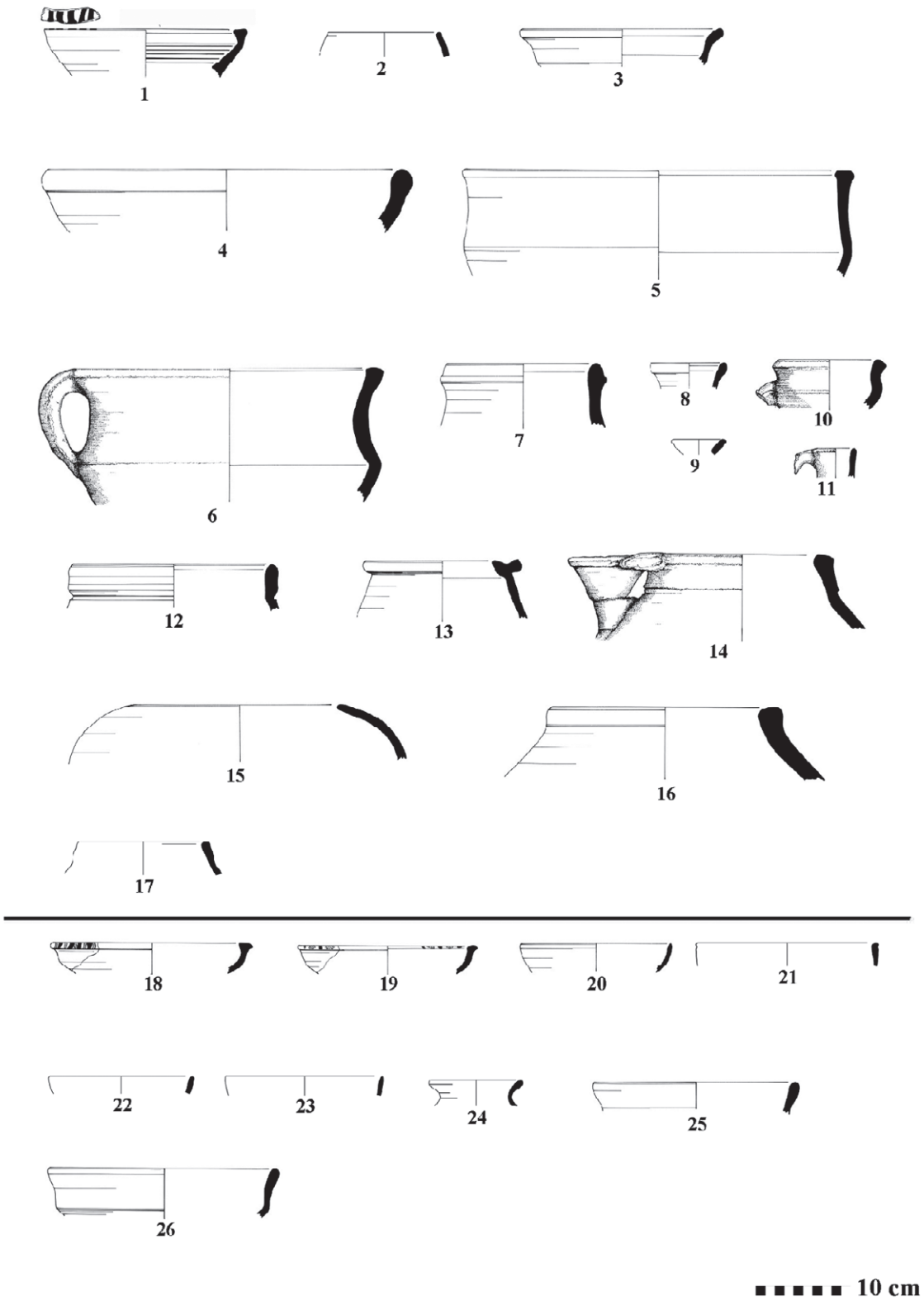

Figure 4.1 KEN Area R: Integrated Phases V, IV.

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Table 4.1 KEN Area R: Integrated Phases V, IV (Fig 4.1).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	881	1810	16094	R3a	V	Bowl	BL3a2	A1	Painted black strokes on rim and white slip (int./ext.)
2	1363	1849	16520	R3a	V	Bowl	BL15b	A2	White slip
3	1369	1848	16481	R3a	V	Bowl	BL24	I1	Red slip and horizontal burnish (int./ext.)
4	688	1829	16251	R3a	V	Bowl	BL28	A2	White slip
5	668	1810	16196	R3a	V	Krater	KR12	A1	
6	708	1828	16228	R3a	V	Krater	KR12b		
7	873	1810	16118	R3a	V	Jug	JG3c		
8	831	1833	16310	R3a	V	Jug	JG12		
9	1360	1849	16520	R3a	V	Jug	JG12		
10	806	1829	16236	R3a	V	Jug	JG25		White slip
11	1391	1846	16448	R3a	V	Juglet	JT1	A1	
12	807	1829	16236	R3a	V	Jar	JR2		White slip
13	660	1830	16269	R3a	V	Jar	JR6		
14	1456	1846	16448	R3a	V	Jar	JR28		Slip
15	735	1828	16228	R3a	V		HMJR		
16	854	1842	16429	R3a	V	Pithos	PT6		
17	686	1829	16251	R3a	V	Cooking pot	CP11		
18	673	1827	16253	R2b	IV	Bowl	BL3a1	A1	Painted design
19	744	1815	16095	R2b	IV	Bowl	BL3a1		Painted design slip
20	740	1817	16157	R2b	IV	Bowl	BL12	A1c	Burnish (int./ext.)
21	1346	1832	16345	R2b	IV	Bowl	BL15b	I1	Red slip and burnish (int./ext.)
22	1327	1832	16373	R2b	IV	Bowl	BL16	I1	Red slip and horizontal burnish (int./ext.)
23	868	1814	16195	R2b	IV	Bowl	BL16c	A2	
24	676	1815	16133	R2b	IV	Bowl	BL21a2	A1	Painted design slip
25	781	1832	16304	R2b	IV	Bowl	BL24	I1	Red slip and horizontal burnish (int./ext.)
26	876	1841	16416	R2b	IV	Bowl	BL24	I1	Red slip and horizontal burnish (int./ext.)

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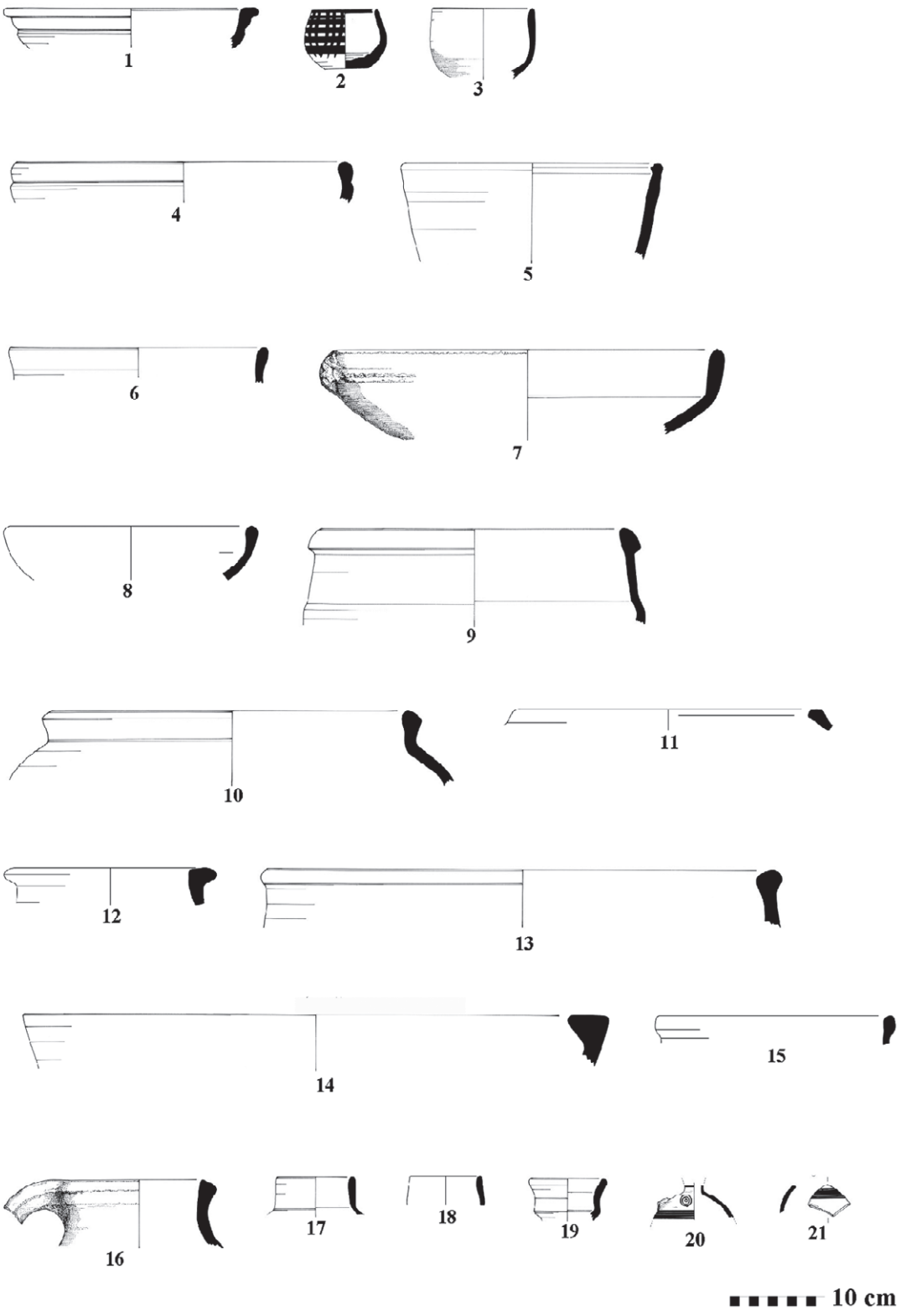

Figure 4.2 KEN Area R: Integrated Phase IV.

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Table 4.2 KEN Area R: Integrated Phases IV (Fig 4.2).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	812	1814	16148	R2b	IV	Bowl	BL25b	A10	White slip (int./ext.) with stepped grooves
2	648	1834	16350	R2b	IV	Bowl	BL26	A1	Painted crosshatch design over white slip (ext.)
3	848	1839	16428	R2b	IV	Bowl	BL26	A2	Creme slip (int./ext.)
4	792	1834	16300	R2b	IV	Bowl	BL29b	A9	
5	739	1822	16157	R2b	IV	Bowl	BL		
6	786	1832	16304	R2b	IV	Bowl	BL		Burnish
7	1450	1834	16396	R2b	IV	Bowl	BL		
8	840	1827	16343	R2b	IV	Bowl	BL		
9	860	1814	16195	R2b	IV	Krater	KR2		
10	714	1831	16285	R2b	IV	Krater	KR3a2		
11	862	1814	16195	R2b	IV	Krater	KR3b		White slip
12	778	1827	16308	R2b	IV	Krater	KR5		
13	865	1814	16195	R2b	IV	Krater	KR8	A9	White slip
14	821	1814	16148	R2b	IV	Krater	KR10		White slip
15	1394	1843	16444	R2b	IV	Krater	KR21		White slip
16	823	1834	16311	R2b	IV	Jug	JG9		White slip
17	756	1815	16095	R2b	IV	Jug	JG14		
18	1400	1839	16411	R2b	IV	Jug	JG15		White slip
19	879	1843	16432	R2b	IV	Jug	JG25		
20	656	1834	16407	R2b	IV	Juglet	JT22		Painted design burnish Cypro-Phoenician
21	657	1827	16287	R2b	IV	Juglet	JT22	I4	Painted design burnish Cypro-Phoenician

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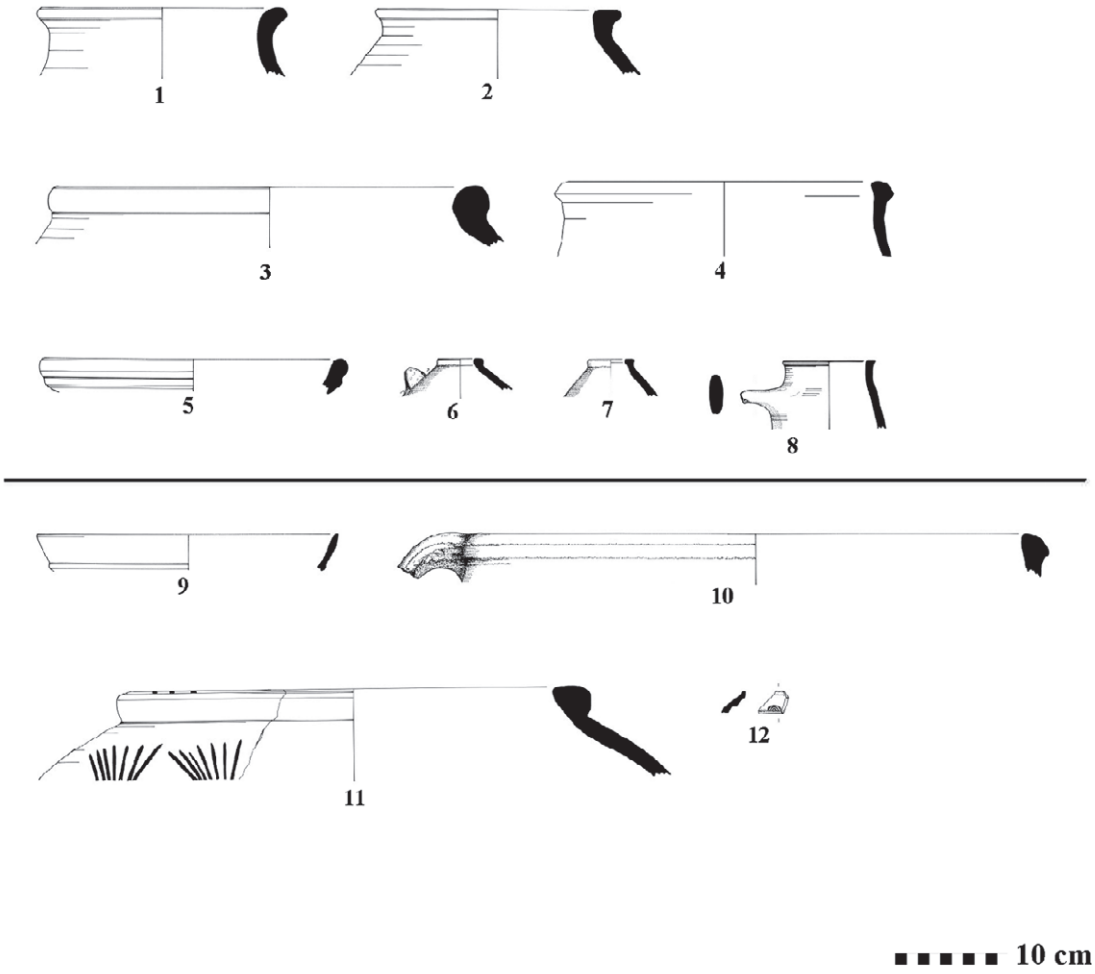

Figure 4.3 KEN Area R: Integrated Phases IV, III.

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Table 4.3 KEN Area R: Integrated Phases IV, III (Fig 4.3).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	767	1827	16308	R2b	IV	Jar	JR17b	A9	
2	877	1841	16416	R2b	IV	Pithos	PT3		
3	838	1827	16343	R2b	IV	Pithos	PT5		White slip
4	1324	1832	16373	R2b	IV	Pithos	PT12	A2	Repair hole
5	692	1822	16157	R2b	IV	Cooking pot	CP4	A6	
6	706	1817	16146	R2b	IV		Pyxis	A1	Black fabric with punctured knob handles
7	822	1834	16311	R2b	IV		Pyxis		Black fabric with punctured knob handles
8	650	1827	16265	R2b	IV		Qurayyah	I2	Painted design with creme slip and burnish
9	700	1809	16136	R2a	III	Bowl	BL22	A1	
10	795	1803	16020	R1b	III	Krater	KR2		White slip
11	647	1816	16210	R1b	III	Jar	JR26		Painted design
12	655	1808	16077	R1b	III	Juglet	JT22		Painted design and burnish (ext.)

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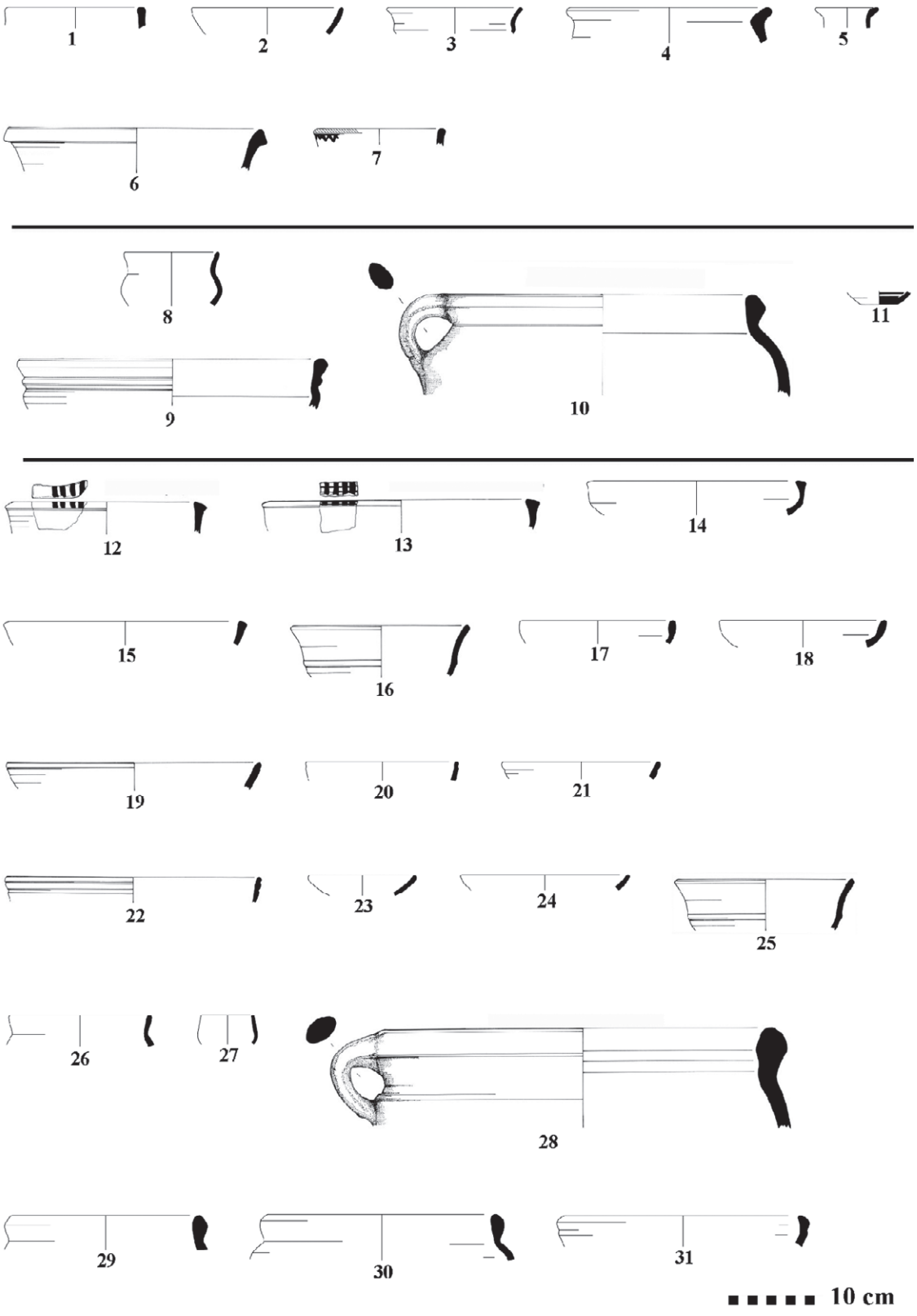

Figure 4.4 KEN Area T: Integrated Phases V, IV, III.

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Table 4.4 KEN Area T: Integrated Phases V, IV, III (Fig 4.4).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	1176	1582	13699	T3	V	Bowl	BL14		White slip
2	1271	1566	13726	T3	V	Bowl	BL16b	A9	White slip (int./ext.)
3	1177	1582	13699	T3	V	Bowl	BL27	A2	
4	1160	1566	13620	T3	V	Krater	KR5		
5	1152	1589	13667	T3	V	Jug	JG18		
6	652	1563	13561	T3	V	Jar	JR8		
7	1173	1563	13591	T3	V		Qurayyah	I2	Painted design slip and burnish
8	588	1542	13300	T2b	IV	Bowl	BL21a1	A2	
9	1279	1578	13698	T2b	IV	Bowl	BL25	I1	Red slip and burnish (int./ext.)
10	641	1542	13307	T2b	IV	Krater	KR3b	A1	
11	653	1542	13338	T2b	IV	Juglet	JT22		Painted design, burnish, Cypriot
12	496	1531	13201	T2a	III	Bowl	BL3a1		Painted design
13	612	1517	13160	T1b	III	Bowl	BL3a2		Painted design, white slip
14	445	1531	13218	T2a	III	Bowl	BL3a2		Painted design, white slip
15	1183	1526	13446	T1b	III	Bowl	BL3a3		Painted design, white slip
16	632	1553	13444	T2a	III	Bowl	BL3b2		Painted design
17	1232	1547	13442	T2a	III	Bowl	BL13b	A2	White slip (int./ext.)
18	1130	1524	13512	T2a	III	Bowl	BL13b	A2	White slip (int./ext.)
19	651	1524	13365	T2a	III	Bowl	BL15	A10	Grooved
20	457	1517	13114	T1b	III	Bowl	BL15	A10	
21	590	1541	13300	T2a	III	Bowl	BL15	A10	White slip
22	635	1524	13365	T2a	III	Bowl	BL15c	A9	Grooved
23	1202	1519	13388	T1b	III	Bowl	BL16b	A9	
24	1187	1579	13660	T2a	III	Bowl	BL16c	A10	White slip
25	636	1526	13446	T1b	III	Bowl	BL19	A1	
26	596	1541	13300	T2a	III	Bowl	BL21a1	A1	White slip
27	609	1517	13160	T1b	III	Bowl	BL26	A1	Painted design slip
28	438	1524	13111	T2a	III	Krater	KR24		White slip
29	471	1517	13196	T1b	III	Krater	KR1		White slip
30	1440	1552	13364	T2a	III	Krater	KR3		White slip
31	1096	1559	13533	T2a	III	Bowl	BL29	A10	White slip (int./ext.)

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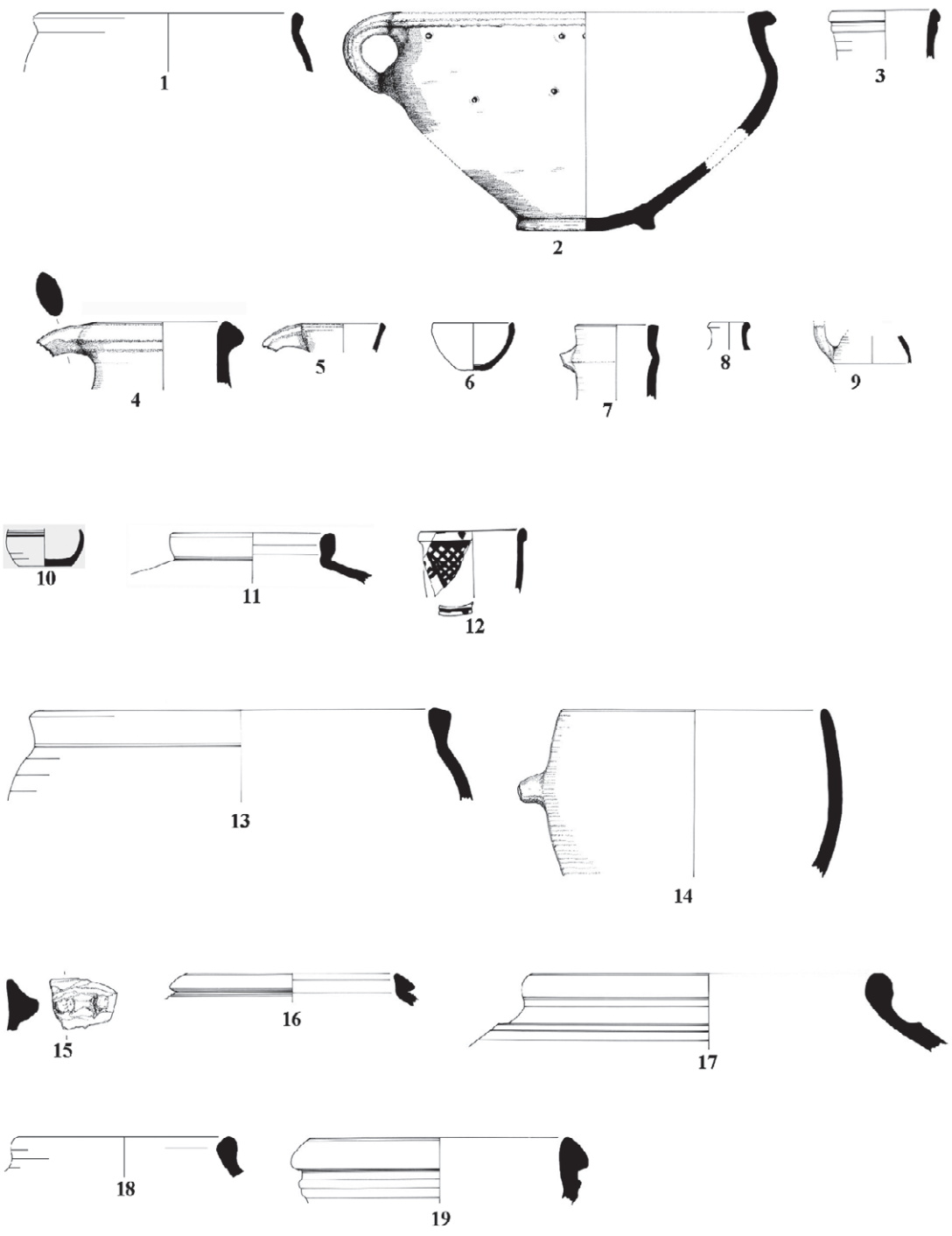

Figure 4.5 KEN Area T: Integrated Phase III.

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Table 4.5 KEN Area T: Integrated Phases III (Fig 4.5).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	474	1517	13082	T1b	III	Krater	KR3b		
2	1454	1541	13300	T2a	III	Krater	KR8		
3	645	1524	13488	T2a	III	Jug	JG3c		
4	639	1552	13391	T2a	III	Jug	JG9		
5	486	1515	13115	T1b	III	Jug	JG14		
6	1191	1565	13597	T2a	III	Jug	JG16		
7	638	1524	13488	T2a	III	Jug	JG49		
8	1114	1553	13444	T2a	III	Juglet	JT10		
9	640	1552	13364	T2a	III	Juglet	JT21		Black slip and burnish (ext.)
10	654	1541	13314	T2a	III	Juglet	JT22		Painted design burnish Cypriot import
11	633	1528	13517	T1b	III	Jar	JR6		
12	643	1553	13413	T2a	III	Jar	JR13	A1	Painted design
13	464	1524	13222	T2a	III	Jar	JR18		White slip
14	619	1523	13264	T1b	III		HM		
15	644	1524	13443	T2a	III		HM		Applied double knob decoration
16	1194	1524	13443	T2a	III	Pithos	PT		White slip
17	475	1518	13082	T1b	III	Pithos	PT5		
18	498	1531	13201	T2a	III	Pithos	PT5	A2	
19	499	1531	13201	T2a	III	Pithos	PT15		

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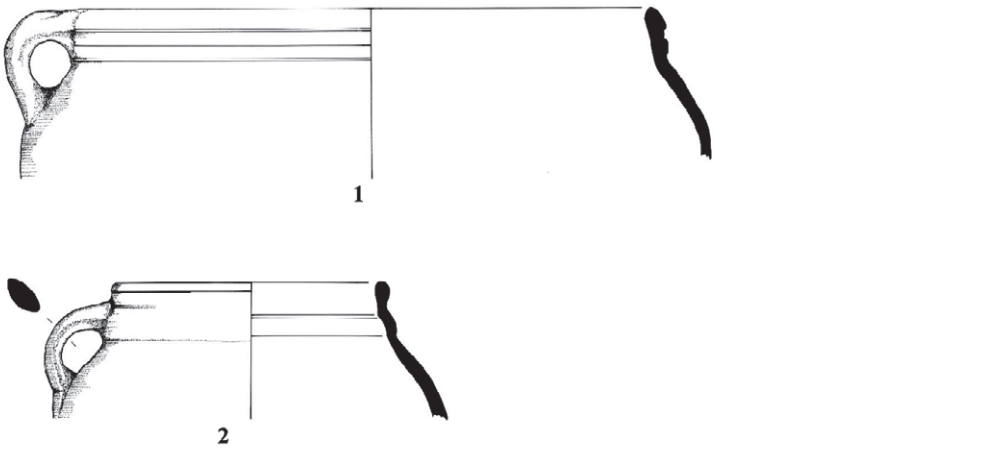

Figure 4.6 KEN Area T: Integrated Phase III.

Table 4.6 KEN Area T: Integrated Phases III (Fig 4.1).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	601	1517	13160	T1b	III	Cooking pot	CP7		White slip
2	637	1553	13444	T2a	III	Cooking pot	CP8	A6	

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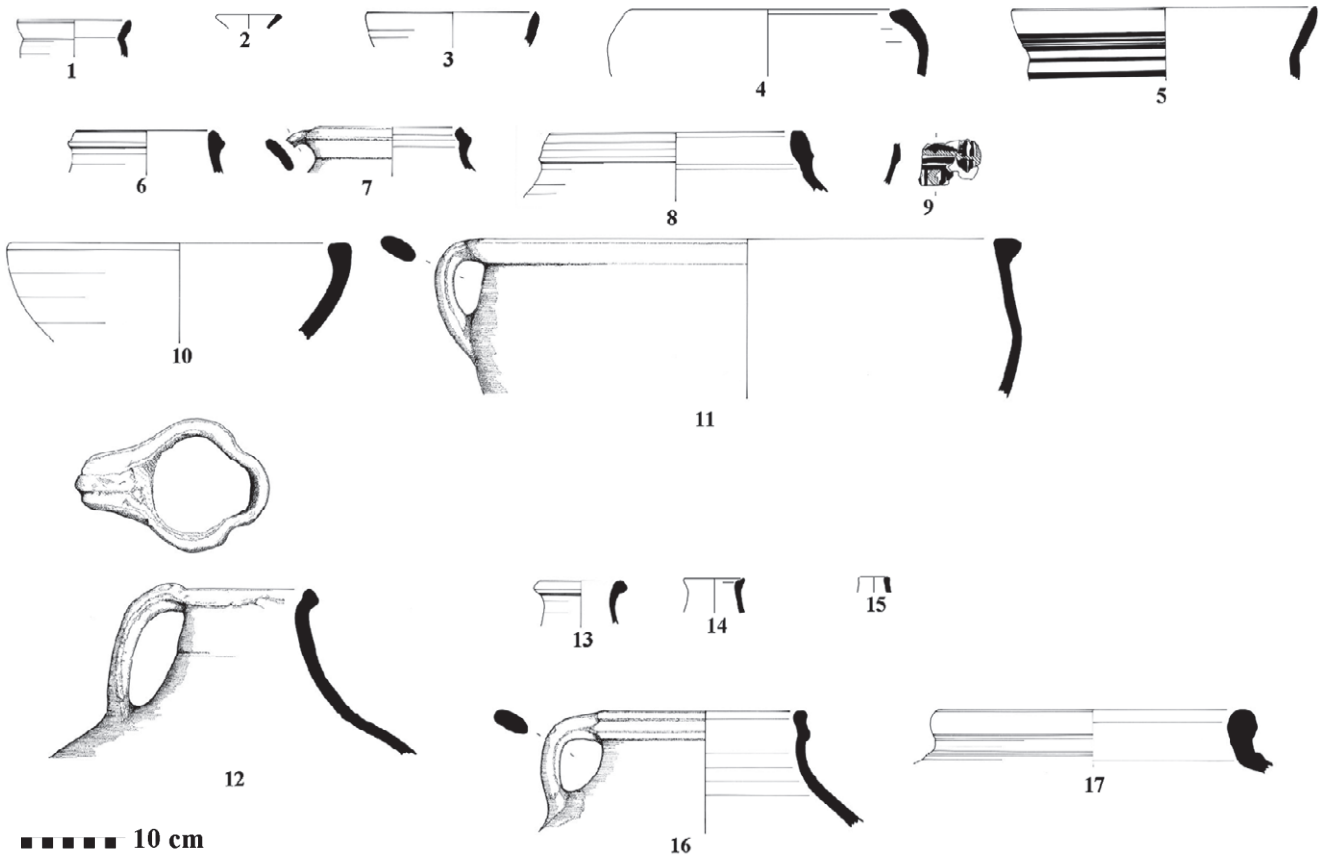

Figure 4.7 KEN Area M: Integrated Phases VII, VI, IV–V, III.

Table 4.7 KEN Area M: Integrated Phases VII, VI, IV-V, III (Fig 4.7).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	566	673	9910	M5a	VII	Bowl	BL		White slip
2	529	667	9823	M4	VI	Bowl	BL46		
3	576	665	9811	M3	IV-V	Bowl	BL1		White slip
4	112	636	9283	M3	IV-V	Bowl	BL37	A2	White slip
5	539	659	9697	M3	IV-V	Jar	JR11		
6	183	647	9555	M3	IV-V	Cooking pot	CP20		
7	223	660	9758	M3	IV-V	Cooking pot	CP20	A6	
8	542	659	9697	M3	IV-V	Cooking pot	CP21		
9	432	660	9754	M3	IV-V		Qurayyah	I2	Painted design, slip, and burnish
10	79	631	9195	M2b	III	Bowl	BL34	A3	White slip
11	1073	717	10430	M2b	III	Krater	KR12		
12	1455	717	10566	M2b	III	Jug	JG4d		
13	78	631	9263	M2b	III	Jug	JG21		
14	195	641	9471	M2b	III	Jug	JG32		
15	191	640	9395	M2b	III	Juglet	JT2		
16	1074	717	10430	M2b	III	Cooking pot	CP9	A6	
17	1241	754	10582	M2b	III	Pithos	PT5	A2	

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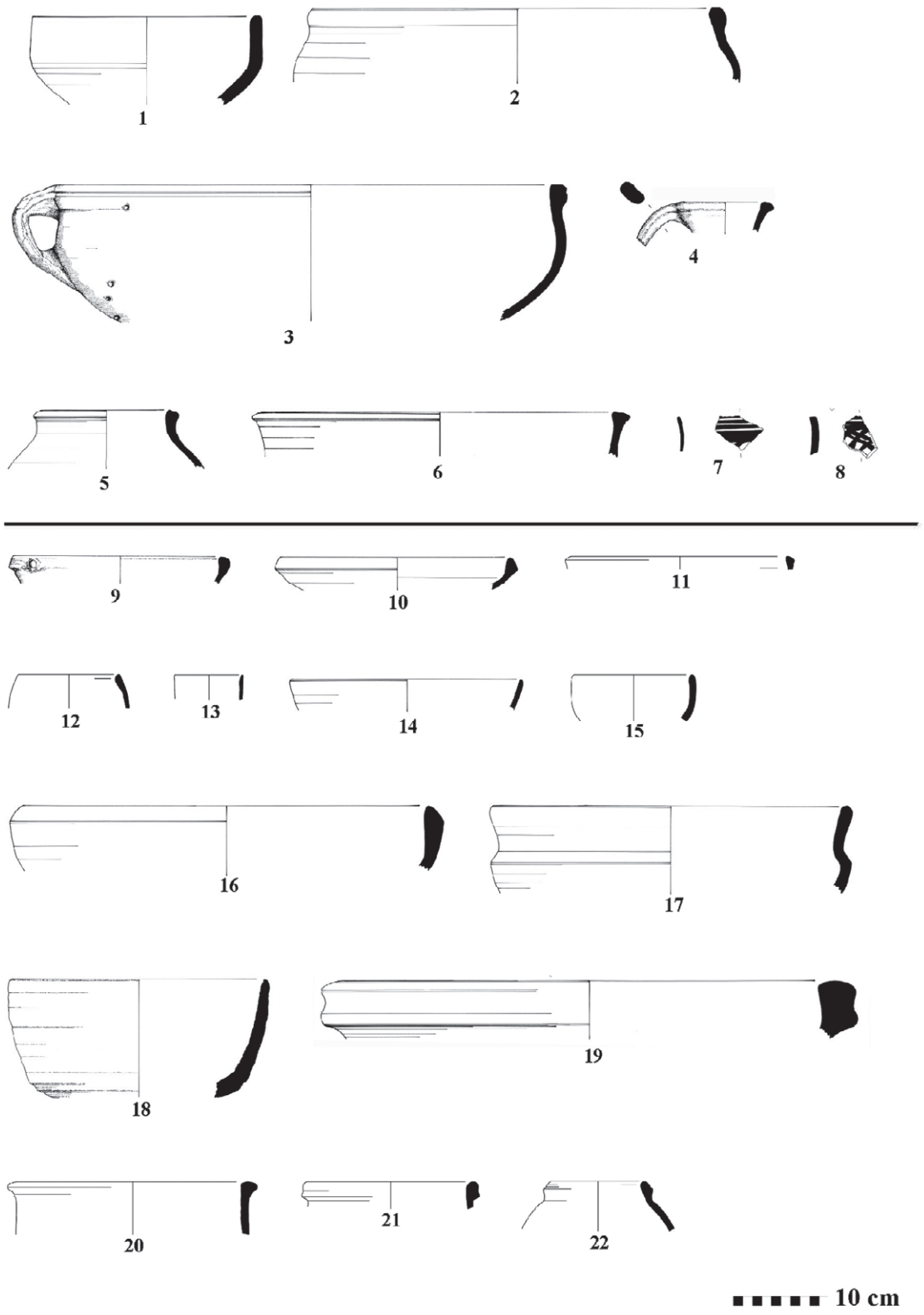

Figure 4.8 KEN Area M: Integrated Phases II–III, II.

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Table 4.8 KEN Area M: Integrated Phases II-III, II (Fig 4.8).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	82	627	9133	M2	II-III	Bowl	BL13a2	A7	White slip
2	1026	700	10076	M2a/2b	II-III	Krater	KR3b	A1	White slip
3	1415	700	10089	M2a/2b	II-III	Krater	KR9		White slip
4	89	602	9013	M2	II-III	Jug	JG12	A9	
5	1003	700	10076	M2a/2b	II-III	Jar	JR8	A1	White slip
6	170	629	9270	M2	II-III	Krater	KR?		
7	43	606	9052	M2	II-III		Qurayyah	A10	Painted design Qurayyah ware
8	41	629	9255	M2	II-III		Qurayyah		Painted design Qurayyah ware
9	163	635	9269	M2a	II	Bowl	BL7	A2	Knob decoration with light gray slip (ext.)
10	1035	725	10237	M1b	II	Bowl	BL9c		White slip
11	167	633	9268	M1b	II	Bowl	BL9	A1	
12	990	680	9988	M2a	II	Bowl	BL13	A2	
13	1030	707	10136	M2a	II	Bowl	BL17	A1	
14	1014	701	10103	M1b	II	Bowl	BL17b	A1b	Highly fired black core
15	1056	695	10049	M1a	II	Bowl	BL33		White slip
16	5	613	9039	M1b	II	Bowl	BL37	A2	White slip
17	196	650	9557	M1b	II	Bowl	BL		White slip
18	1047	721	10216	M2a	II		HMBL		
19	1053	701	10172	M1b	II	Krater	KR10		
20	996	708	10119	M2a	II	Krater	KR		
21	57	630	9266	M2a	II	Cooking pot	CP3	A6	
22	62	624	9180	M1b	II	Cooking pot	CP13		White slip (ext.)

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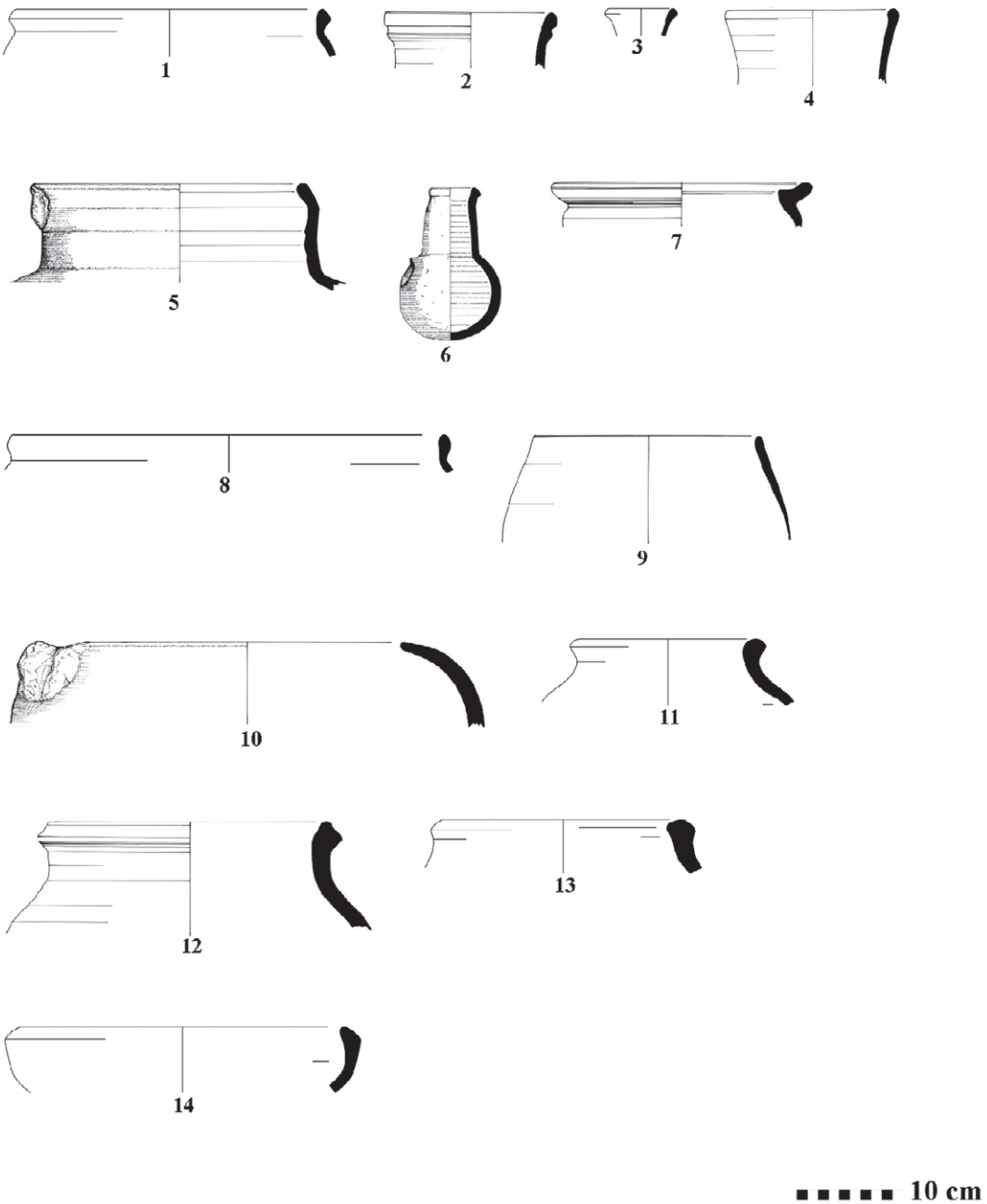

Figure 4.9 KEN Area M: Integrated Phase II.

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Table 4.9 KEN Area M: Integrated Phases II (Fig 4.9).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	521	681	10007	M1a	II	Cooking pot	CP14		
2	3	607	9016	M1b	II	Jug	JG3		
3	38	619	9061	M2a	II	Jug	JG10		
4	423	687	10017	M1a	II	Jug	JG15c		White slip
5	1012	707	10118	M2a	II	Jug	JG42		
6	278	650	9652	M1b	II	Juglet	JT		Red slip with hand burnish (ext.)
7	1006	718	10202	M1a	II	Jar	JR6		
8	520	681	10007	M1a	II	Jar	JR8		
9	71	630	9266	M2a	II		HMJR		
10	1040	707	10169	M2a	II		HMJR		Applied double knob decoration
11	1039	707	10169	M2a	II	Pithos	PT9		
12	1060	663	9772	M1a	II	Pithos	PT13	A3	
13	991	680	9988	M2a	II	Pithos	PT14	A7	
14	1420	0	0	M		Bowl	BL37	A3	

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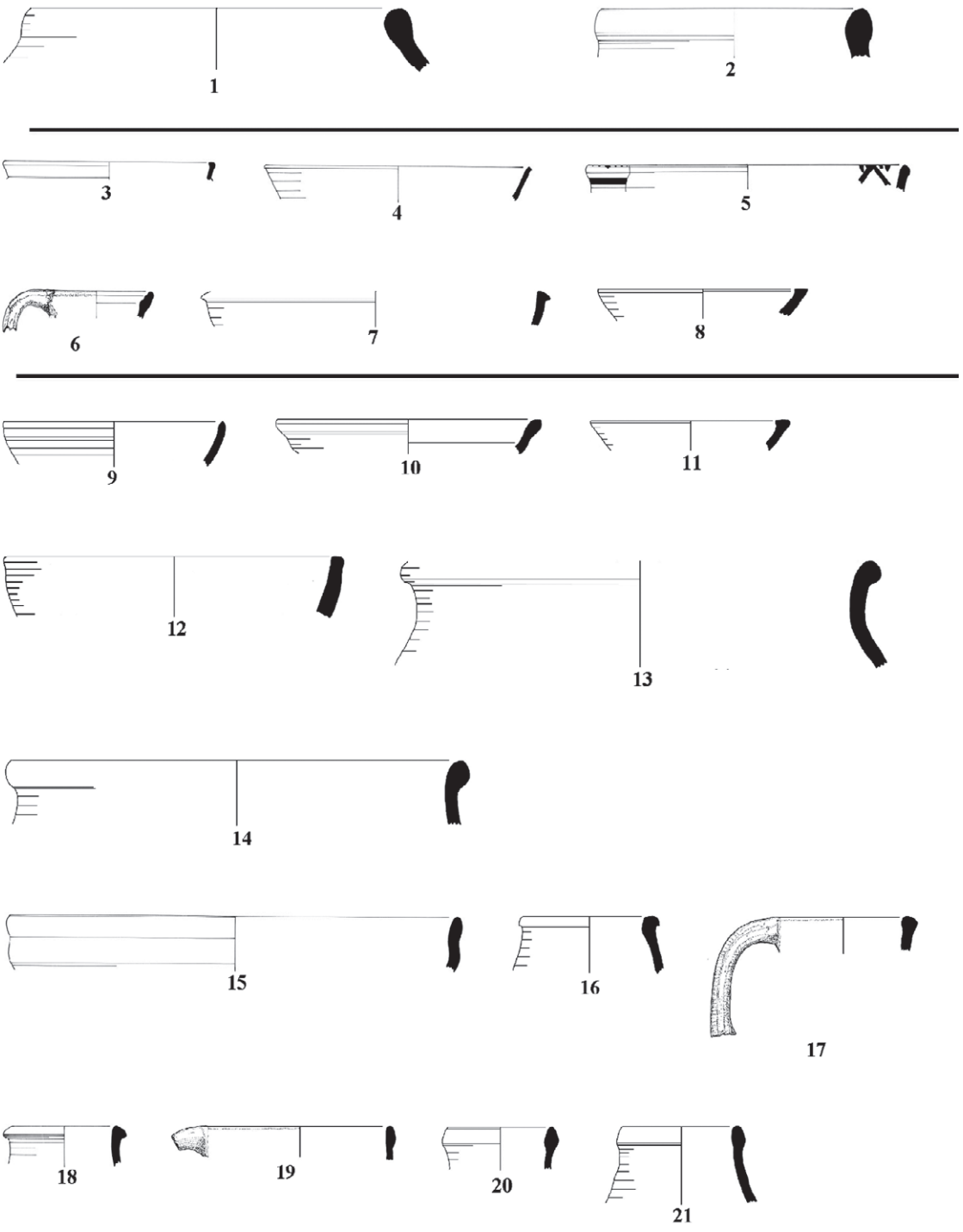

Figure 4.10 KEN Area A: Integrated Phases Virgin, V, IV, III–IV.

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Table 4.10 KEN Area A: Integrated Phases Virgin, V, IV, III-IV (Fig 4.10).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	773	93	1933	A4b	Virgin	Pithos	PT10	A2	White slip (int./ext.)
2	136	166	4128	A4	V	Pithos	PT8	A2b	White slip (ext.)
3	364	190	4354	A3a	IV	Bowl	BL1f		
4	382	180	4230	A3a	IV	Bowl	BL17b	A1b	High fired dark gray fabric
5	391	180	4297	A3a	IV	Bowl	BL21a2		Painted design with cream slip
6	366	180	4329	A3a	IV	Juglet	JT3		
7	267	41	1242	A3	III-IV	Bowl	BL3a3		
8	341	36	1204	A3	III-IV	Bowl	BL10	A1	
9	180	41	1263	A3	III-IV	Bowl	BL16	I1	Red slip and horizontal burnish (int./ext.)
10	345	40	1234	A3	III-IV	Bowl	BL24	A1	Red slip (ext.)
11	178	40	1289	A3	III-IV	Bowl	BL		
12	181	41	1263	A3	III-IV	Bowl	BL		
13	884	97	2127	A3	III-IV	Krater	KR6		White slip (ext.)
14	885	97	2127	A3	III-IV	Krater	KR6		
15	95	161	4095	A3	III-IV	Krater	KR18		
16	263	40	1306	A3	III-IV	Jug	JG2		Cream slip (ext.)
17	352	58	1399	A3	III-IV	Jug	JG4		
18	46	161	4110	A3	III-IV	Jug	JG4d		White slip (ext.)
19	344	40	1225	A3	III-IV	Jug	JG6		
20	769	94	1934	A3	III-IV	Jug	JG6		
21	770	94	1934	A3	III-IV	Jug	JG6		

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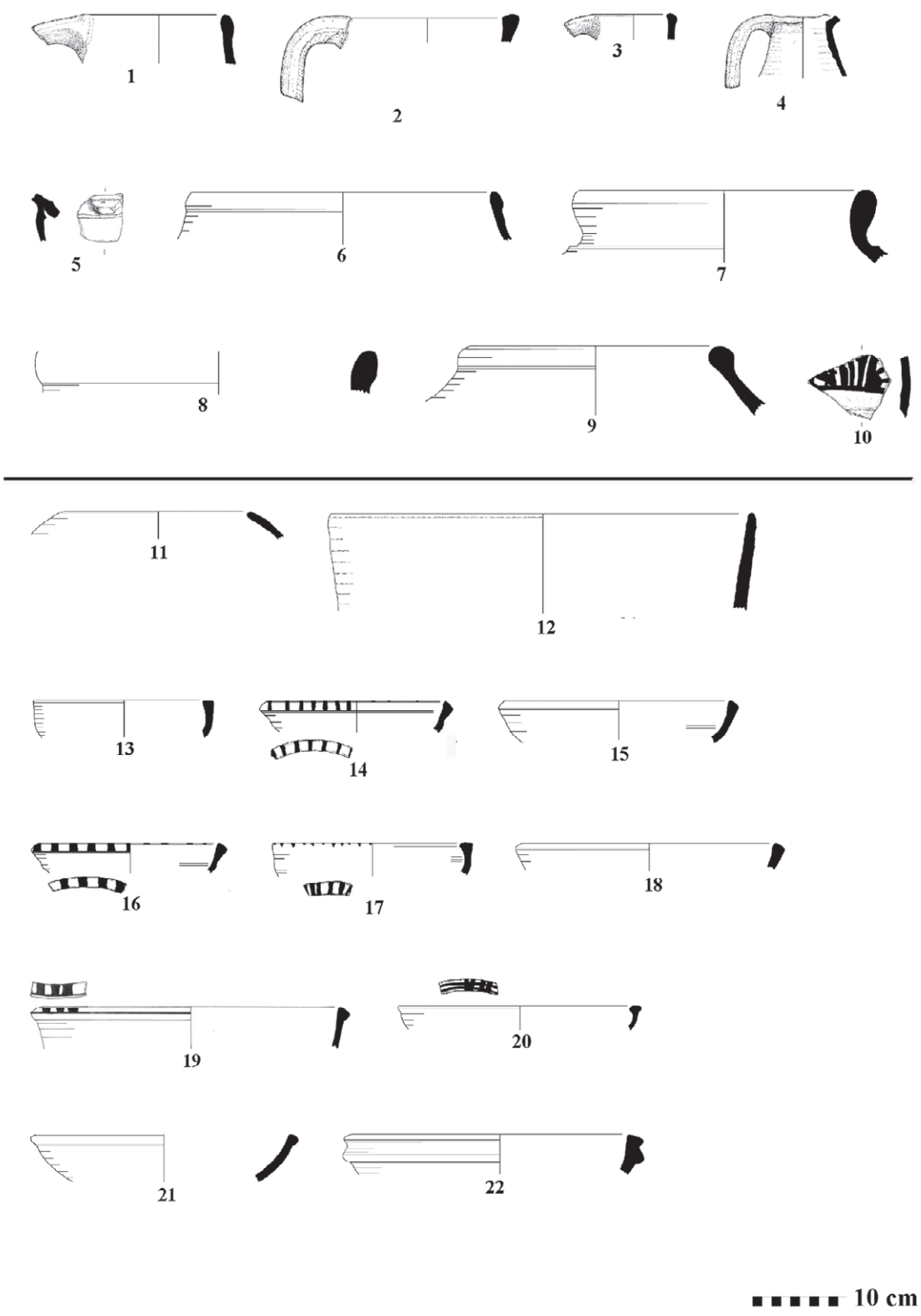

Figure 4.11 KEN Area A: Integrated Phases III–IV, II.

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Table 4.11 KEN Area A: Integrated Phases III-IV, II (Fig 4.11).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	883	97	2127	A3	III-IV	Jug	JG6		
2	762	89	1900	A3	III-IV	Jug	JG9		
3	265	41	1242	A3	III-IV	Jug	JG14		
4	771	89	1900	A3	III-IV	Juglet	JT23		
5	51	161	4110	A3	III-IV	Jar	JR5		White slip
6	886	97	2127	A3	III-IV	Jar	JR42		
7	266	41	1242	A3	III-IV	Pithos	PT5	A2	
8	706	89	1824	A3	III-IV	Pithos	PT8		White slip (int./ext)
9	269	53	1327	A3	III-IV	Pithos	PT10		
10	264	40	1306	A3	III-IV		Qurayyah		Painted design, slip and burnish
11	449	58	1450	A3	III-IV		Holemouth		Ashy
12	882	97	2127	A3	III-IV		HMBL		
13	153	21	1154	A2a	II	Bowl	BL3a1		
14	490	62	1516	A2a	II	Bowl	BL3a1		Black horizontal bands, white slip (int./ext.)
15	554	62	1623	A2a	II	Bowl	BL3a1	A1	
16	606	62	1623	A2a	II	Bowl	BL3a1		Black horizontal bands on rim
17	612	62	1623	A2a	II	Bowl	BL3a1		Black horizontal bands white slip (int./ext.)
18	636	77	1727	A2b	II	Bowl	BL3a1		
19	9	157	4021	A2a	II	Bowl	BL3a1		Painted design slip
20	634	77	1727	A2b	II	Bowl	BL3a2		Black horizontal bands on rim, white slip (int./ext.)
21	333	37	1198	A2b	II	Bowl	BL3a3		
22	337	21	1361	A2a	II	Bowl	BL3a4		White slip (int./ext.)

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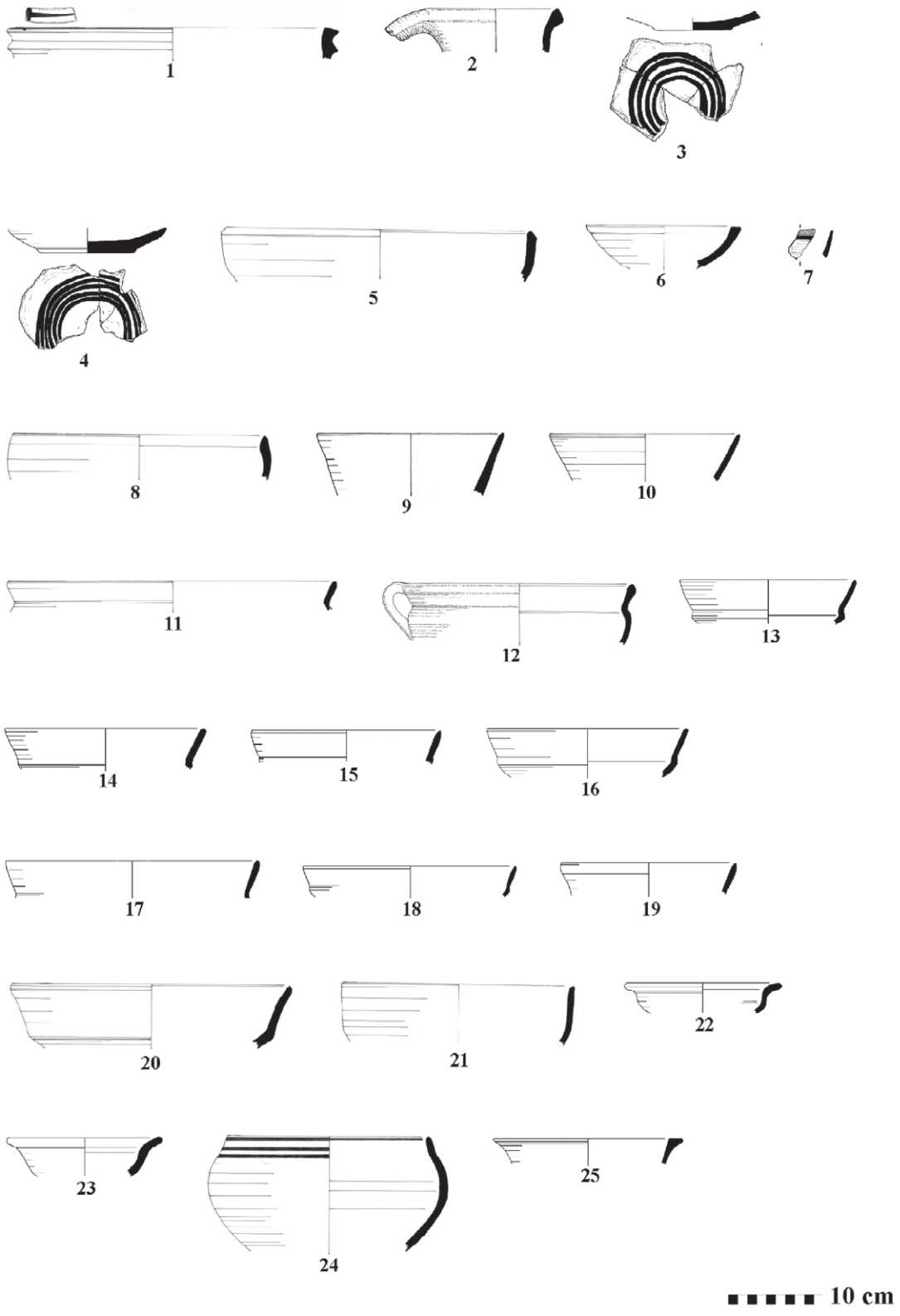

Figure 4.12 KEN Area A: Integrated Phase II.

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Table 4.12 KEN Area A: Integrated Phase II (Fig 4.12).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	126	168	4171	A2a	II	Bowl	BL3a4		Painted design
2	630	77	1727	A2b	II	Bowl	BL3 base		Black horizontal bands white slip (int.)
3	1077	62	1623	A2a	II	Bowl	BL3 base		Black horizontal bands white slip (int./ext.)
4	1308	21	0	A2a	II	Bowl	BL3 base		
5	257	189	4341	A2a	II	Bowl	BL9	A1	Slip
6	210	168	4158	A2a	II	Bowl	BL10	A3	
7	563	74	1640	A2b	II	Bowl	BL12b	A7	Pale red and black painted design, bichrome
8	250	187	4328	A2a	II	Bowl	BL13	A2	White slip
9	114	21	1108	A2a	II	Bowl	BL17	A1	White slip (int./ext.)
10	154	21	1154	A2a	II	Bowl	BL17	A1	
11	283	179	4245	A2b	II	Bowl	BL21a2		
12	339	174	4202	A2b	II	Bowl	BL21b	A9	
13	325	21	1418	A2a	II	Bowl	BL22	A1	White slip (int./ext.)
14	329	21	1418	A2a	II	Bowl	BL22		
15	450	61	1451	A2a	II	Bowl	BL22		Burnish interior
16	460	21	1452	A2a	II	Bowl	BL22		
17	553	77	1717	A2b	II	Bowl	BL22		Ring burnishing (int./ext.)
18	558	76	1710	A2b	II	Bowl	BL22		White slip (int./ext.), ring burnished
19	561	76	1710	A2b	II	Bowl	BL22		
20	249	187	4328	A2a	II	Bowl	BL23	A2	White slip and burnish
21	352	170	4208	A2a	II	Bowl	BL23	A2	
22	258	25	1315	A2a	II	Bowl	BL30	A1	
23	615	62	1623	A2a	II	Bowl	BL30	A1	
24	122	174	4190	A2b	II	Bowl	BL32	A1	White slip (int./ext.) With black horizontal lines on neck
25	568	74	1670	A2b	II	Bowl	BL33		Red slip burnish (int./ext.)

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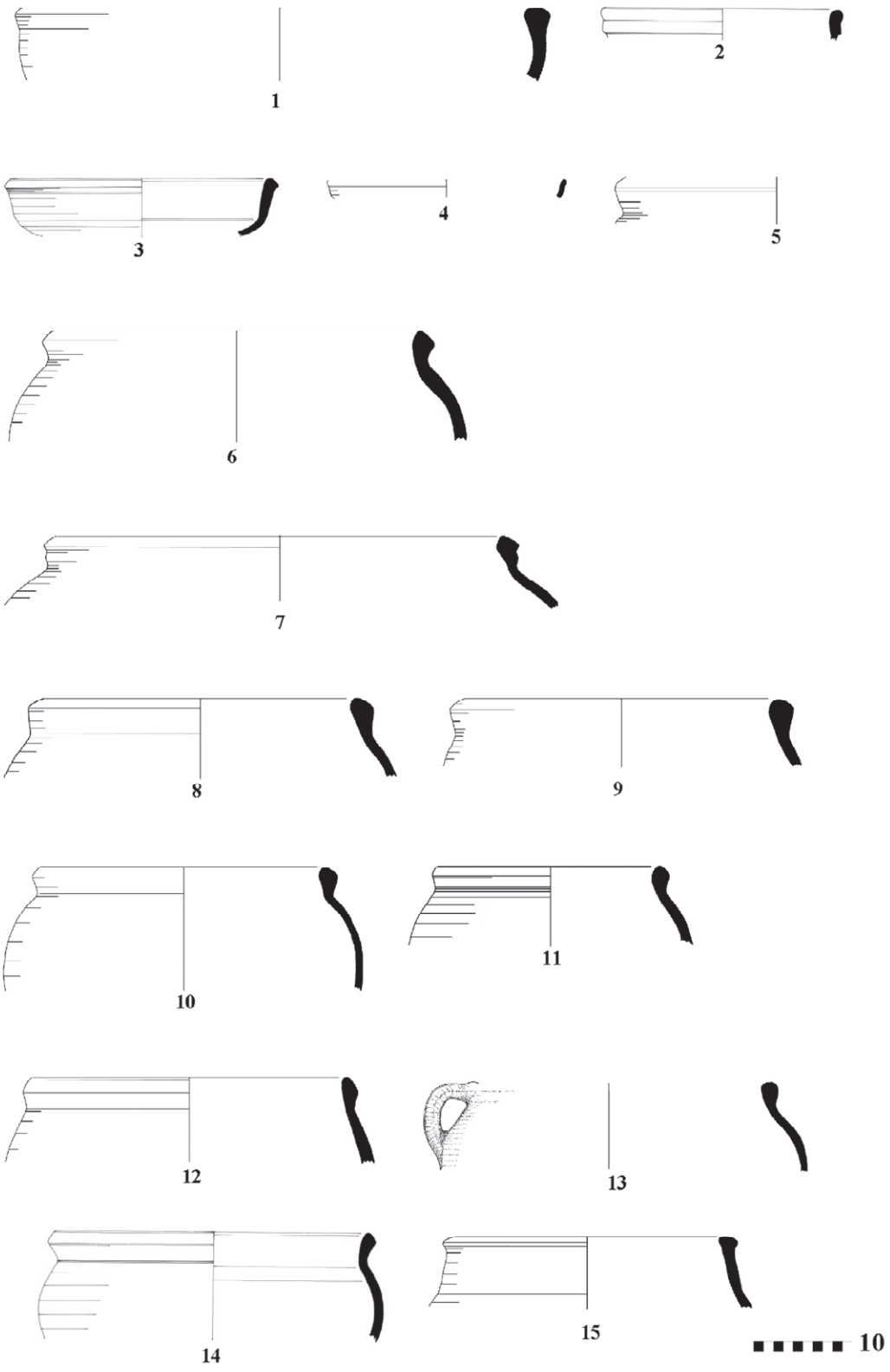

Figure 4.13 KEN Area A: Integrated Phase II.

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Table 4.13 KEN Area A: Integrated Phase II (Fig 4.13).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	709	83	1814	A2b	II	Bowl	BL34	A2	
2	117	171	4174	A2a	II	Bowl	BL47		
3	268	187	4320	A2a	II	Bowl	BL		Red slip and burnish (int./ext.); rich in dolomite
4	621	74	1670	A2b	II	Bowl	BL		
5	488	62	1516	A2a	II	Krater	KR3		
6	590	62	1668	A2a	II	Krater	KR3		White slip, exterior blistering
7	596	62	1623	A2a	II	Krater	KR3a2		White slip (int./ext.)
8	598	62	1623	A2a	II	Krater	KR3		White slip (ext.)
9	599	62	1623	A2a	II	Krater	KR3a2		
10	261	25	1315	A2a	II	Krater	KR3b		
11	354	56	1364	A2b	II	Krater	KR3b	A2	
12	464	62	1561	A2a	II	Krater	KR3b		White slip (ext.)
13	564	76	1710	A2b	II	Krater	KR3b		
14	253	187	4328	A2a	II	Krater	KR3b	A2	
15	6	13	1030	A2a	II	Krater	KR4	A7	Very pale brown slip (ext.)

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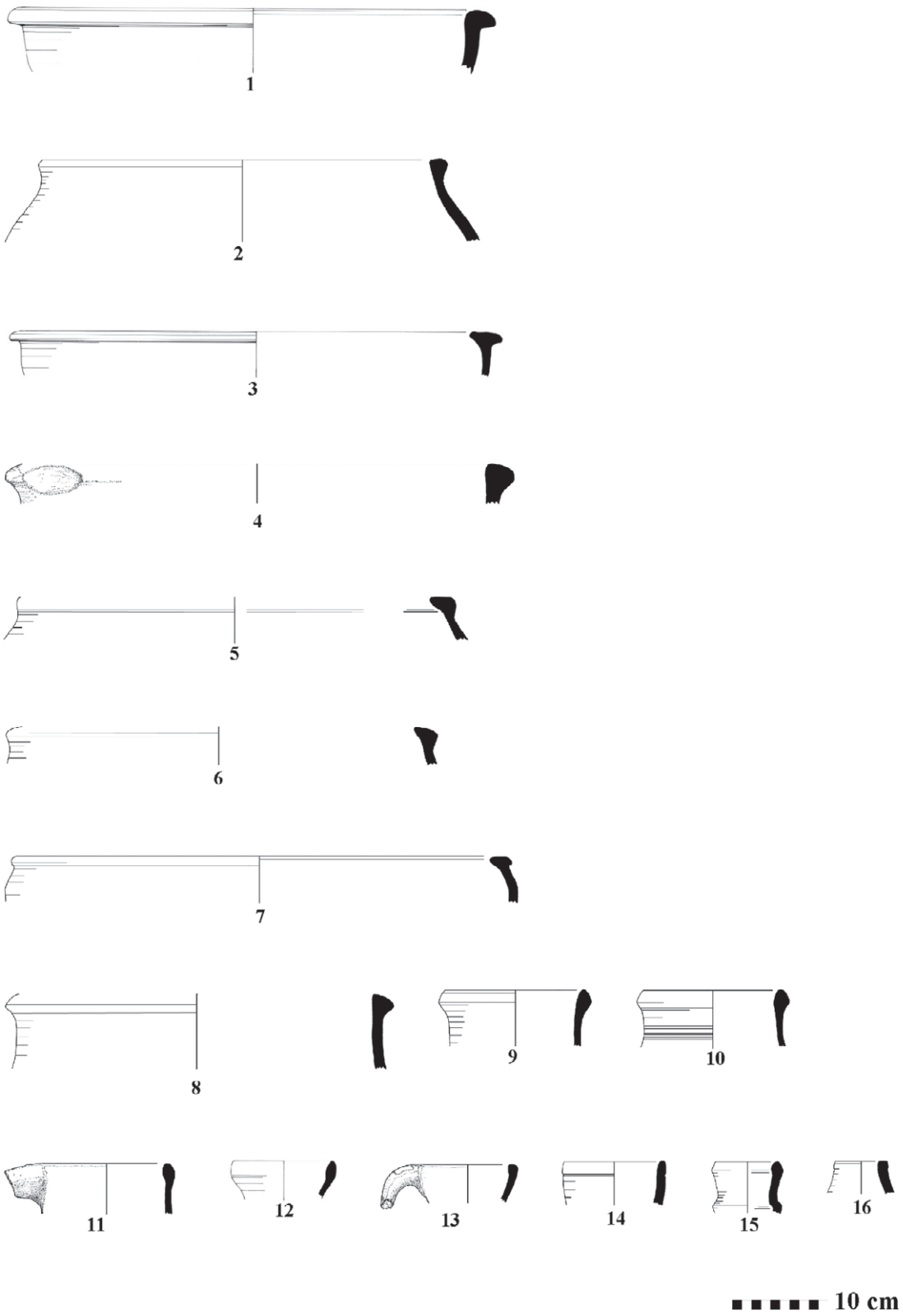

Figure 4.14 KEN Area A: Integrated Phase II.

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Table 4.14 KEN Area A: Integrated Phase II (Fig 4.14).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	258	193	4377	A2b	II	Krater	KR5		
2	487	62	1516	A2a	II	Krater	KR6		
3	351	170	4208	A2a	II	Krater	KR7		
4	349	37	1181	A2b	II	Krater	KR9		White slip (ext.)
5	928	92	2061	A2b	II	Krater	KR11b		White slip (int./ext.)
6	932	103	2172	A2b	II	Krater	KR11b	A1	White slip (ext.)
7	732	92	1925	A2b	II	Krater	KR14		White slip (ext.) Burnish (int.)
8	631	77	1727	A2b	II	Krater	KR25		White slip (int./ext.)
9	332	37	1198	A2b	II	Jug	JG4		White slip (int./ext.), ridges at lower end of neck
10	467	62	1561	A2a	II	Jug	JG4d	A2	White slip (int./ext.)
11	731	92	1925	A2b	II	Jug	JG6		
12	299	179	4245	A2b	II	Jug	JG6		White slip
13	355	56	1364	A2b	II	Jug	JG14		White slip (ext.)
14	623	28	1728	A2a	II	Jug	JG15b		White slip (int./ext.), possible secondary use as burnishing tool
15	482	62	1516	A2a	II	Jug	JG17		White slip (ext.)
16	183	49	1259	A2b	II	Jug	JG		

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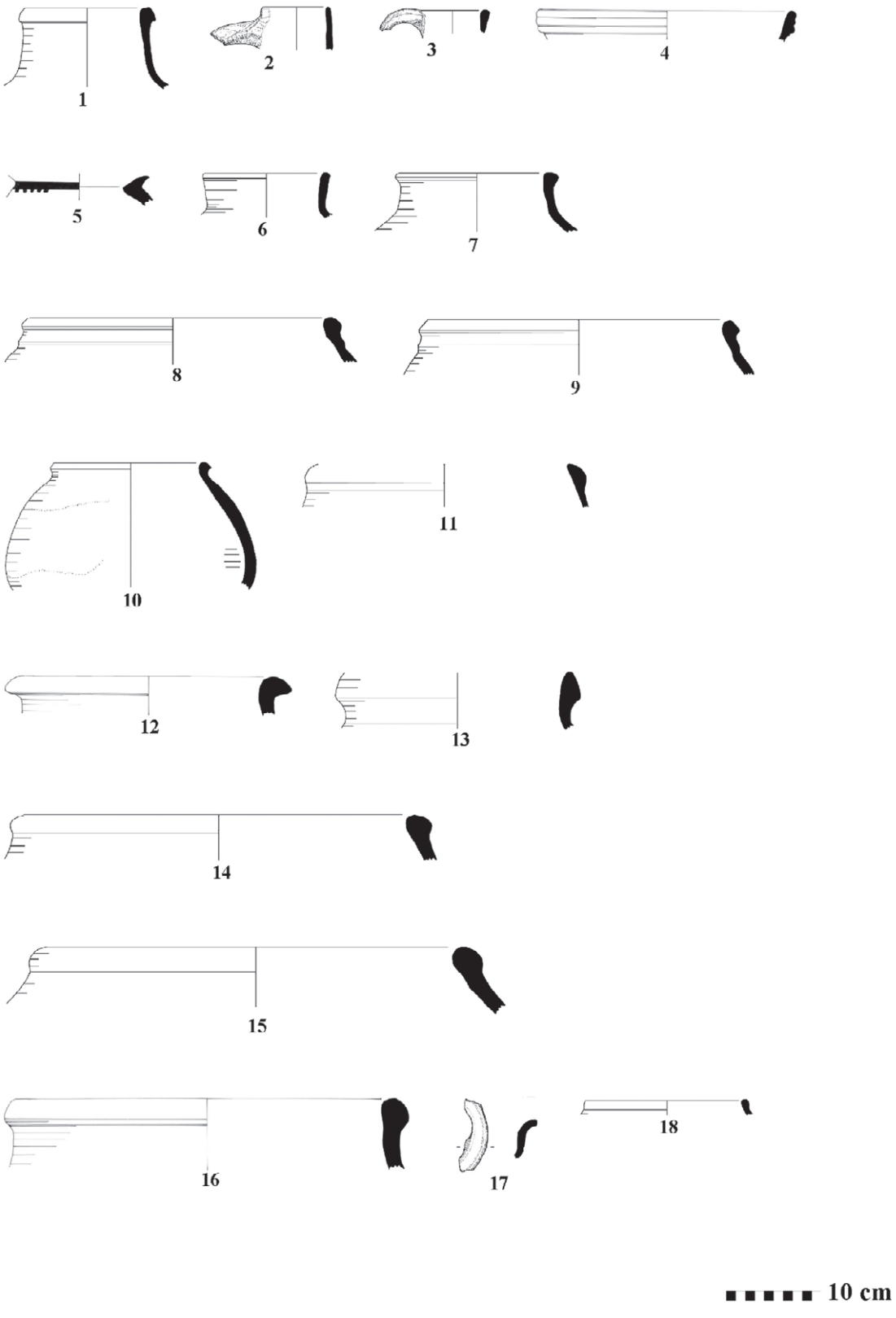

Figure 4.15 KEN Area A: Integrated Phase II.

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Table 4.15 KEN Area A: Integrated Phase II (Fig 4.15).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	463	21	1452	A2a	II	Jug	JG		White slip exterior
2	350	37	1181	A2b	II	Jug	JG		Broken rim
3	766	74	1901	A2b	II	Juglet	JT3		White slip (ext.)
4	208	168	4158	A2a	II	Jar	JR4		White slip
5	263	174	4190	A2b	II	Jar	JR6	A2	Painted design
6	257	25	1315	A2a	II	Jar	JR7		
7	351	34	1153	A2a	II	Jar	JR7	A9	
8	331	37	1198	A2b	II	Jar	JR15	A2	White slip (ext.)
9	445	21	1361	A2a	II	Jar	JR15		
10	486	62	1516	A2a	II	Jar	JR47		
11	705	74	1784	A2b	II	Jar	JR		Coated with slag, copper, and ash
12	106	171	4174	A2a	II	Pithos	PT2	A7	White slip
13	446	28	1477	A2a	II	Pithos	PT4		
14	456	70	1566	A2b	II	Pithos	PT10		White slip (ext.)
15	704	74	1784	A2b	II	Pithos	PT10		White slip (ext.)
16	340	174	4202	A2b	II	Pithos	PT10		
17	632	77	1727	A2b	II		Lp		
18	551	74	1640	A2b	II		Holemouth		

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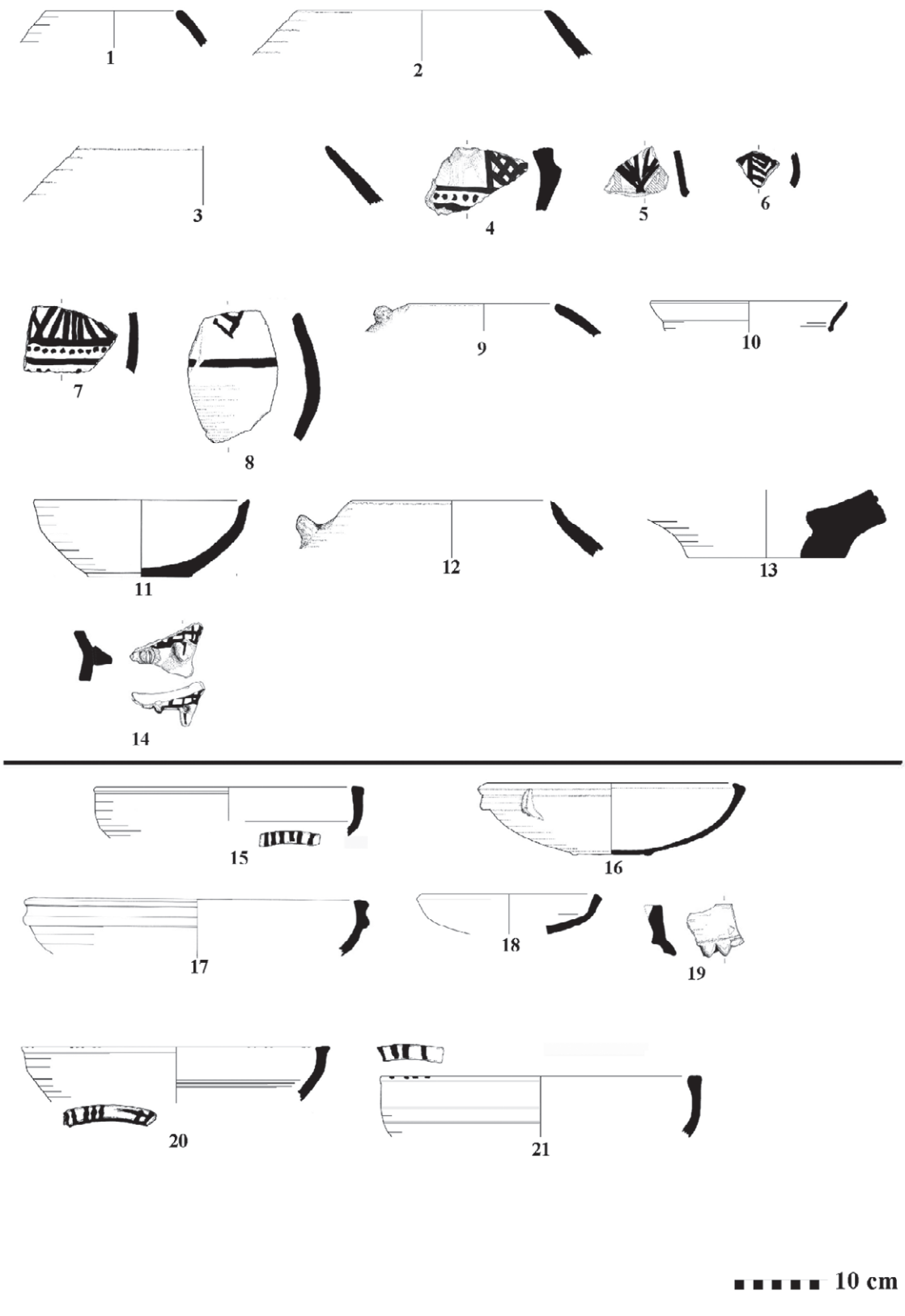

Figure 4.16 KEN Area A: Integrated Phases II, I.

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Table 4.16 KEN Area A: Integrated Phases II, I (Fig 4.16).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	162	31	1112	A2a	II		HMJR		
2	334	37	1198	A2b	II		HMJR	A2b	
3	565	76	1710	A2b	II		HMJR		
4	336	21	1361	A2a	II		Qurayyah		Black painted design slip and burnish
5	324	21	1418	A2a	II		Qurayyah		Black painted design slip and burnished design
6	557	76	1710	A2b	II		Qurayyah		Black painted design slip and burnish
7	574	62	1561	A2a	II		Qurayyah		Black painted design slip and burnish
8	586	62	1668	A2a	II		Qurayyah?		Black painted design slip and burnish
9	605	62	1623	A2a	II		HMJR		
10	620	62	1623	A2a	II	Bowl	BL22		White slip (int./ext.)
11	881	30	1159	A2a	II	Bowl	BL11		
12	1327	21	1326	A2a	II		HMJR		Grooved
13	1334	74	1846	A2b	II		Base		
14	101	174	4190	A2b	II		Painted		Painted design and knob handle decoration
15	455	63	1519	A1b	I	Bowl	BL3a1		Black horizontal bands on rim white slip (int./ext.)
16	1060	79	1847	A1b	I	Bowl	BL3a4	I1	Red slip burnish interior/exterior draw
17	7	155	4014	A1b	I	Bowl	BL3a4	A2	White slip
18	401	184	4291	A1b	I	Bowl	BL3a4		Painted design slip
19	144	163	4139	A1b	I	Bowl	BL3a8		Denticulated
20	174	44	1298	A1b	I	Bowl	BL3b3	A1	Black horizontal bands, white slip (int./ext.)
21	447	55	1448	A1b	I	Bowl	BL3b3		Black painted design on rim, white slip

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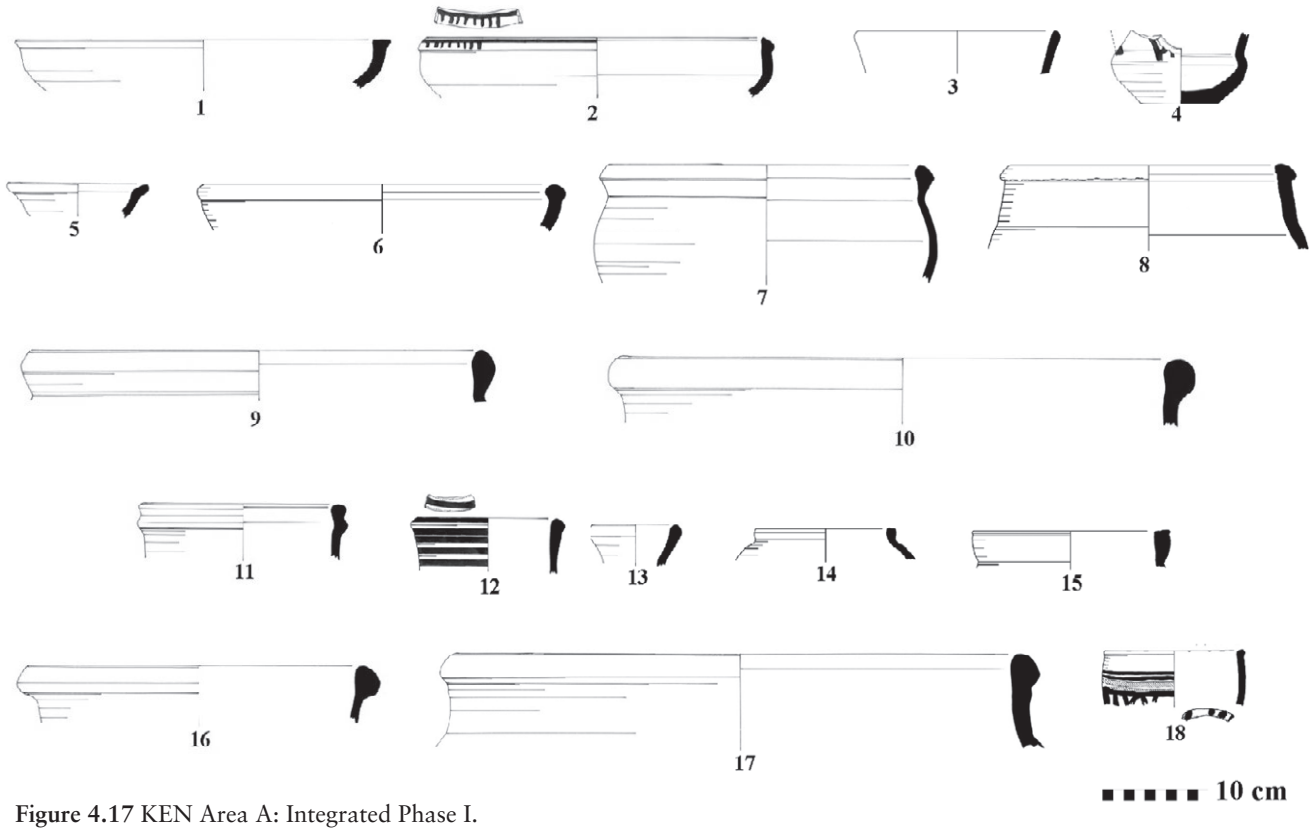

Figure 4.17 KEN Area A: Integrated Phase I.

Table 4.17 KEN Area A: Integrated Phase I (Fig 4.17).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	404	158	4147	A1b	I	Bowl	BL3b1		Painted design, white slip
2	1460	183	4299	A1b	I	Bowl	BL9b	A2	Painted design
3	333	183	4299	A1b	I	Bowl	BL14b2		White slip
4	32	158	4036	A1b	I	Bowl	BL21a1		Painted design, white slip
5	149	163	4139	A1b	I	Bowl	BL24b	A1	White slip (ext.)
6	10	12	1026	A1b	I	Bowl	BL38		White slip, possible import
7	347	176	4231	A1a	I	Krater	KR3b	A2	White slip
8	1	18	1057	A1b	I	Krater	KR4		Very pale brown slip
9	332	183	4299	A1b	I	Krater	KR13		White slip
10	356	183	4271	A1b	I	Krater	KR24		White slip
11	269	183	4271	A1b	I	Jug	JG3		
12	1461	183	4268	A1b	I	Jug	JG15c		Painted design slip
13	274	183	4246	A1b	I	Juglet	JT19		
14	448	55	1448	A1b	I	Jar	JR16		
15	703	81	1813	A1a	I	Jar	JR43		
16	109	163	4139	A1b	I	Jar	JR51		Painted design
17	325	183	4299	A1b	I	Pithos	PT10	A2	
18	578	79	1730	A1b	I		Qurayyah		Painted design, slip and burnish

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Figure 4.18 KEN Area A: Integrated Phase I.

Table 4.18 KEN Area A: Integrated Phase I (Fig 4.18).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	266	183	4246	A1b	I	Bowl	BL		
2	7	0	0			Krater	KR11		

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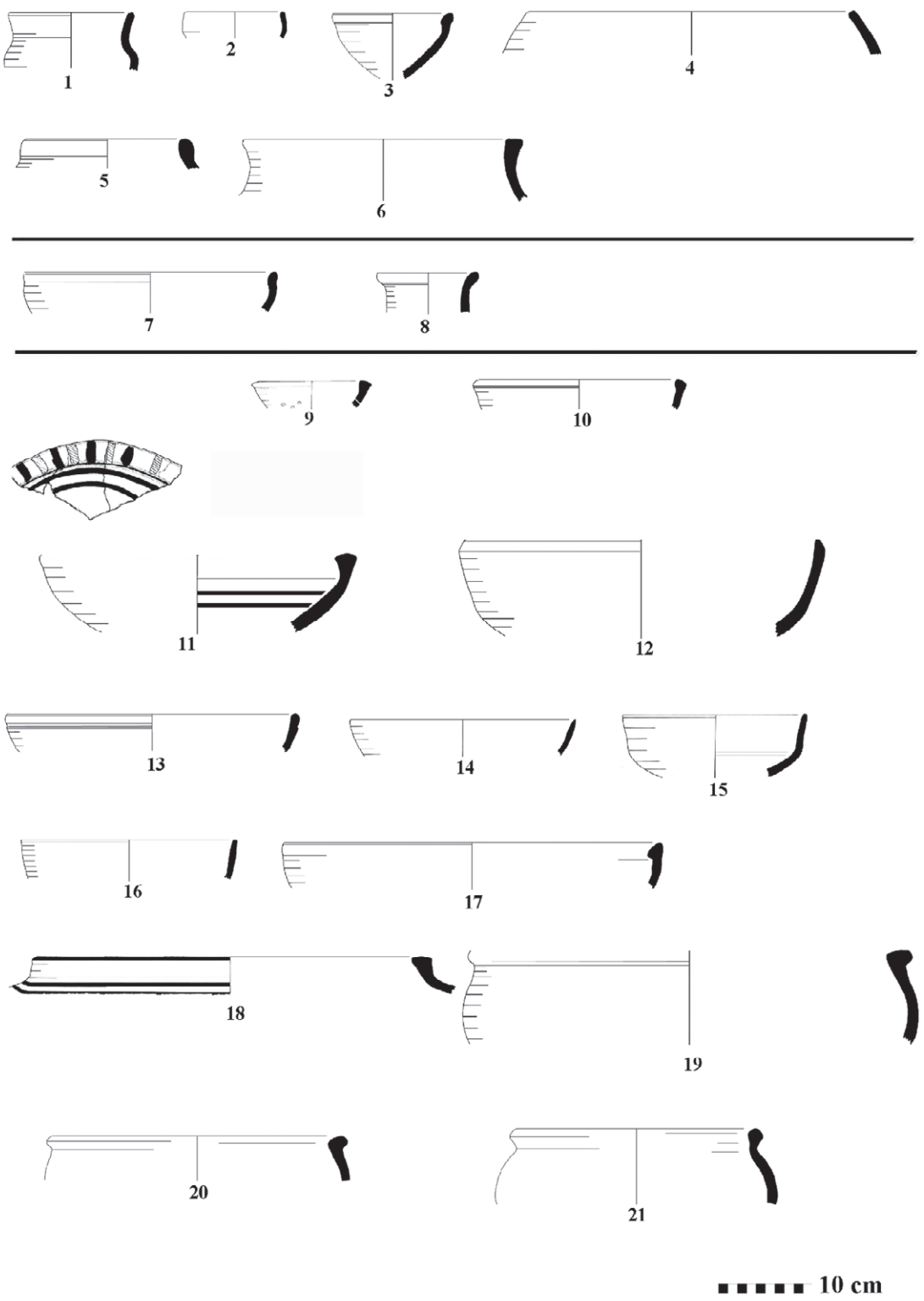

Figure 4.19 KEN Area S: Integrated Phases VI, V, III.

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Table 4.19 KEN Area S: Integrated Phases VI, V, III (Fig 4.19).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	965	352	7725	S4	VI	Bowl	BL21a1		
2	970	350	7715	S4	VI	Bowl	BL26	A2	
3	971	350	7715	S4	VI	Bowl	BL31	A8	White slip (int./ext.); contains glassy slag
4	964	347	7657	S4	VI		HMBL		White slip (int./ext.), pot mark on handle
5	969	350	7715	S4	VI	Jar	JR1		
6	961	351	7716	S4	VI	Jar	JR45		
7	887	341	7518	S3	V	Bowl	BL31	A1	
8	888	344	7540	S3	V	Jug	JG18		
9	926	336	7521	S2b	III	Bowl	BL3a1		White slip (ext.)
10	945	338	7441	S2b	III	Bowl	BL3a1		White slip (int./ext.)
11	914	336	7521	S2b	III	Bowl	BL3b1	B1	Black horizontal bands and rim burnish exterior, bichrome
12	792	336	7321	S2b	III	Bowl	BL9	A2	White slip (int./ext.)
13	381	311	6174	S2b	III	Bowl	BL15b	A9	
14	987	336	7444	S2b	III	Bowl	BL17	A2	White slip (int./ext.)
15	910	336	7521	S2b	III	Bowl	BL23	A2	White slip (ext.)
16	956	339	7442	S2b	III	Bowl	BL23	A2	White slip (int./ext.)
17	989	336	7444	S2b	III	Bowl	BL38		White slip (int./ext.)
18	782	336	7321	S2b	III	Krater	KR3a2		Black horizontal bands, white slip (ext.)
19	990	336	7444	S2b	III	Krater	KR8	A9	White slip (int./ext.)
20	962	336	7689	S2b	III	Krater	KR8		White slip (int./ext.)
21	844	336	7321	S2b	III	Krater	KR3		

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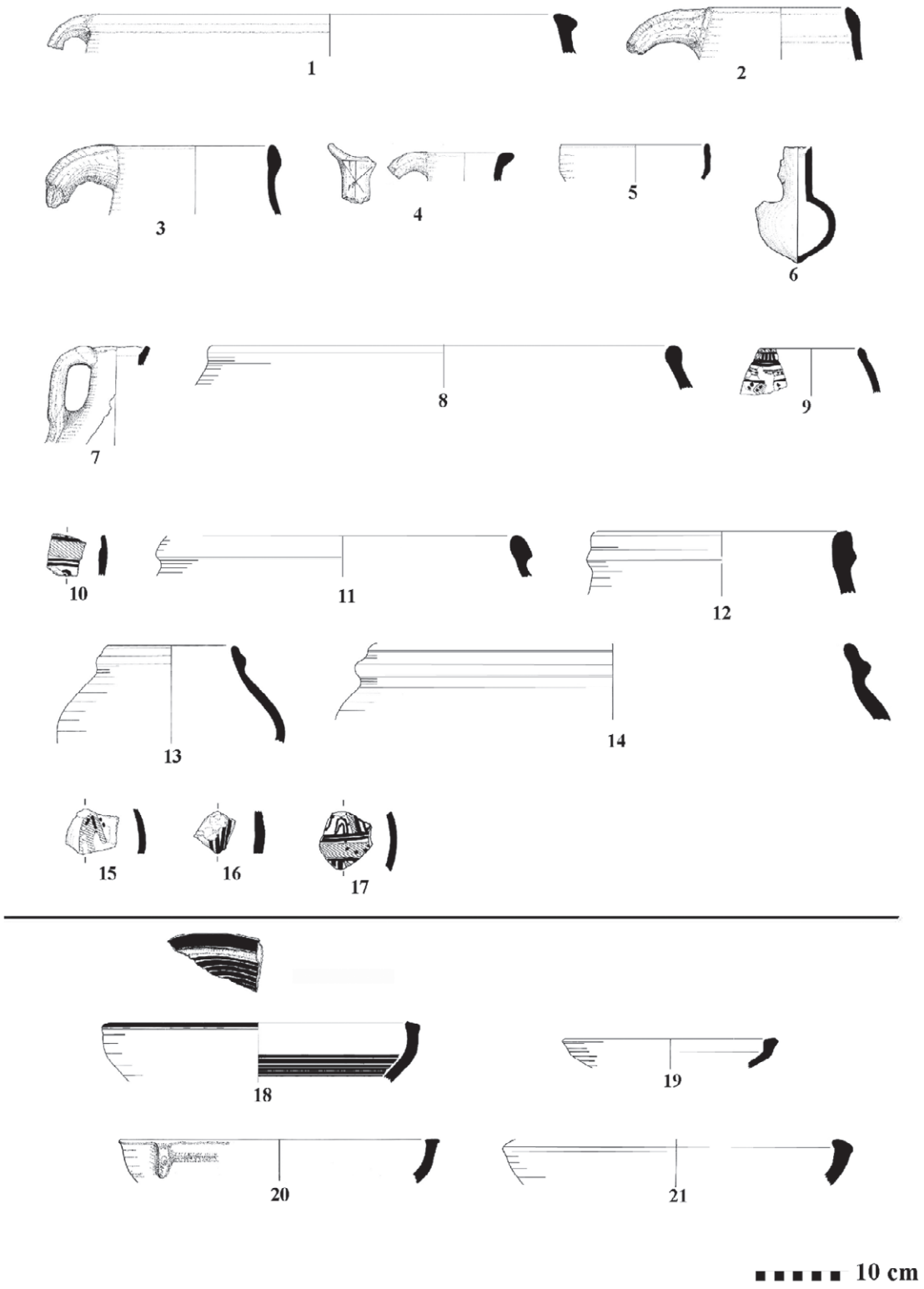

Figure 4.20 KEN Area S: Integrated Phases III, II.

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Table 4.20 KEN Area S: Integrated Phases IIII, II (Fig 4.20).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	908	336	7521	S2b	III	Krater	KR11		White slip (int./ext.)
2	843	336	7321	S2b	III	Jug	JG6		White slip (ext.)
3	992	336	7444	S2b	III	Jug	JG6		
4	787	339	7377	S2b	III	Jug	JG14	A1b	Incised decoration on handle
5	975	336	7444	S2b	III				
6	880	336	7322	S2b	III	Juglet	JT19		
7	826	332	7107	S2b	III	Juglet	JT23		
8	942	337	7440	S2b	III	Jar	JR1		
9	842	339	7377	S2b	III		Qurayyah		Black, red, pinkish-white painted design, slip, and burnish
10	890	338	7543	S2b	III		Qurayyah		Black, weak red horizontal bands, white slip (ext.)
11	786	336	7321	S2b	III	Pithos	PT5		White slip (ext.)
12	924	336	7521	S2b	III	Pithos	PT20b		White slip (ext.)
13	988	336	7444	S2b	III	Cooking Pot	CP2	A6b	
14	784	336	7321	S2b	III	Cooking Pot	CP6		White slip (ext.)
15	583	325	6597	S2b	III		Qurayyah		Black, weak red horizontal bands white slip (ext.)
16	891	338	7543	S2b	III		Qurayyah		Black painted design on rim white slip (ext.)
17	576	318	6523	S2b	III		Qurayyah		Black, weak red horizontal bands
18	804	331	7228	S2a	II	Bowl	BL3a1	A2	Black horizontal bands
19	829	334	7144	S2a	II	Bowl	BL3a3		Black horizontal bands and on rim white slip (ext.)
20	611	322	6868	S2a	II	Bowl	BL3a4		
21	290	307	6014	S2a	II	Bowl	BL3b2		White slip (int./ext.)

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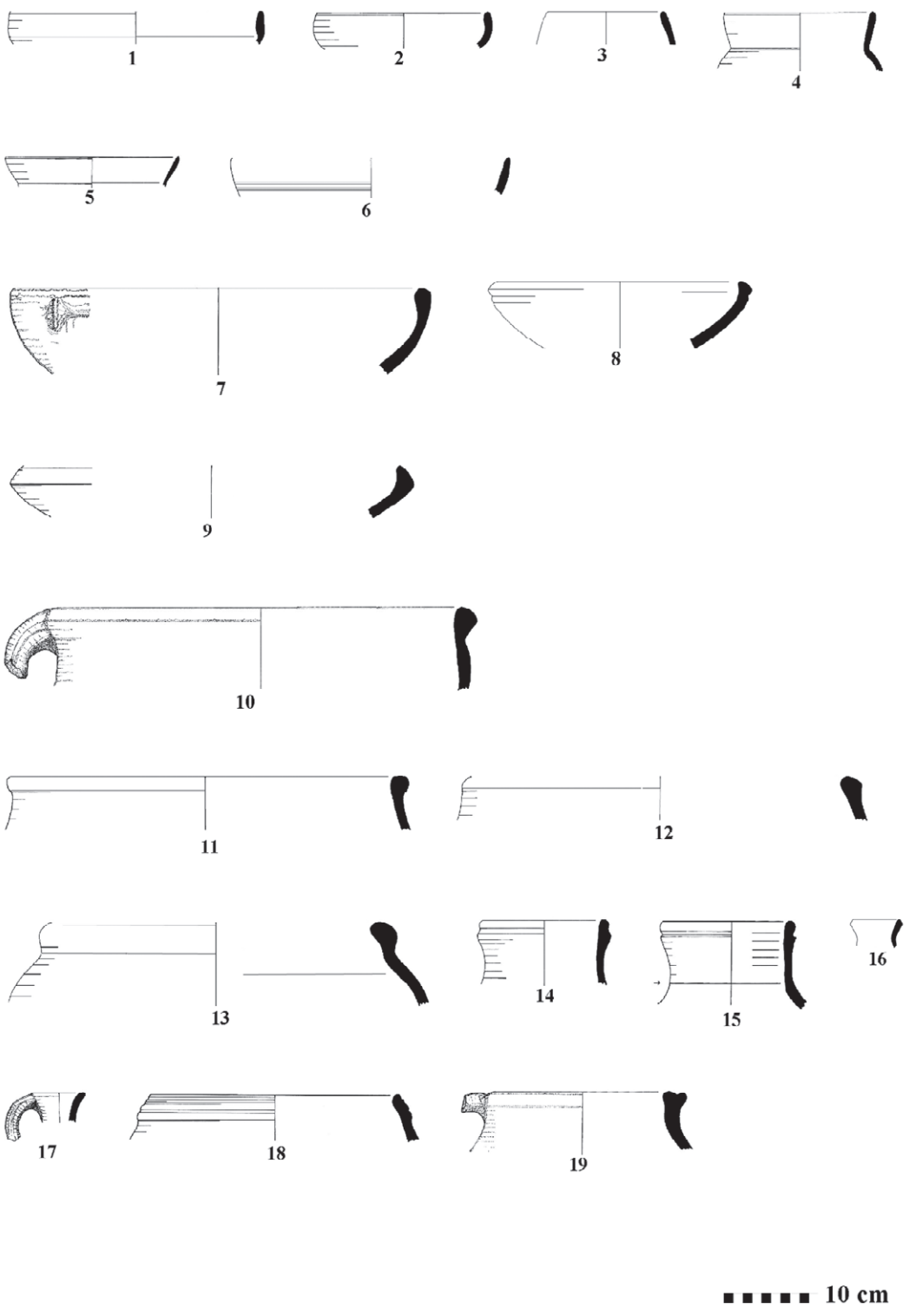

Figure 4.21 KEN Area S: Integrated Phase II.

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Table 4.21 KEN Area S: Integrated Phase II (Fig 4.21).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	432	301	6099	S2a	II	Bowl	BL13b	A2	White slip (ext.), ashy
2	433	301	6099	S2a	II	Bowl	BL13c	A2	White slip (ext.) ashy
3	375	310	6171	S2a	II	Bowl	BL15b	A2	Grooved, white slip (int./ext.)
4	899	340	7529	S2a	II	Bowl	BL21a1	A2	
5	808	331	7228	S2a	II	Bowl	BL22	A1	Burnish (int./ext.)
6	797	331	7108	S2a	II	Bowl	BL23	A2	White slip (ext.), burnish (int.)
7	799	331	7228	S2a	II	Bowl	BL28	A2	Attached bar handle, interior blackened with soot
8	793	331	7326	S2a	II	Bowl	BL29	A9	
9	718	322	6868	S2a	II	Bowl	BL35		White slip (int./ext.)
10	423	301	6168	S2a	II	Krater	KR3		
11	734	328	6871	S2a	II	Krater	KR6		White slip (int./ext.)
12	859	327	7325	S2a	II	Krater	KR9		White slip (int./ext.)
13	653	322	6544	S2a	II	Krater	KR13		
14	356	301	6097	S2a	II	Jug	JG3		
15	701	327	6759	S2a	II	Jug	JG3		
16	435	301	6099	S2a	II	Jug	JG10		White slip (int./ext.), ashy
17	410	307	6102	S2a	II	Juglet	JT3		White slip (ext.)
18	788	331	7367	S2a	II	Jar	JR4		White slip (int./ext.)
19	285	301	6006	S2a	II	Jar	JR19		White slip (ext.)

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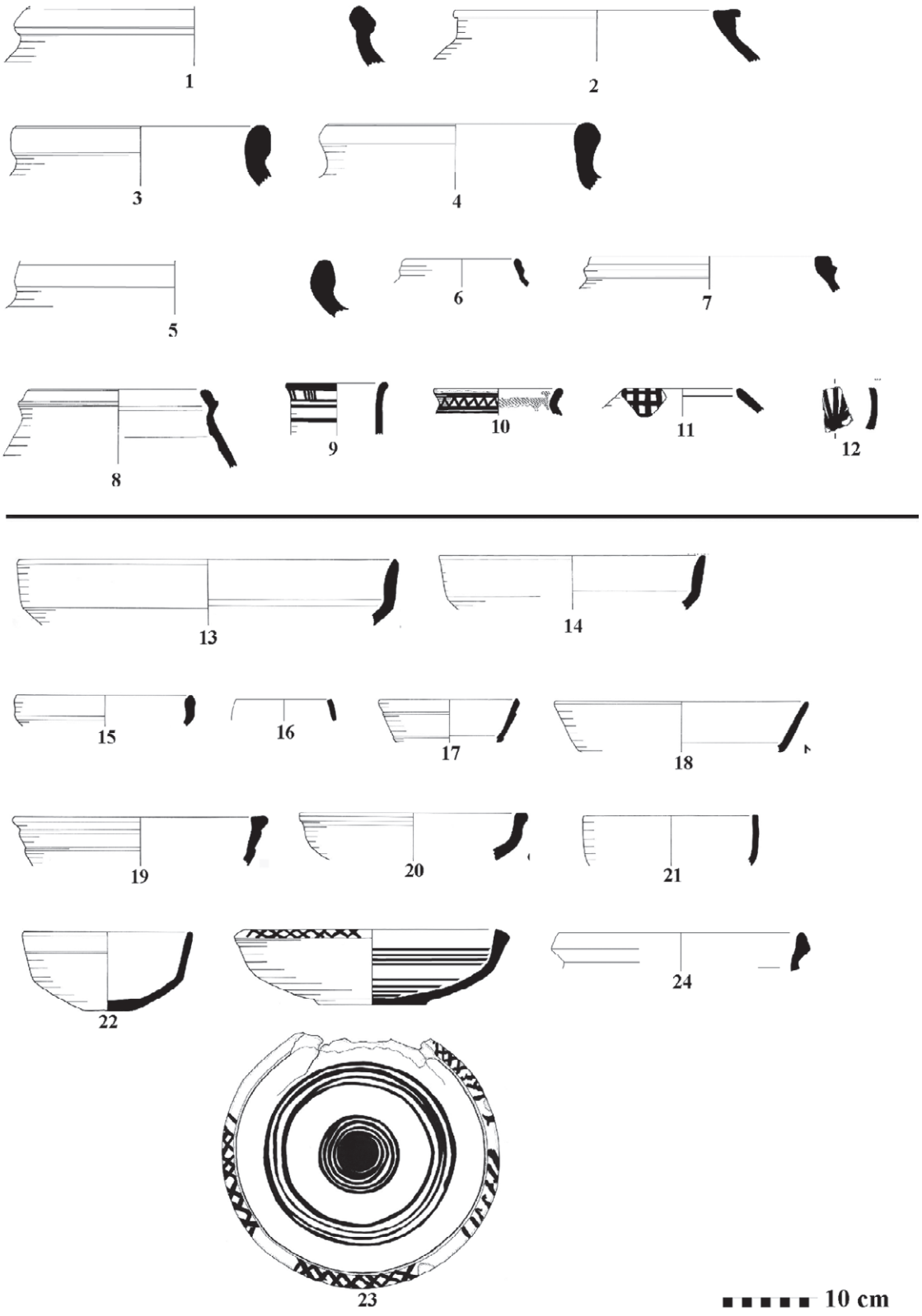

Figure 4.22 KEN Area S: Integrated Phases II, I.

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Table 4.22 KEN Area S: Integrated Phases II, I (Fig 4.22).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	801	331	7228	S2a	II	Jar	JR		White slip (ext.)
2	834	331	7012	S2a	II	Pithos	PT3	A9	Grooved
3	359	301	6097	S2a	II	Pithos	PT5		White slip (ext.), ashy on outside of vessel
4	1228	322	6626	S2a	II	Pithos	PT5		
5	821	333	7227	S2a	II	Pithos	PT8		White slip (ext.)
6	897	340	7529	S2a	II	Cooking Pot	CP2		White slip (ext.)
7	358	301	6097	S2a	II	Cooking Pot	CP3		White slip (ext.), ashy on outside of vessel
8	676	322	6758	S2a	II	Cooking Pot	CP?		White slip (int./ext.)
9	901	340	7529	S2a	II		Qurayyah		Black horizontal bands, white slip (ext.)
10	301	301	5935	S2a	II		Qurayyah		Painted design, slip and burnish
11	803	331	7228	S2a	II		Qurayyah?		Black painted design
12	802	331	7228	S2a	II		Qurayyah		Black painted design
13	220	263	5873	S1	I	Bowl	BL13	A2	White slip (ext.) Burnish (int.)
14	740	312	6973	S1	I	Bowl	BL13	A2	White slip (int./ext.) Burnish (int.)
15	227	263	5873	S1	I	Bowl	BL13b	A1	White slip (int./ext.)
16	214	294	5806	S1	I	Bowl	BL16b	A9	
17	34	263	5076	S1	I	Bowl	BL22		White slip (int./ext.); fine horizontal grooves below rim and above carination
18	100	274	5429	S1	I	Bowl	BL23	A2	
19	101	274	5429	S1	I	Bowl	BL25b	A10	White slip (int./ext.) with stepped grooves
20	196	263	5809	S1	I	Bowl	BL36		White slip (int./ext.)
21	37	268	5435	S1	I	Bowl	BL		White slip (int.)
22	878	317	6863	S1	I	Bowl	BL13		
23	879	275	5989	S1	I	Bowl	BL3b		Black horizontal bands, white slip (int./ext.)
24	21	262	5074	S1	I	Krater	KR1		

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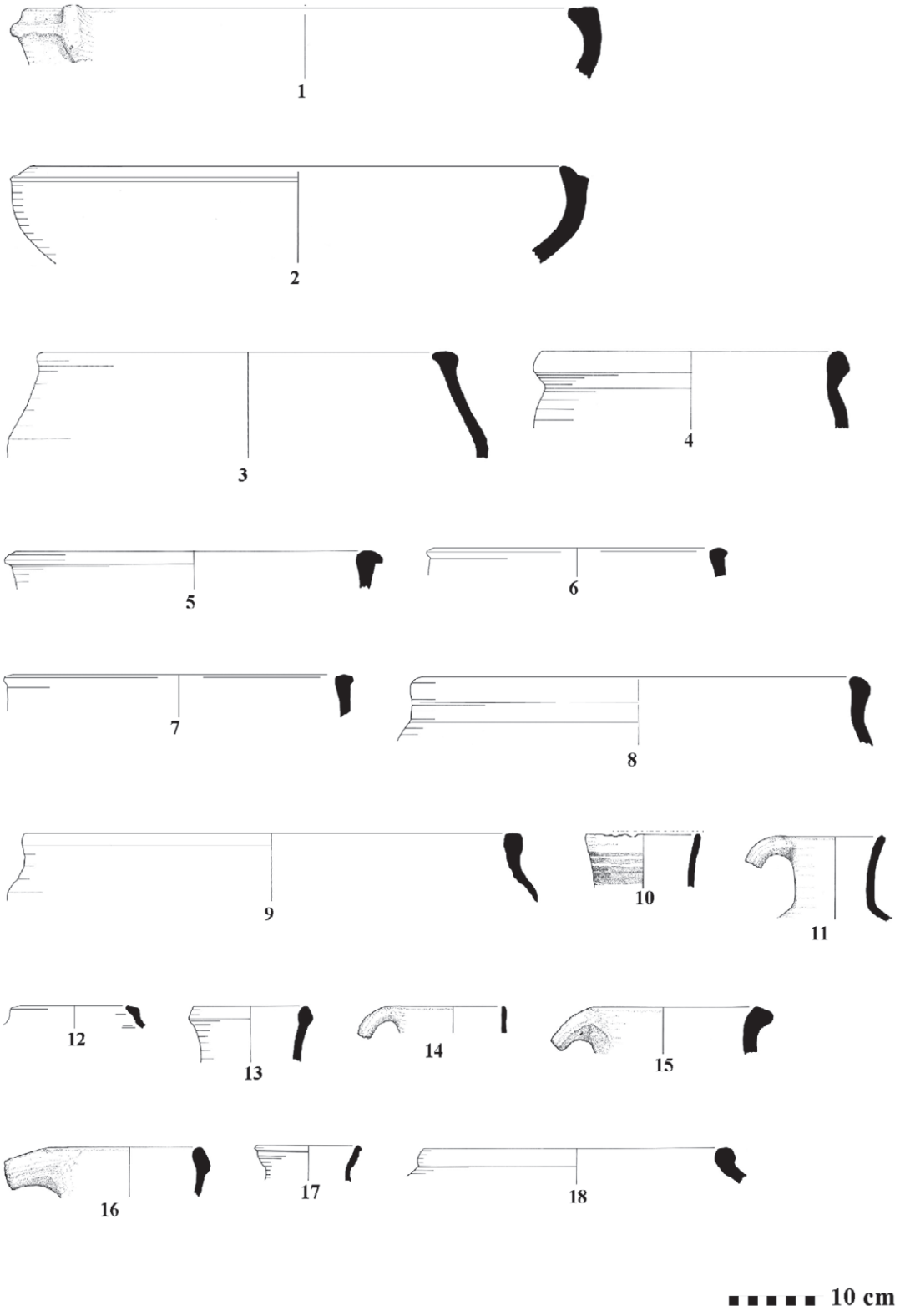

Figure 4.23 KEN Area S: Integrated Phase I.

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Table 4.23 KEN Area S: Integrated Phase I (Fig 4.23).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	190	263	5809	S1	I	Krater	KR10		
2	208	263	5809	S1	I	Krater	KR10		
3	746	312	6973	S1	I	Krater	KR11	A1	White slip (int./ext.)
4	52	263	5267	S1	I	Krater	KR3		White slip (ext.)
5	226	263	5873	S1	I	Krater	KR8		
6	73	263	5436	S1	I	Krater	KR8		
7	224	263	5873	S1	I	Krater	KR8		
8	123	268	5596	S1	I	Krater	KR9		White slip
9	742	312	6973	S1	I	Krater	KR9		White slip (int./ext.)
10	69	275	5280	S1	I	Jug	JG15c		Black painted design on rim, white slip
11	569	312	6541	S1	I	Jug	JG15		
12	200	263	5809	S1	I	Cooking pot	CP20	A7	
13	74	263	5436	S1	I	Jug	JG4		Top of rim is eroded
14	191	263	5809	S1	I	Jug	JG8		White slip (int./ext.)
15	85	268	5137	S1	I	Jug	JG9		White slip
16	186	263	5873	S1	I	Jug	JG9		
17	217	263	5873	S1	I				White slip (ext.)
18	234	263	5873	S1	I	Jar	JR1		White slip (ext.)

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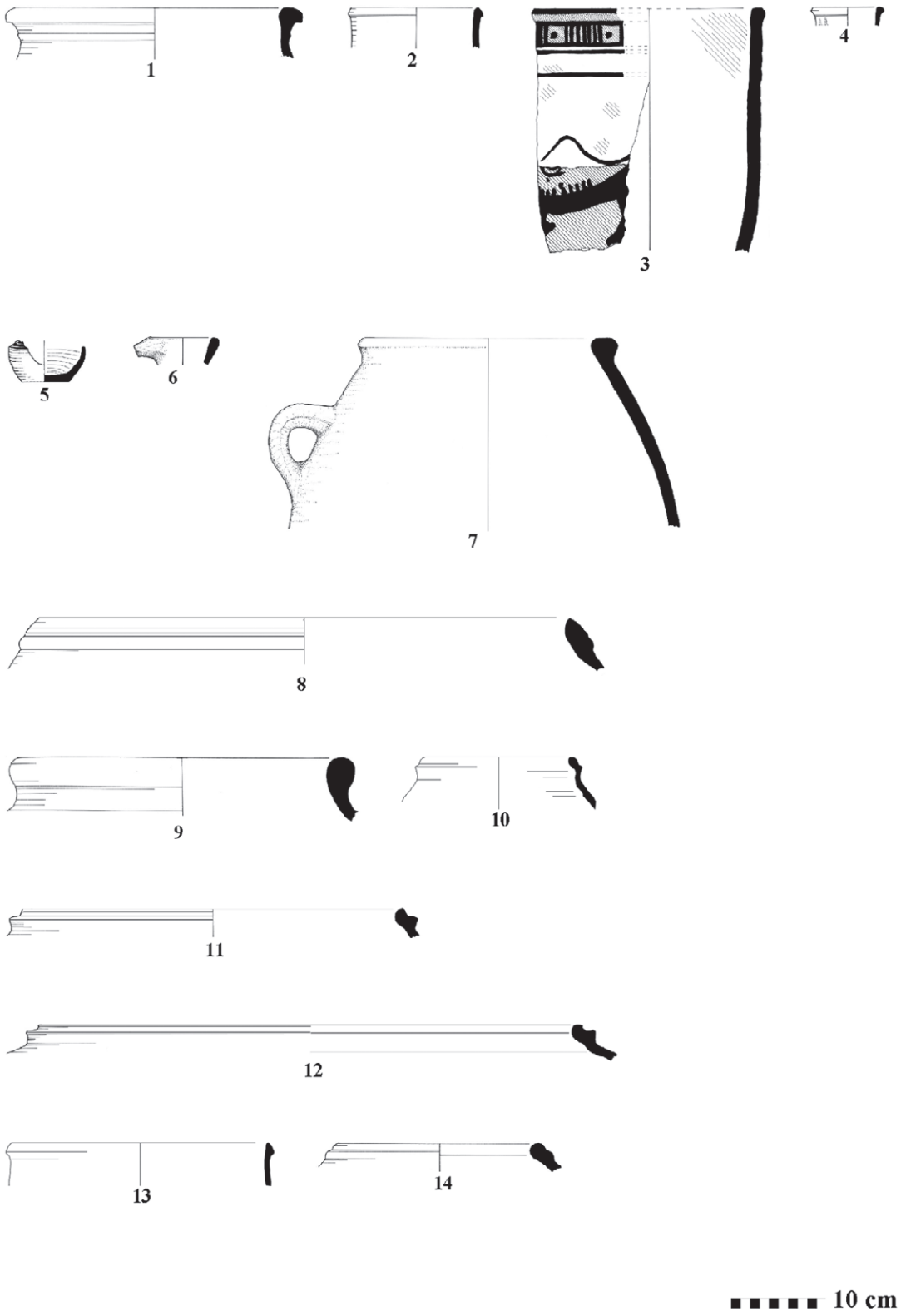

Figure 4.24 KEN Area S: Integrated Phase I.

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Table 4.24 KEN Area S: Integrated Phase I (Fig 4.24).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	51	271	5502	S1	I	Jar	JR20		Black horizontal bands
2	202	263	5809	S1	I	Jar	JR41		White slip (int./ext.)
3	608	317	6863	S1	I		Qurayyah?		Black painted design on red slip
4	81	266	5253	S1	I	Juglet	JT1		Gray painted (ext.)
5	571	264	5615	S1	I	Juglet	JT22	I4	Black horizontal bands, burnish exterior Cypro-Phoenician
6	58	266	5189	S1	I	Juglet	JT3		White slip
7	789	317	5756	S1	I	Pithos	PT10		
8	198	263	5809	S1	I	Pithos	PT19		
9	137	270	5597	S1	I	Pithos	PT5		White slip
10	49	268	5501	S1	I	Cooking pot	CP?		White slip (int./ext.)
11	70	275	5280	S1	I	Cooking pot	CP1	A6b	
12	197	263	5809	S1	I	Cooking pot	CP1	A6	
13	514	317	6468	S1	I	Cooking pot	CP10		
14	232	263	5873	S1	I	Cooking pot	CP3	A6	

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Figure 4.25 KEN Area S: Integrated Phase I.

Table 4.25 KEN Area S: Integrated Phase I (Fig 4.25).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	39	268	5191	S1	I	Cooking pot	CP		White slip (ext.)
2	280	263	5873	S1	I		FL2	I1	Pink, black horizontal bands, red slip burnish (ext.)

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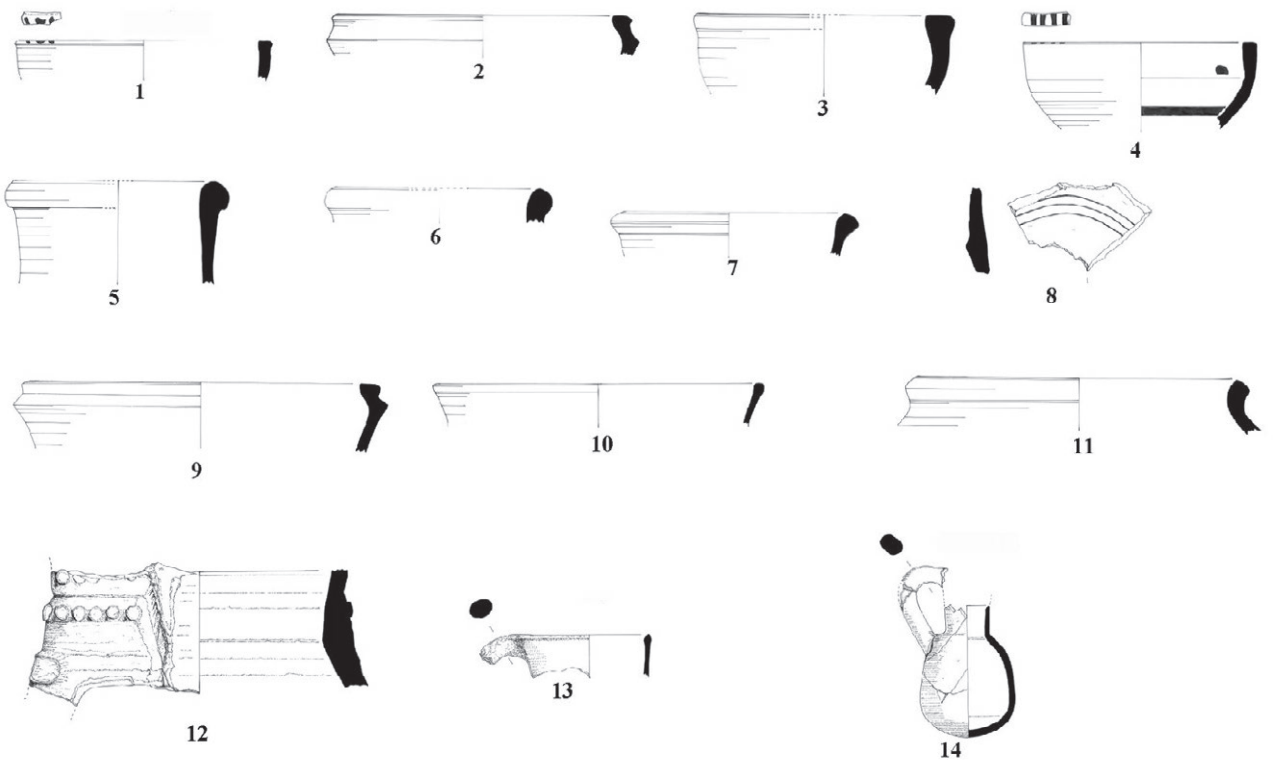

Figure 4.26 KEN Area F: Integrated Phases IV, III–IV, III, I.

Table 4.26 KEN Area F: Integrated Phases IV, III-IV, II, I (Fig 4.26).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	104	888	1370	F2b	IV	Bowl	BL3		Painted design and white slip
2	154	900	1376	F2b	IV	Bowl	BL3		White slip
3	216	900	1461	F2b	IV	Bowl	BL3		White slip
4	218	900	1429	F2b	IV	Bowl	BL3		Painted design and white slip
5	241	900	1503	F2b	IV	Jar	JR		White slip
6	103	888	1370	F2b	IV	Pithos	PT		White slip
7	231	888	1413	F2b	IV	Bowl	BL		White slip
8	240	900	1503	F2b	IV	Bowl	BL		Painted design
9	227	905	1431	F2	III-IV	Bowl	BL13	A2	White slip
10	234	905	1431	F2	III-IV	Krater	KR		
11	197	902	1388	F2	III-IV	Pithos	PT		White slip
12	28	861	1183	F2a	III		FV	A1	Fenestrated vessel with attached button decoration
13	20	803	1020	F1a	I	Jug	JG		
14	279	819	1189	F1a	I	Juglet	JT		Possible dipper juglet, but rim is broken

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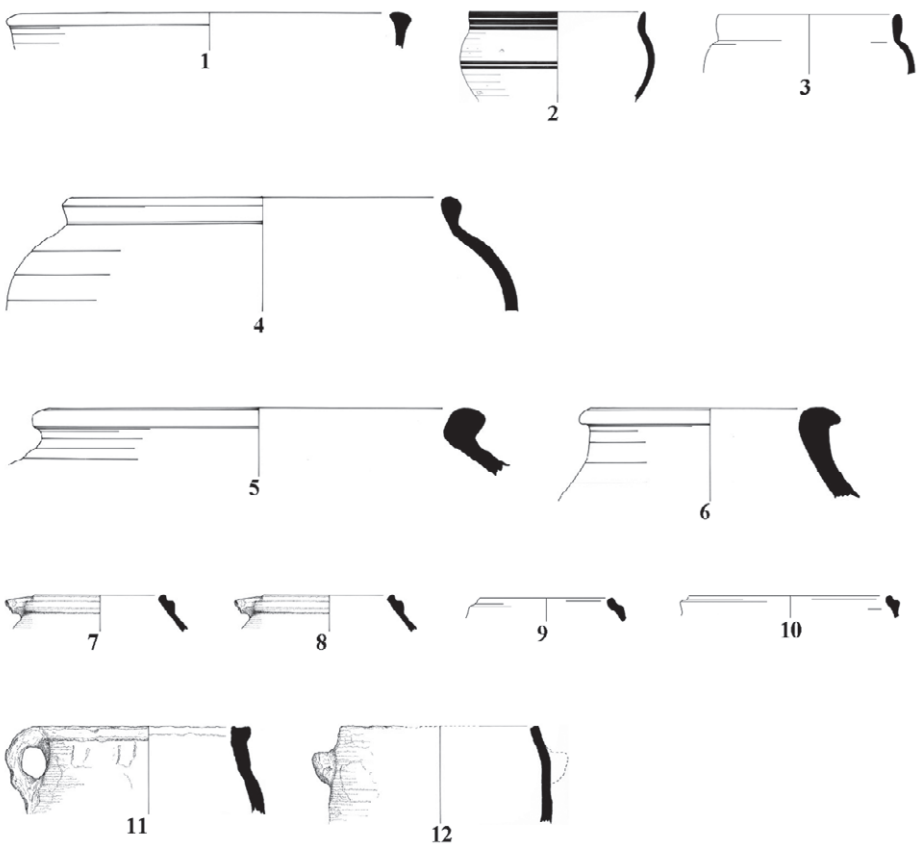

Figure 4.27 RHI04 Sounding A.

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Table 4.27 RHI04 Sounding A (Fig. 4.27).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	282	518	139			Bowl	BL3b3	A3	White slip (int./ext.)
2	122	510	100			Bowl	BL32	A1	Painted black horizontal lines on neck
3	268	515	123			Bowl	BL32		Painted black horizontal lines on neck
4	242	519	146			Krater	KR3B	A2	
5	236	510	111			Pithos	PT2	A2	
6	254	515	122			Pithos	PT3		
7	121	518	139			Cooking pot	CP15	A6	
8	121	518	139			Cooking pot	CP15	A6	
9	295	525	158			Cooking pot	CP16		
10	296	525	158			Cooking pot	CP18		
11	123	500	1				HMJR		
12	100	506	72				HMJR		

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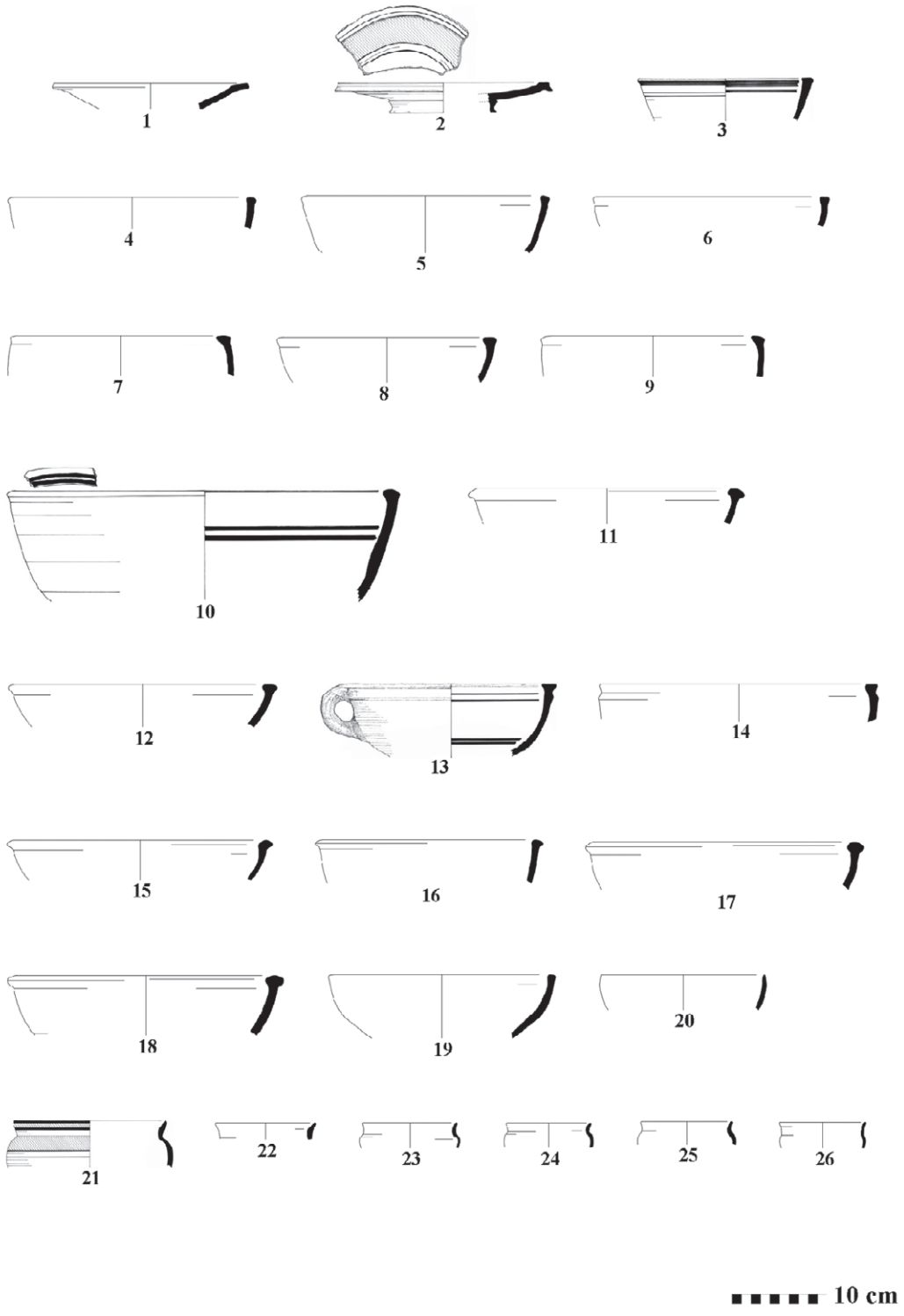

Figure 4.28 RHI04 Sounding B.

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Table 4.28 RHI04 Sounding B (Fig. 4.28).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	104	531	211			Bowl	BL1c		
2	120	536	263			Bowl	BL2		Painted red and black horizontal bands
3	125	533	206			Bowl	BL3A3		Red and black horizontal bands
4	1016	534	222			Bowl	BL3a5		
5	874	535	261			Bowl	BL3a5		
6	588	532	199			Bowl	BL3a5		Black painted horizontal lines
7	408	530	187			Bowl	BL3b3		
8	358	531	211			Bowl	BL3b2		
9	504	531	197			Bowl	BL3b3		
10	562	534	222			Bowl	BL3c1	B1	Painted black horizontal bands
11	596	532	199			Bowl	BL3c1		
12	711	533	209			Bowl	BL3c1		
13	118	531	211			Bowl	BL3d	B1	Painted black horizontal bands
14	632	533	206			Bowl	BL4		
15	932	537	268			Bowl	BL4b		
16	1019	534	222			Bowl	BL4c		
17	1020	534	222			Bowl	BL5		
18	935	537	268			Bowl	BL5		
19	153	533	209			Bowl	BL8		
20	459	530	210			Bowl	BL16c		
21	101	533	206			Bowl	BL20		Red and black painted design, red slip and burnish
22	458	530	210			Bowl	BL20	B4	
23	137	531	197			Bowl	BL20	B5	
24	181	531	197			Bowl	BL20	B4	
25	477	531	197			Bowl	BL20		
26	478	531	197			Bowl	BL20		

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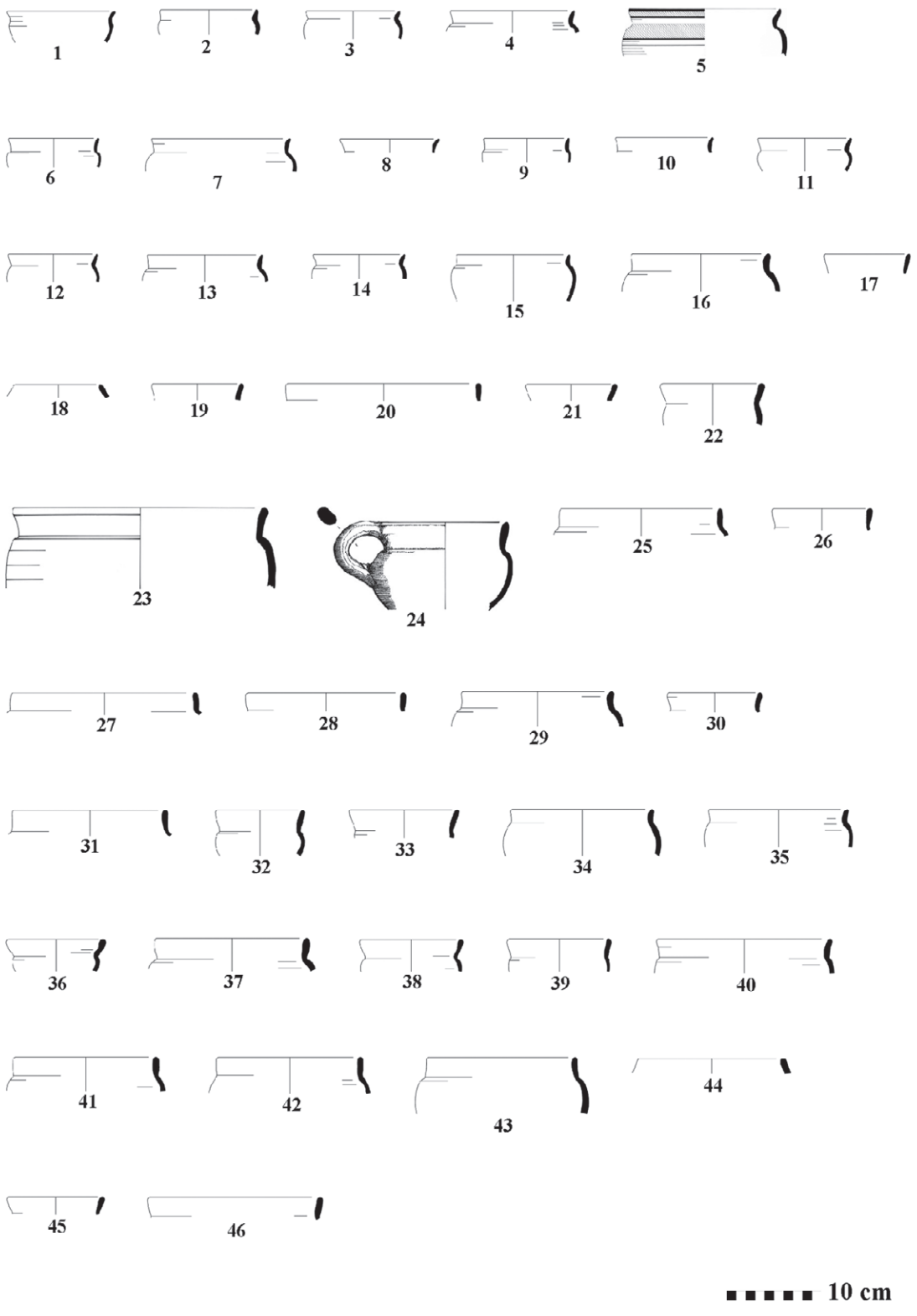

Figure 4.29 RHI04 Sounding B.

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Table 4.29 RHI04 Sounding B (Fig. 4.29).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	479	531	197			Bowl	BL20		
2	481	531	197			Bowl	BL20		
3	170	532	268			Bowl	BL20		
4	587	532	199			Bowl	BL20	B4	
5	101	533	206			Bowl	BL20		Red and black painted design, red slip and burnish
6	149	533	206			Bowl	BL20	B5	
7	184	533	206			Bowl	BL20		
8	637	533	206			Bowl	BL20	B5	
9	705	533	209			Bowl	BL20		
10	729	533	209			Bowl	BL20		
11	127	534	222			Bowl	BL20		
12	1105	534	222			Bowl	BL20	B4	
13	1107	534	222			Bowl	BL20		
14	160	536	263			Bowl	BL20	B4	
15	961	537	268			Bowl	BL20		
16	476	531	197			Bowl	BL21a3		
17	1112	534	222			Bowl	BL21a3		
18	869	535	261			Bowl	BL21a3	B4	
19	763	536	263			Bowl	BL21a3	B4	
20	767	536	263			Bowl	BL21a3	B4	
21	926	537	268			Bowl	BL21a3		
22	1063	538	277			Bowl	BL21a3	B1	
23	429	530	187			Bowl	BL21b		
24	766	536	263			Bowl	BL21b		
25	398	531	211			Bowl	BL21b		
26	480	531	197			Bowl	BL21b		
27	482	531	197			Bowl	BL21b	B4	
28	590	532	199			Bowl	BL21b		
29	618	532	217			Bowl	BL21b		
30	707	533	209			Bowl	BL21b		
31	156	534	222			Bowl	BL21b		
32	803	534	222			Bowl	BL21b		
33	1081	534	222			Bowl	BL21b	B4	
34	1090	534	222			Bowl	BL21b	B4	
35	1092	534	222			Bowl	BL21b	B4	
36	1100	534	222			Bowl	BL21b		
37	1101	534	222			Bowl	BL21b	B4	
38	1102	534	222			Bowl	BL21b		
39	1103	534	222			Bowl	BL21b	B4	
40	1106	534	222			Bowl	BL21b		
41	1108	534	222			Bowl	BL21b	B4	
42	867	535	261			Bowl	BL21b		
43	871	535	261			Bowl	BL21b	B4	
44	956	537	268			Bowl	BL21b		
45	963	537	268			Bowl	BL21b		
46	964	537	268			Bowl	BL21b		

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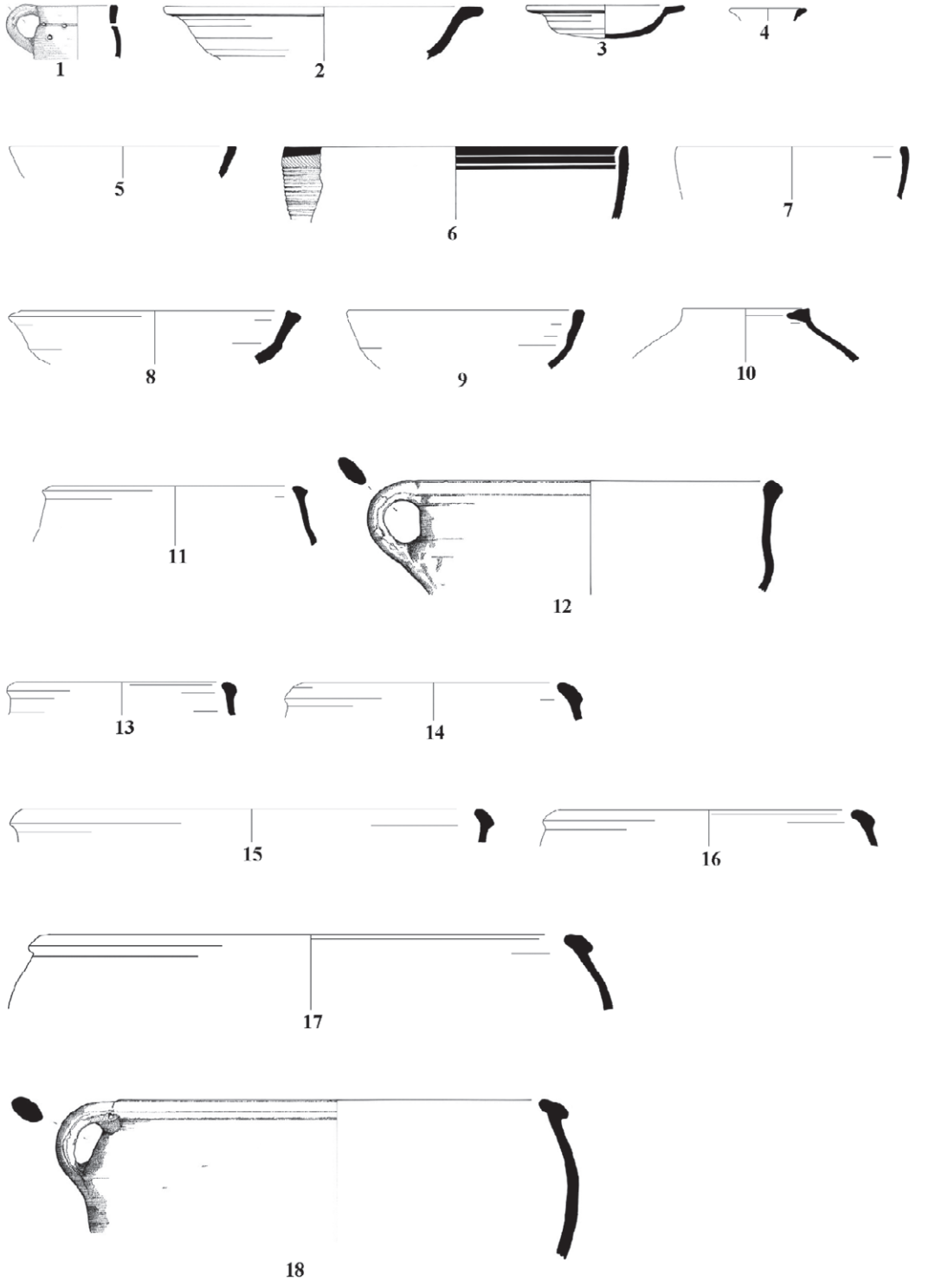

Figure 4.30 RHI04 Sounding B.

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Table 4.30 RHI04 Sounding B (Fig. 4.30).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	102	531	189			Bowl	BL21f		Perforated holes throughout body
2	584	532	199			Bowl	BL30a3	B1	
3	1087	534	222			Bowl	BL30b	B1	
4	330	531	189			Bowl	BL40		
5	891	535	261			Bowl	BL42		
6	1017	534	222			Bowl	BL43		Black painted design
7	712	533	209			Bowl	BL43		
8	813	534	222			Bowl	BL44		
9	770	536	263			Bowl	BL45		
10	690	533	209			Krater	KR1b	B1	
11	439	530	187			Krater	KR4		
12	583	532	199			Krater	KR4b		
13	495	531	197			Krater	KR14		
14	1086	534	222			Krater	KR15		
15	581	532	199			Krater	KR15d		
16	855	539	279			Krater	KR15d		
17	692	533	209			Krater	KR15e		
18	833	534	222			Krater	KR17	B1	

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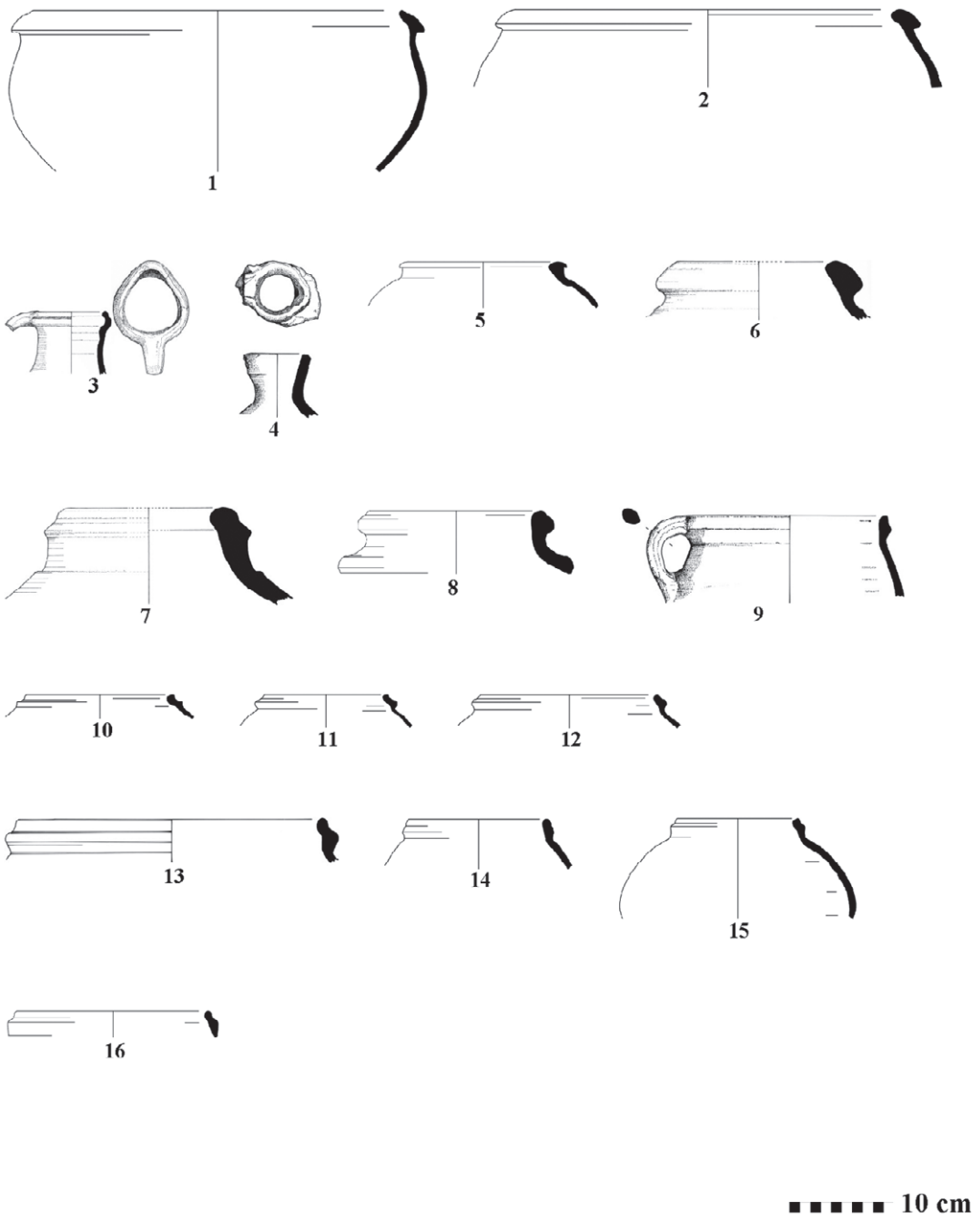

Figure 4.31 RHI04 Sounding B.

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Table 4.31 RHI04 Sounding B (Fig. 4.31).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	119	531	211			Krater	KR17		
2	962	537	268			Krater	KR17		
3	124	534	222			Jug	JG27		
4	1122	534	222			Juglet	JT13		
5	465	530	210			Pithos	PT3	B1	
6	147	534	222			Pithos	PT15	B3	
7	183	531	211			Pithos	PT18	B3	
8	604	532	217			Pithos	PT18	B2	
9	793	534	222			Cooking pot	CP25		
10	400	530	187			Cooking pot	CP30	B6	
11	484	531	197			Cooking pot	CP31		
12	565	533	209			Cooking pot	CP33	B6	
13	788	536	263			Cooking pot	CP33		
14	677	533	209			Cooking pot	CP34		
15	769	536	263			Cooking pot	CP		
16	1052	538	277			Cooking pot	CP		

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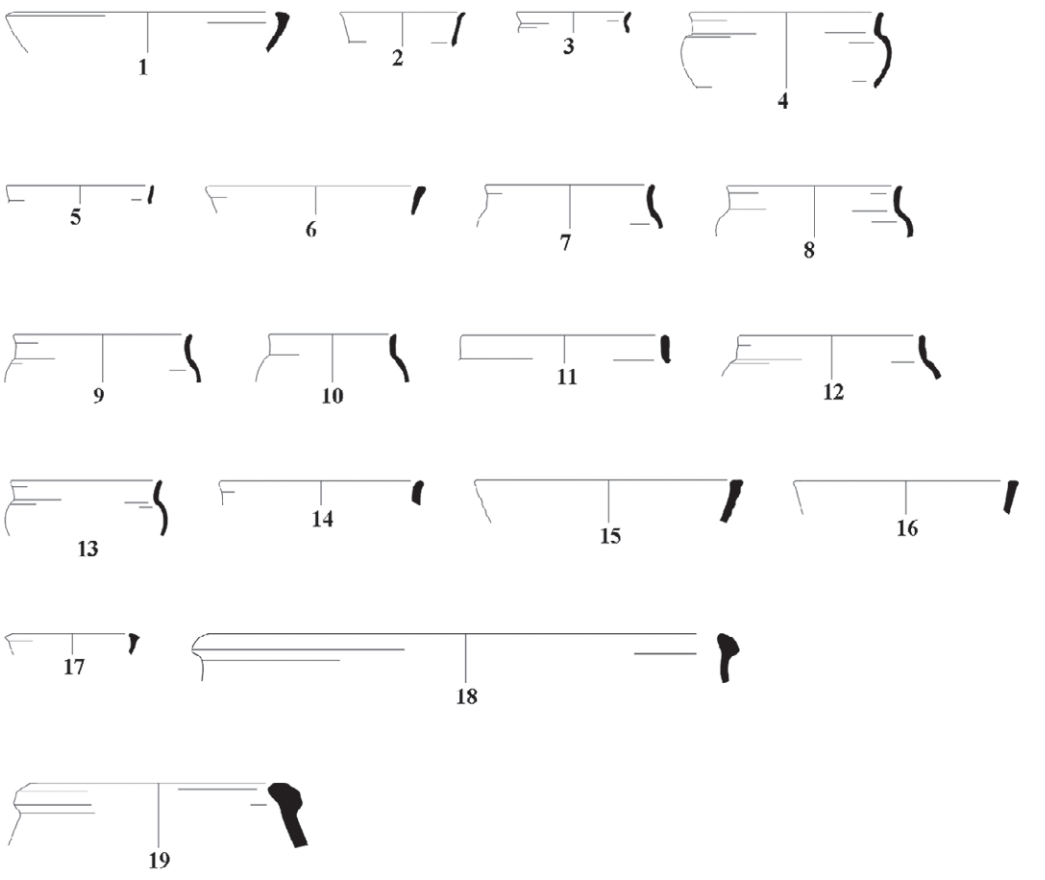

Figure 4.32 KAM-A.

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Table 4.32 KAM-A (Fig. 4.32).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	190	3013	10114			Bowl	BL3b1		Red horizontal bands
2	168	3013	10131			Bowl	BL12c	B1	Red, black, and white horizontal bands, red burnish
3	202	3006	10015			Bowl	BL20		
4	126	3026	10129			Bowl	BL20b		Black horizontal bands, pale purple slip
5	100	3028	10131			Bowl	BL20		Red and black horizontal bands
6	259	3016	10057			Bowl	BL21a3		
7	328	3026	10149			Bowl	BL21a3		
8	346	3026	10149			Bowl	BL21a3		Black horizontal bands
9	349	3026	10149			Bowl	BL21a3		Black and white horizontal bands
10	112	3027	10130			Bowl	BL21a3	B1	Black horizontal bands, red burnish
11	58	3032	10189			Bowl	BL21a3		White slip
12	209	3007	10072			Bowl	BL21b		Red horizontal bands
13	104	3032	10174			Bowl	BL21b	B1	Red slip and burnish
14	63	3032	10189			Bowl	BL21d		Black horizontal bands, red slip and burnish
15	319	3036	10241			Bowl	BL41	B1	Black horizontal bands, red slip, grooved
16	154	3013	10056			Bowl	BL56b		Red and black horizontal bands
17	223	3026	10112			Bowl	BL56	B1	
18	347	3026	10149			Krater	KR17	B1	White slip
19	327	3026	10149			Pithos	PT18b	B1b	

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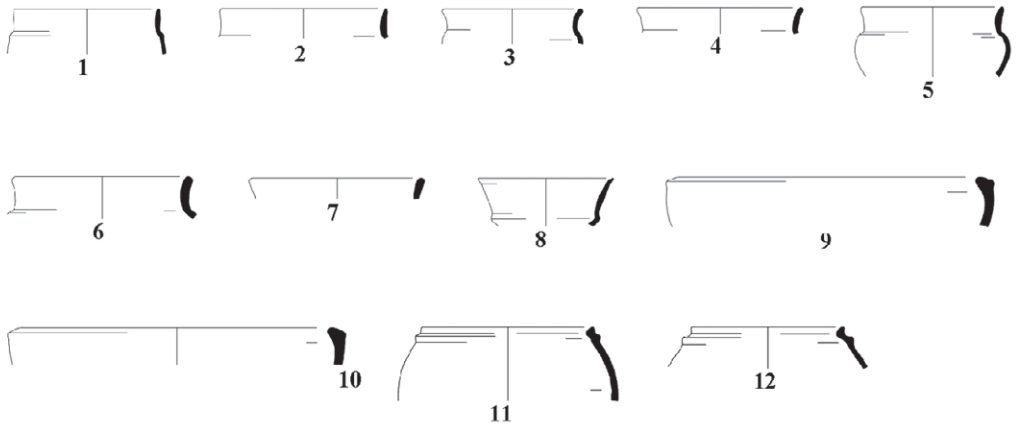

Figure 4.33 KAM-B.

Table 4.33 KAM-B (Fig. 4.33).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	430	3041	10313			Bowl	BL20b	B5	Black horizontal bands
2	117	3030	10179			Bowl	BL21a3		Black horizontal bands
3	47	3037	10263			Bowl	BL21a3		Black and red horizontal bands
4	48	3037	10263			Bowl	BL21a3		Black horizontal bands, cream slip
5	265	3022	10108			Bowl	BL21b	B1	
6	121	3030	10179			Bowl	BL21d		Black horizontal bands
7	17	3035	10219			Bowl	BL21f		Red slip and burnish
8	38	3038	10280			Bowl	BL22d	B1	Black horizontal bands, red slip and burnish
9	16	3035	10219			Bowl	BL51		White slip
10	35	3035	10200			Bowl	BL51		White
11	284	3021	10095			Cooking pot	CP35		
12	21	3035	10219			Cooking pot	CP37		

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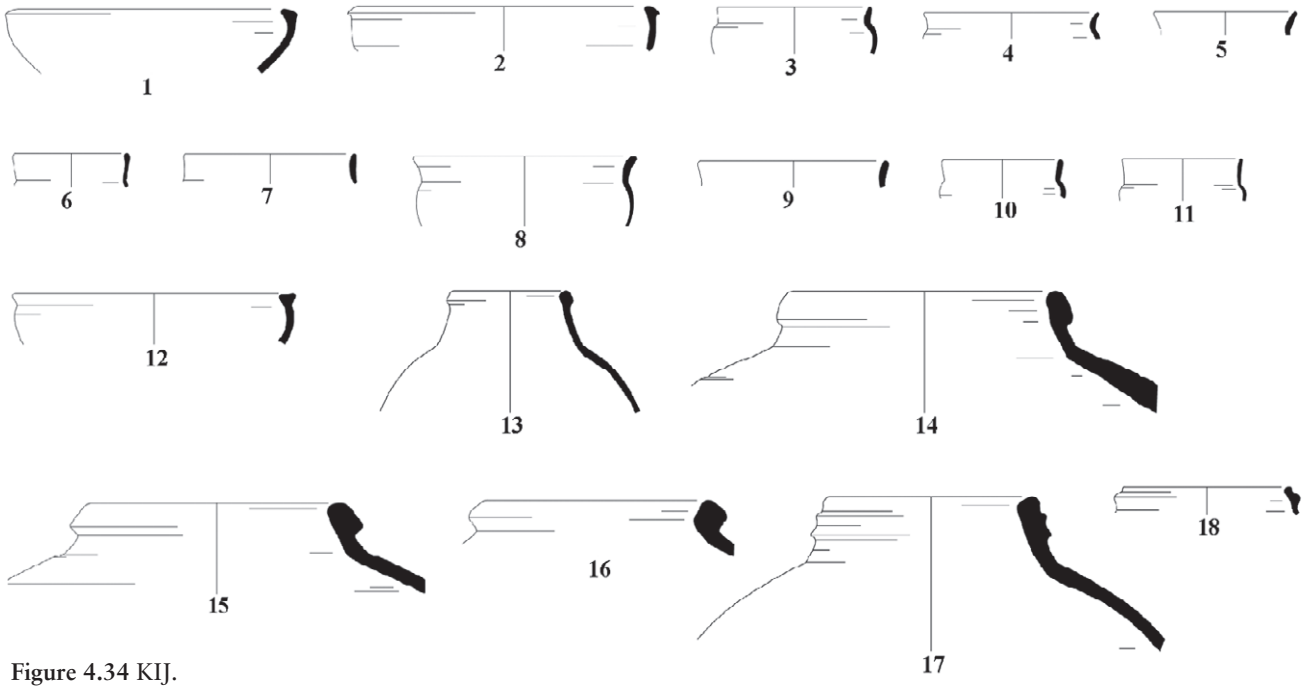

Figure 4.34 KIJ.

Table 4.34 KIJ (Fig. 4.34).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	423	4006	11089			Bowl	BL3b1		
2	468	4000	11004			Bowl	BL3B3		
3	368	4010	11074			Bowl	BL20		
4	1274	4011	11072			Bowl	BL20		Black horizontal bands
5	443	4002	11018			Bowl	BL21a3		
6	382	4009	11051			Bowl	BL21a3		
7	366	4010	11074			Bowl	BL21a3	B1	Red and black horizontal bands
8	359	4011	11104			Bowl	BL21a3	B1	
9	402	4012	11101			Bowl	BL21a3		
10	417	4006	11073			Bowl	BL21b		
11	463	4000	11001			Bowl	BL21b	B5	Black horizontal band just below rim (int./ext.)
12	355	4010	11088			Bowl	BL52b		
13	427	4006	11073			Jug	JG3d2		White slip
14	425	4006	11073			Pithos	PT15	B1b	
15	383	4009	11051			Pithos	PT15		
16	386	4009	11051			Pithos	PT18	B1b	
17	426	4006	11089			Pithos	PT20	B1b	
18	400	4012	11101			Cooking pot	CP36	B6	

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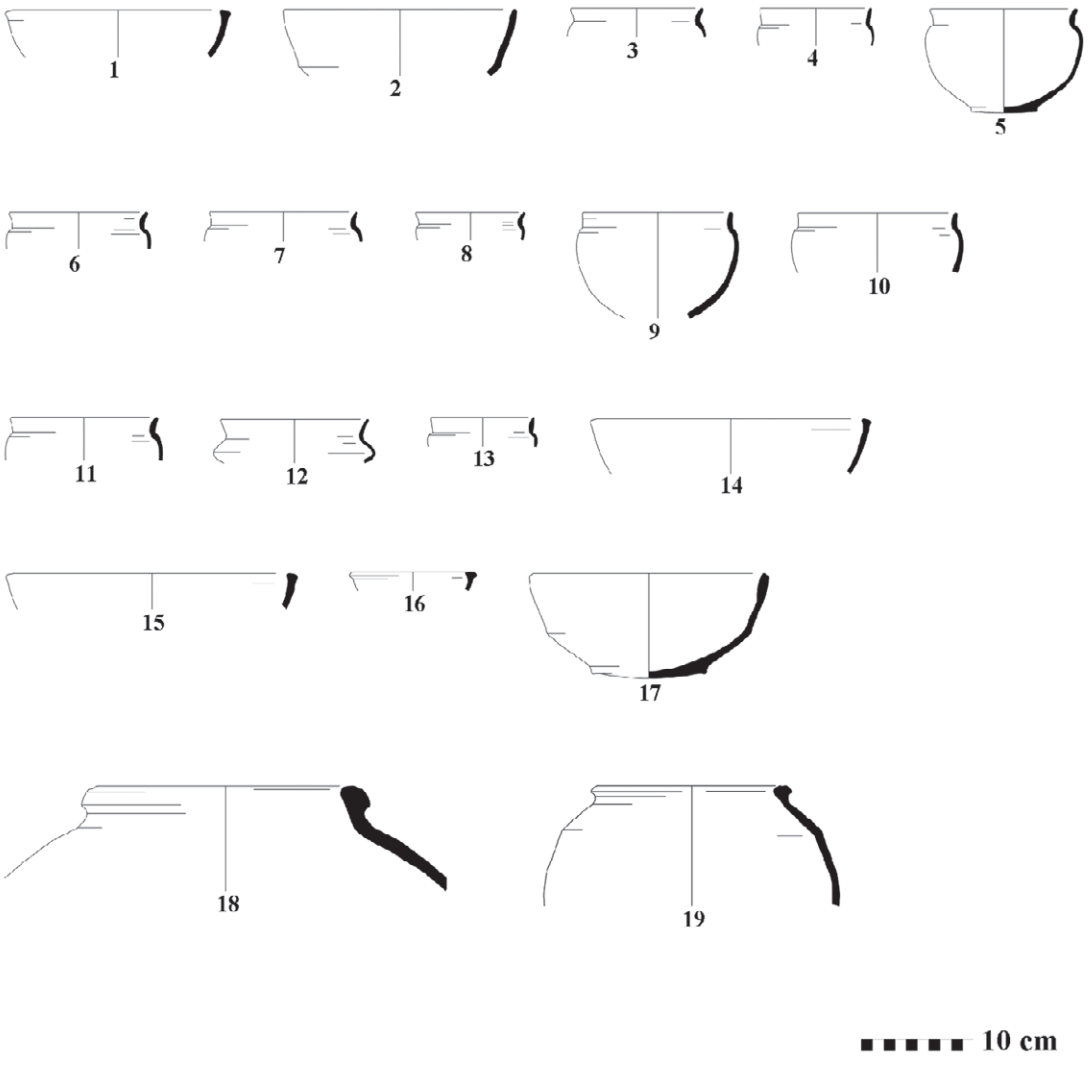

Figure 4.35 KIS.

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Table 4.35 KIS (Fig. 4.35).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	1130	5017	12114			Bowl	BL3a1		Red and black horizontal bands
2	1201	5013	12096			Bowl	BL10		
3	1162	5000	12001			Bowl	BL20		Black horizontal bands
4	1197	5010	12041			Bowl	BL20		Black horizontal bands
5	1268	5011	12056			Bowl	BL20		Dark red horizontal bands
6	1173	5012	12095			Bowl	BL20	B5	Black red horizontal bands
7	1174	5012	12095			Bowl	BL20	B5	Black horizontal bands
8	1113	5013	12038			Bowl	BL20		Black horizontal bands
9	1202	5013	12096			Bowl	BL20		Black and white horizontal bands
10	1184	5014	12110			Bowl	BL20		Black and white horizontal bands
11	1120	5017	12130			Bowl	BL20		Black horizontal bands, ring burnish
12	1128	5017	12114			Bowl	BL20g		Black horizontal bands
13	1136	5017	12114			Bowl	BL20	B5	Black horizontal bands
14	1138	5013	12096			Bowl	BL56		Black horizontal bands
15	1172	5016	12112			Bowl	BL56b		
16	1123	5017	12130			Bowl	BL56	B1	Black and white horizontal bands
17	1106	5017	12130			Bowl	BL		
18	1152	5014	12097			Pithos	PT18	B1b	
19	1098	5017	12126			Cooking pot	CP47		

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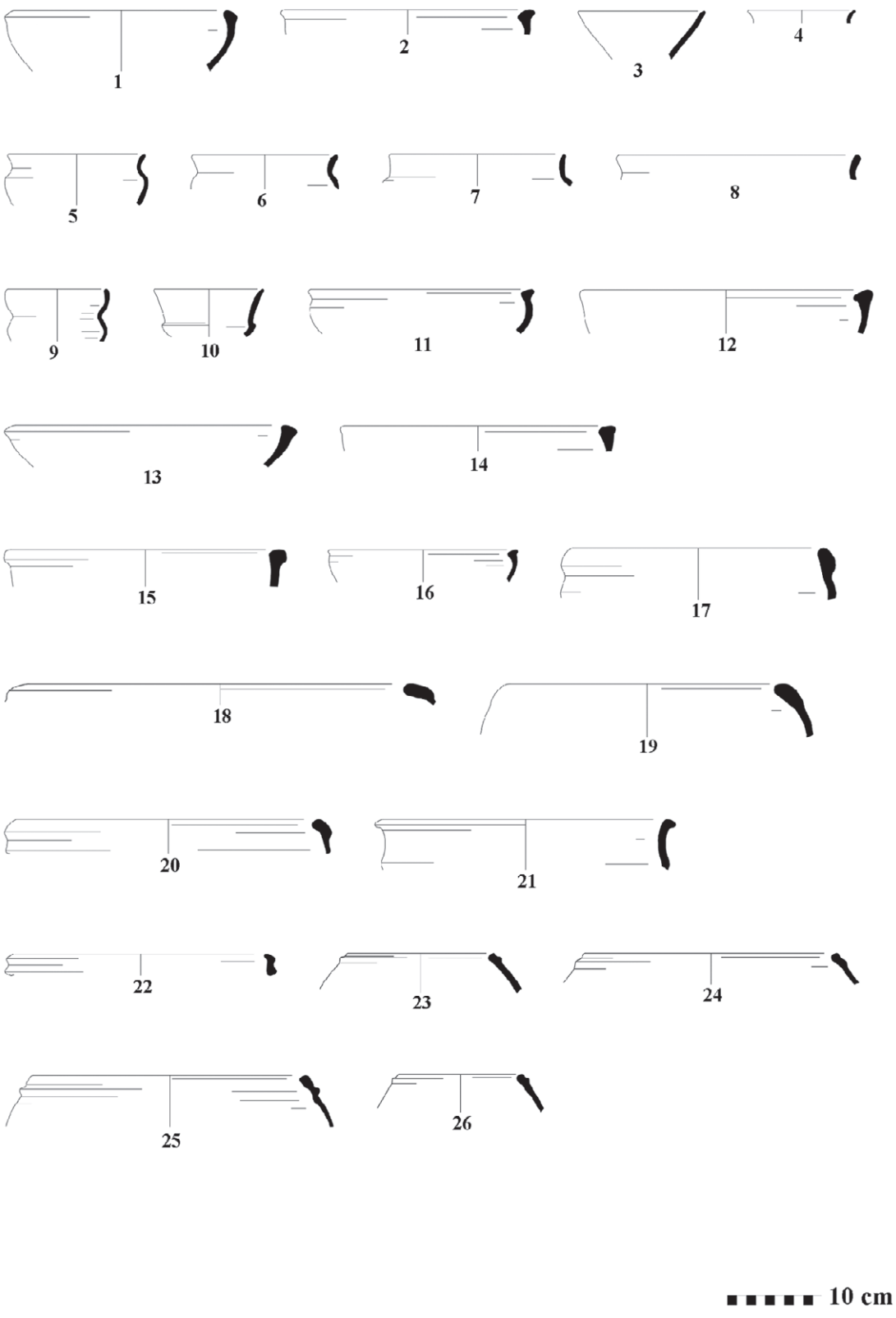

Figure 4.36 TW-J.

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Table 4.36 TW-J (Fig. 4.36).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	1368	6013	13128			Bowl	BL3b1		Red horizontal bands, ring burnish
2	577	6013	13081			Bowl	BL4		Brown horizontal bands
3	954	6008	13035			Bowl	BL12c	B5	Black and red horizontal bands
4	1311	6013	13103			Bowl	BL20		
5	1005	6022	13143			Bowl	BL20c	B5	Black and white horizontal bands
6	770	6013	13103			Bowl	BL21a3	B1	Black horizontal bands
7	1310	6013	13103			Bowl	BL21b		Black horizontal bands
8	620	6017	13086			Bowl	BL21d		
9	1063	6020	13132			Bowl	BL21e	B1	
10	748	6017	13129			Bowl	BL22d	B1	Black red ring burnish
11	761	6013	13103			Bowl	BL52		
12	1347	6013	13128			Bowl	BL53b		Black and white horizontal bands
13	1353	6013	13128			Bowl	BL53		Black and white horizontal bands
14	993	6022	13143			Bowl	BL53		Black and white horizontal bands
15	926	6008	13035			Bowl	BL54		Black and white horizontal bands
16	551	6013	13081			Bowl	BL57		
17	952	6008	13035			Krater	KR15		
18	994	6022	13143			Krater	KR15		White slip (ext.)
19	757	6013	13103			Krater	KR15b		
20	756	6013	13103			Krater	KR15d		
21	958	6026	13136			Krater	KR19		
22	520	6013	13081			Cooking pot	CP17		
23	616	6017	13086			Cooking pot	CP35		
24	998	6022	13143			Cooking pot	CP37		
25	1337	6013	13128			Cooking pot	CP38		
26	753	6013	13103			Cooking pot	CP40		

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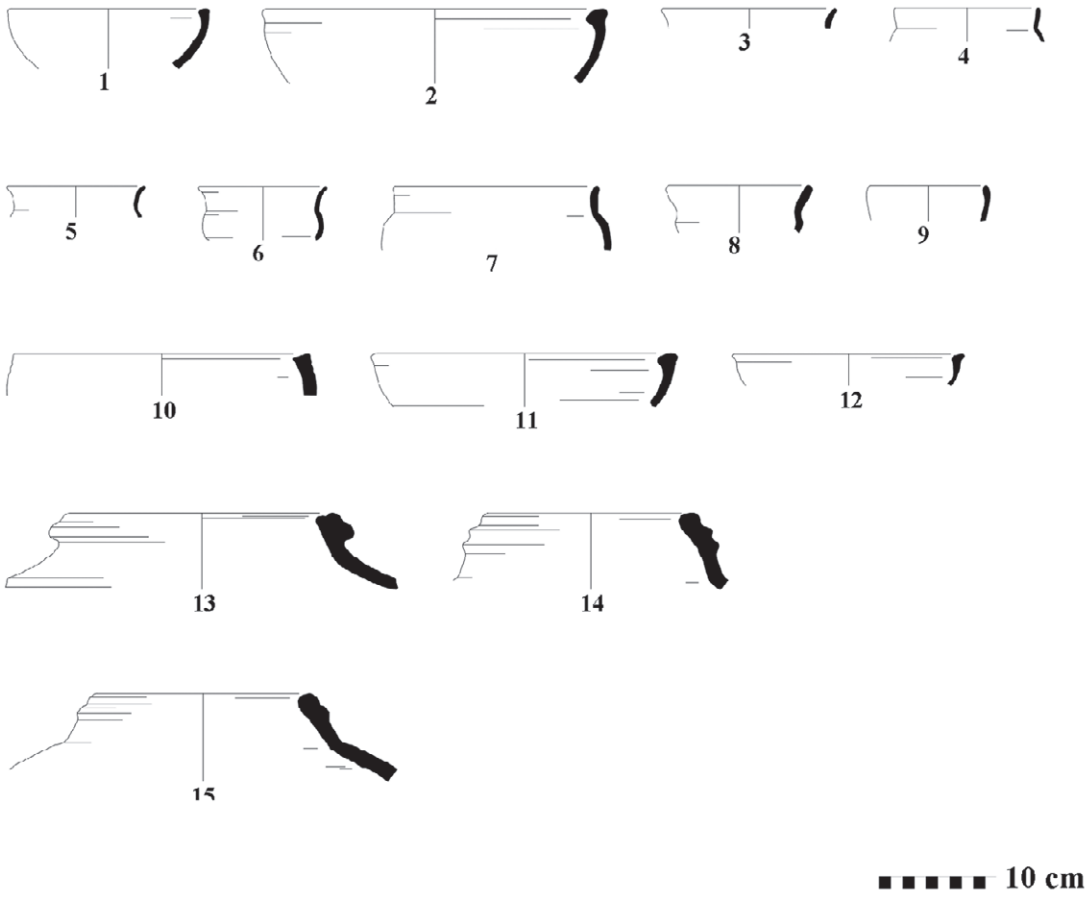

Figure 4.37 TW-K.

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Table 4.37 TW-K (Fig. 4.37).

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	1021	6025	13161			Bowl	BL3a1		Black and white horizontal bands
2	974	6028	13210			Bowl	BL3c1		Black and white horizontal bands
3	484	6010	13063			Bowl	BL20		Red horiztonal bands
4	659	6012	13063			Bowl	BL20	B5	Black horizontal bands, creme slip
5	715	6016	13080			Bowl	BL20		
6	886	6027	13211			Bowl	BL20b		Black and red horizontal bands
7	895	6027	13211			Bowl	BL21b		
8	702	6015	13105			Bowl	BL21d		
9	690	6018	13147			Bowl	BL21e		
10	658	6012	13063			Bowl	BL41	B1	Three grooves
11	983	6028	13210			Bowl	BL53b		Black and white horizontal bands
12	1037	6025	13161			Bowl	BL57	B1	Black horizontal bands, red burnish
13	1027	6025	13161			Pithos	PT18	B1b	
14	906	6027	13193			Pithos	PT19b	B1	
15	898	6027	13211			Pithos	PT20		

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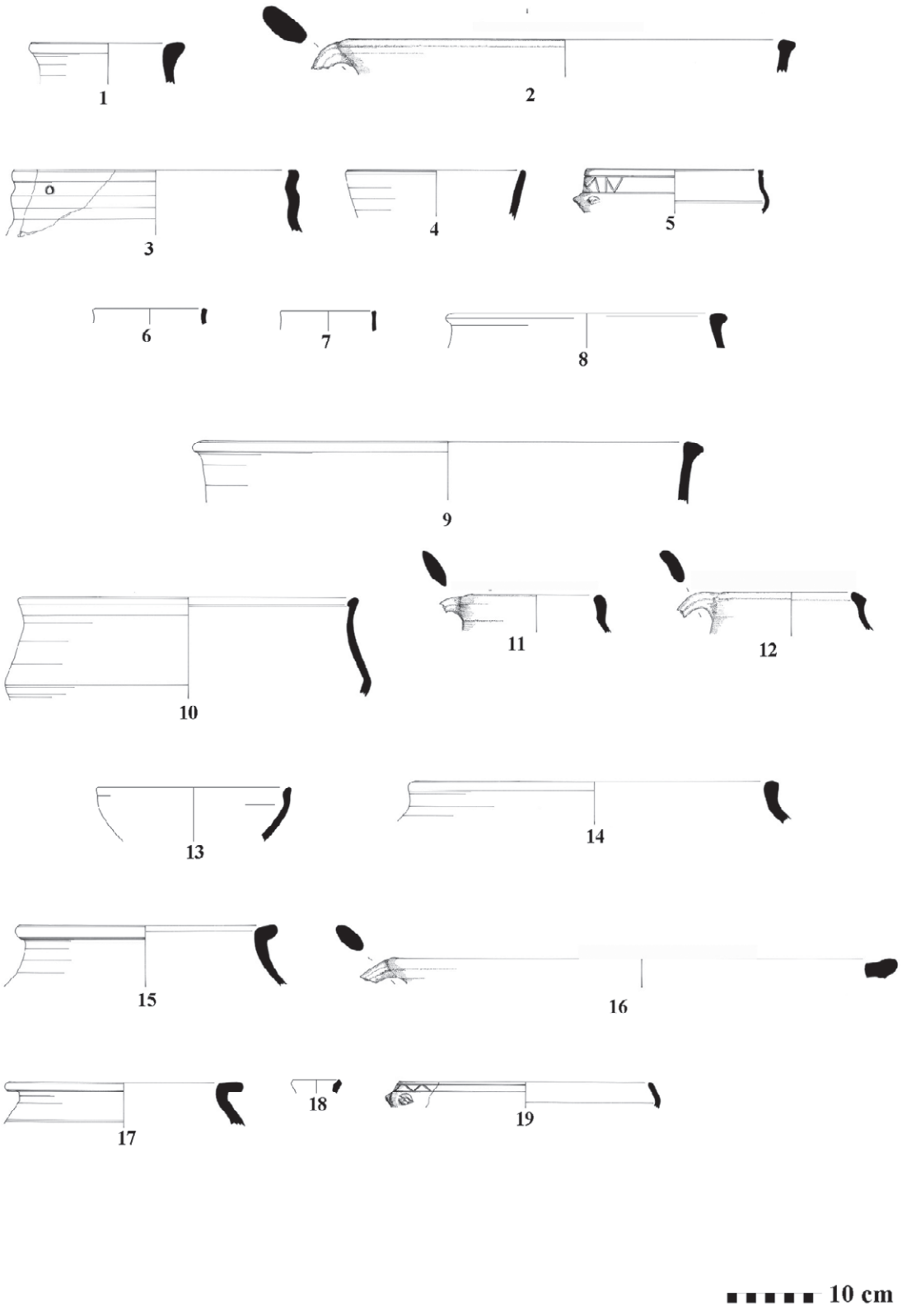

Figure 4.38 KEN Area KAJ06: Integrated Phases V–VI, VI, IV–V, III, I.

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Table 4.38 KEN Area KAJ06: Integrated Phases V-VI, VI, IV-V, III, I.

#	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description
1	962	119	3213	A4-5	V-VI	Jar	JR		
2	928	121	3231	A5	VI	Krater	KR27		
3	1424	122	3246	A5	VI	Jar	JR		Perforated hole in sherd
4	938	105	3196	A3	IV-V	Bowl	BL16	I1	Red slip and horizontal burnish (int./ext.)
5	394	106	3105	A3	IV-V	Bowl	BL18	A4	Cream slip (ext.), applied knob decoration; high concentration of calcite
6	956	106	3188	A3	IV-V	Bowl	BL18	A4	Decorated unique design inscribed along neck
7	1431	105	3203	A3	IV-V	Bowl	BL18		Inscribed decoration
8	906	105	3041	A3	IV-V	Krater	KR8		White slip (ext.)
9	978	118	3205	A3	IV-V	Krater	KR26		
10	937	105	3196	A3	IV-V	Krater	KR27		
11	947	105	3196	A3	IV-V	Jug	JG26		
12	974	118	3205	A3	IV-V	Cooking pot	CP20		
13	971	118	3205	A3	IV-V				
14	929	105	3196	A3	IV-V	Jar	JR		
15	975	118	3205	A3	IV-V	Jar	JR		
16	908	107	3072	A2	III	Jar	JR6	A5	
17	903	107	3014	A2	III	Jar	JR		
18	490	101	3001	A1a	I	Jug	JG14		
19	1451	0	3212			Bowl	BL18	A4	Inscribed decoration and applied knob handles

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Area	IP	Count	% (n=216)
A	I	22	10.2%
	II	47	21.8%
	II-III	0	0.0%
	III-IV	2	0.9%
	IV	5	2.3%
	V	0	0.0%
Total		**76**	**35.2%**
M	II	4	1.9%
	III	1	0.5%
	II-III	5	2.3%
	IV-V	2	0.9%
	VI	0	0.0%
	VII	0	0.0%
Total		**12**	**5.6%**
R	III	5	2.3%
	IV	23	10.6%
	V	6	2.8%
Total		**34**	**15.7%**
S	I	18	8.3%
	II	24	11.1%
	III	10	4.6%
	V	0	0.0%
	VI	0	0.0%
Total		**52**	**24.1%**
T	I	0	0.0%
	III	31	14.4%
	IV	2	0.9%
	V	1	0.5%
Total		**34**	**15.7%**
F	I	1	0.5%
	III	2	0.9%
	III-IV	1	0.5%
	IV	4	1.9%
Total		8	3.7%
Grand Total		**216**	**100.0%**

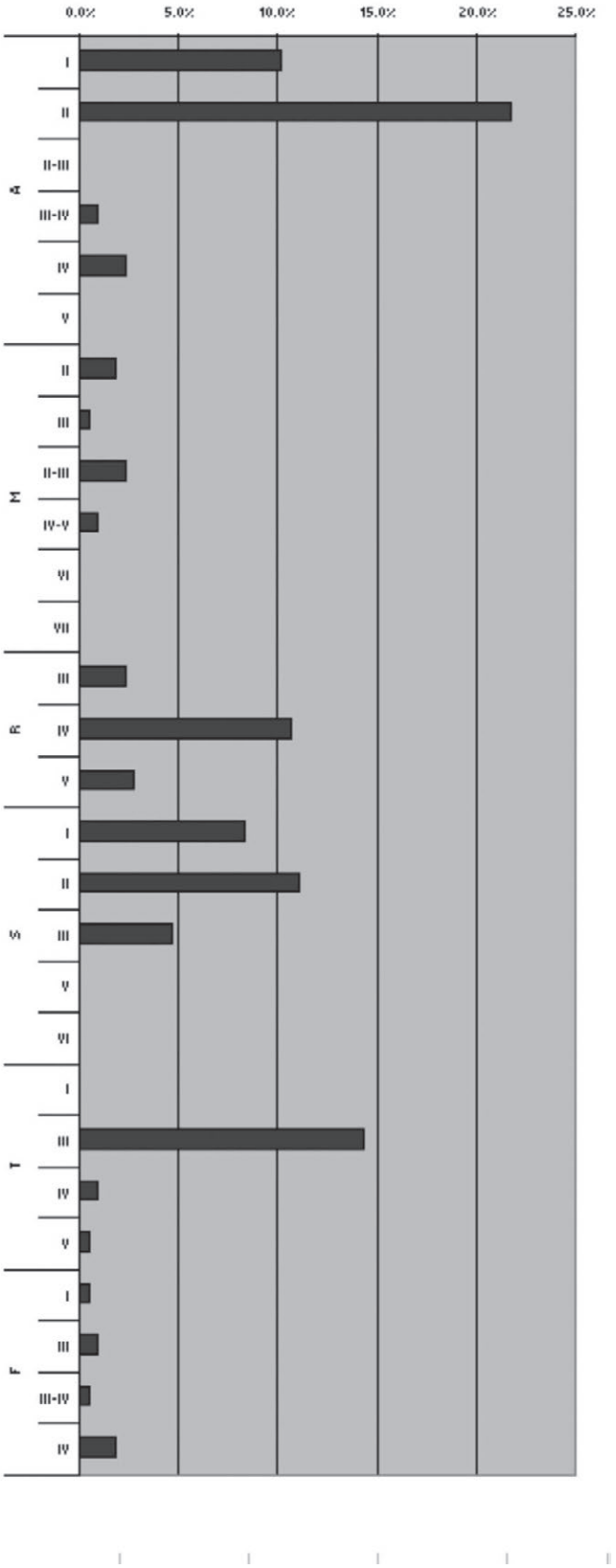

Figure 4.39 KEN painted pottery by stratum.

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Table 4.39 Distribution of vessel families by site.

Site	Bowl (BL)		Jug (JG)		Juglet (JT)		Krater (KR)		Jar (JR)		Pithos (PT)		Cooking Pot (CP)		Lamp (LP)		Import		Total
KEN	778	36.9%	345	16.4%	50	2.4%	229	10.9%	519	24.6%	108	5.1%	52	2.5%	16	0.8%	9	0.4%	2,106
KEN 2009	163	39.5%	53	12.8%	20	4.8%	28	6.8%	59	14.3%	29	7.0%	19	4.6%	8	1.9%	6	1.5%	413
KAJ06	19	18.6%	21	20.6%	3	2.9%	23	22.5%	32	31.4%	0	0.0%	4	3.9%	0	0.0%		0.0%	102
RHI04 Sounding A	35	36.5%	6	6.3%	0	0.0%	2	2.1%	45	46.9%	2	2.1%	5	5.2%	0	0.0%	1	1.0%	96
RHI04 Sounding B	369	49.5%	99	13.3%	9	1.2%	70	9.4%	42	5.6%	21	2.8%	133	17.9%	2	0.3%		0.0%	745
KAM	177	50.9%	26	7.5%	0	0.0%	21	6.0%	10	2.9%	20	5.7%	91	26.1%	3	0.9%		0.0%	348
KIJ	62	50.0%	11	8.9%	1	0.8%	6	4.8%	10	8.1%	9	7.3%	23	18.5%	2	1.6%		0.0%	124
KIS	65	57.0%	10	8.8%	2	1.8%	1	0.9%	4	3.5%	10	8.8%	19	16.7%	2	2.6%		0.0%	114
TW	320	45.1%	79	11.1	10	1.4%	66	9.3%	57	8.0%	68	9.6%	98	13.8%	11	1.6%		0.0%	709
Total	1,988		650		95		446		778		267		444		45		16		4,757

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General Quantitative Analysis

Figure 4.39 and the tables in Figures 4.39 to 4.44 summarize the distribution of the identified vessel types across the excavated sites in this study. These represent the minimum number of individual (MNI) vessels found in the assemblage based on the analysis of the diagnostic pottery sherds from each site. A total of 4,757 diagnostic sherds were used for the quantitative analyses presented below (see table in Figure 4.39 for the distribution from each site). In this study, we use the MNI as an important index for measuring the percentage of ceramic types through time. Similar approaches are more common in late prehistoric ceramic studies (cf. Commenge et al. 2006; Levy and Menachem 1987). The importance of MNI studies is due to the scarcity of complete vessels with which to establish a typology.

For the study presented here, a simple quantitative approach is taken to facilitate an understanding of the structure of ceramic assemblages from these Iron Age sites and for intrasite comparison in the northern Edom study area that transects both the lowland and highland regions. These basic data can serve as a starting point for more sophisticated statistical analyses when future researchers analyze their assemblages as systematically as the studies presented here (cf. Lee and Wong 2001; Shennan 1997; Thomas 1986). Several immediate observations can be made when comparing the percentage of vessel families found at each site (see table in Figure 4.39). With the exception of KAJ and RHI Sounding A, the predominant vessel family found at all these sites included bowls. The MNI for RHI Sounding A includes handmade wares, which were more abundant than the wheel-made pottery; therefore, the higher quantity of jars is skewed toward the predominance of handmade jars found at the site. The function of this distribution at RHI is unclear.

The distribution of vessel families is markedly different when comparing the Late Iron Age II sites found in the highlands of Edom to KEN and the lowland soundings. For example, among RHI Sounding B and the four L2HE sites, a very similar distribution of vessel families occurs. Bowls at these sites are the predominant form and represent around 50 percent of the assemblage. The second, most common vessel family is cooking pots, which represent approximately twice the amount of the other vessel families among L2HE sites KAM, KIJ, and KIS (16–26 percent of the assemblage). The Tawilan site has a more even distribution with jugs, jars, kraters, and pithoi each representing around 10 percent of the assemblage. In contrast, at the Early Iron Age II sites, a different distribution of vessel families occurs. First, at all these sites, cooking pots represent a small percentage of the assemblage. Small jars represent either a larger percentage (RHI04, KAJ06) than bowls or, as seen in KEN, they are the second most common family (ca. 24.6 percent).

These marked differences in assemblages may be due to a number of factors. For example, KEN and KAJ are primarily industrial sites, and thus cooking pots would not be expected to be abundant in rooms linked to metallurgical production. However, the functional differences between these Early IA II sites and the later phase sites do not fully explain these data. The high proportion of bowls and kraters traditionally associated with domestic activities, along with many other domestic material artifacts (grinding slabs, mortars, tabuns, etc.), may suggest that domestic activities were conducted in the same rooms as industrial activity. Even though these sites were industrial, the laborers still had to eat. The low percentage of ridged-rim cooking pots at the Early IA II sites may be understood by Meshel's (2002:291) observation that handmade jars found in the Negev were commonly associated with cooking. All of the earlier sites in our study (KEN, KAJ, RHI Sounding A) had a large amount of these handmade jars, containing a similar fabric to the cooking pot A6 ware found among the ridged-rim cooking pots during the Late Iron II (see Chapter 5, this volume). These handmade jars may have been used as the primary domestic cooking vessel instead of the ridged-rim cooking pots that dominate later periods. This observation can be extended to RHI Sounding A, which is located very close to summit of the site where Glueck (1934) identified an IA watchtower, and we found evidence of a small domestic habitation area that primarily used handmade wares for domestic activities, with only a few cooking pots found (n = 5; 5 percent of the assemblage).

Handmade Ware

The presence of abundant handmade vessels in the Early Iron Age II assemblages at Khirbat en-Nahas, Rujm Hamra Ifdan (Sounding A), and Khirbat al-Jariya is important from a temporal and cultural perspective compared to the later sites in this study. The handmade ware found at KEN, KAJ, and RHI Sounding A are not the same as those found on the plateau. Specifically, they contain large granule-size inclusions or basalt, shales,

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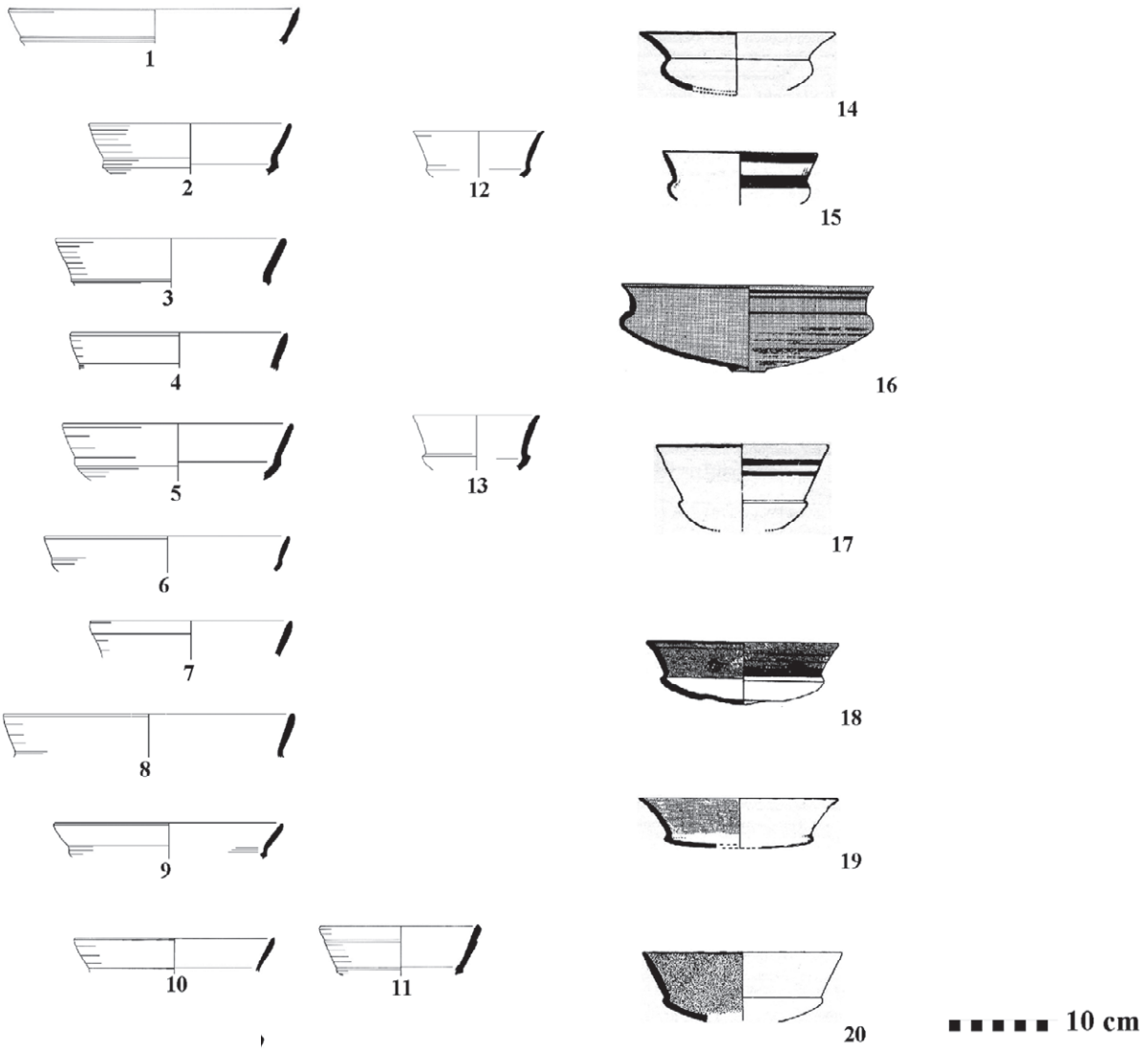

Figure 4.40 Comparison of BL22 from KEN, L2HE sites, and Busayra.

Table 4.40 Comparison of handmade to wheel-made pottery at sites.

Site	HM		WM		Total
KEN	415	14.6%	2,426	85.4%	2,841
KEN09	164	28.4%	413	71.6%	577
KAJ06	15	2.8%	102	87.2%	117
RHI04-A	61	58.7%	43	41.3%	104
RHI04-B	0	0.0%	848	100.0%	848
KAM	6	1.7%	349	98.3%	355
KIJ	5	3.7%	130	96.3%	135
KIS	0	0.0%	118	100.0%	118
TW	30	3.9%	747	96.1%	777
Total	696		5,176		5,872

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and slag. The appearance of slag as an inclusion in many of the vessels may be one of the best indicators of the intense metallurgical production that occurred during the Early Iron Age II around the vicinity of KEN. In contrast, the handmade wares found on the plateau[11] had large quartz inclusions and many cavities from organic material. A study of the ceramic petrography from KEN is presented in Chapter 3 (this volume).

For the lowland and highland sites discussed in this study, the handmade vessels were differentiated into two primary categories of bowls and hole-mouth jars. Many of these vessels had knob and ledge handles attached. Several examples had white slip and/or grooving. The morphological difference between these handmade wares found at the sites is a study for future research. For examples of handmade bowls (HMBL) found on the plateau sites, see *Tawilan* (6.36:1–9), *Tell el-Kheleifeh* (pl. 14–15), and *Ghrareh* (pls. 24:1–15; 28:7–10); for handmade jars (HMJ), see *Tawilan* (6:36:10–11) and the Arabah Valley lowlands at *Tell el-Kheleifeh* (pl. 12:1) and Barqa el-Hatiye (Fritz 1994:Abb. 13:1–9). For published parallels in the Negev desert, see Meshel (2002), Cohen and Cohen-Amin (2004), and the detailed typology by Cohen et al. (2007) at Kadesh Barnea (discussed above). A number of the morphological distinctions made in that study apply here as well. A sample of the handmade wares from Khirbat en-Nahas were previously published (Smith and Levy 2008), and some additional examples are illustrated here (Figures HMBL: 4.8:18; 4.11:12; 4.19:4; HMJR: 4.1:15; 4.9:9–10; 4.16:1–3, 9, 12; 4.27:11–12).

The quantitative analysis of the handmade and wheel-made vessels reveals another significant distinction between the early industrial and domestic sites and the later period sites (see table in Figure 4.40). At KEN and KAJ, the handmade wares represent a significant percentage of the entire ceramic assemblage (14.6 percent and 12.8 percent, respectively). At RHI Sounding A, the handmade wares are predominant, representing around 58.7 percent of the entire ceramic assemblage. The later period site handmade wares represent a small percentage of the assemblage (KAM: 1.7 percent; KIJ: 3.7 percent; TW: 3.9 percent) or lacked any handmade wares. The most striking difference is seen between RHI Sounding A and Sounding B. It is clear that at this site, there was a significant change in the use of handmade wares over time. Sounding A (1000–800 BCE) and Sounding B (800–500 BCE) are completely separate occupations during different phases of the Iron Age. The distribution of handmade wares thus corroborates what is seen among the morphology, petrography, and radiometric dating for these two soundings. An examination of the quantitative data suggests that the use of handmade wares among inhabitants at KEN, KAJ, and RHI Sounding A was an Early Iron Age II phenomenon. During the later period sites, studied here, handmade wares became less commonly used.

A second important aspect of the handmade wares at KEN is their relation to so-called Negebite pottery. Petrographic and INAA studies on Negebite wares at other sites have emphasized local production of ceramics but also a significant portion originating from Transjordan Edom (Gunneweg et al. 1991; Haiman and Goren 1992; Rothenberg 1988; Slatkine 1974). On one hand, these data suggest that the handmade wares need to be distinguished between these two regions, if not by morphology then by fabric. It is more appropriate to use the term *handmade* vessels as opposed to *Negebite* pottery when referring to these vessels found at the lowland Transjordan Edom sites, since these vessels may have no direct relationship with sites in the Negev region but may be a local manifestation of the south Levantine desert zone. However, on the other hand, the presence of handmade wares from the east side of the Wadi Araba may suggest intense social interaction and exchange. The distribution of these handmade ceramics at many sites in the Negev and Transjordan should not be used as an indicator of a single regional group (i.e., Negabite) but rather a techno-practice of several groups perhaps related to semi-sedentary activities.

Imports

During the excavations of KEN, KAJ, and RHI Sounding A, imported pottery was found in the ceramic assemblages from these sites. As of yet, none of the L2HE sites or RHI Sounding B shows any evidence of imported pottery. All of these sites are rural villages in contrast to Bennett's (cf. Bienkowski 2002) excavations at Busayra, which has a range of imported ceramics and other objects. All the imports found at the lowland sites can be clearly dated to the Early Iron Age II.

The most predominant import found at KEN comes from the western Negev. One example was found in the small sounding at KAJ. The petrographic study revealed that these fine-ware bowls (BL3a [n = 1], BL15 [n = 1], BL16 [n = 2], BL24 [n = 4], BL25 [n = 1]; see Table 3.6

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in Chapter 3, this volume) were made of loess soil—common to the northern Negev but foreign to Edom (see Chapter 3, Table 3.6 this volume). All of these imports are red slipped, and most are burnished, as is commonly found at the Early Iron Age II sites in the western Negev (e.g., Tel Arad, Tel Beersheba, and Aroer; see Singer-Avitz 1999). BL3a are remarkably similar to the early irregularly hand-slipped bowls found in the Negev (Singer-Avitz 1999). The other examples have an even red slip and horizontal burnish. This is in contrast with KEN, where red slip burnish rarely occurs. The evidence of these imports at KEN suggests interaction with its western neighbors. In addition, fine-ware bowls were imported in small numbers.

Each season at KEN has yielded several examples of Cypro-Phoenician black-on-red juglets (JT22; compare Bikai 1987; Schreiber 2003). These are easily identifiable by their well-sorted clay, thin walls, and well-burnished red exterior with black decoration in the form of concentric circles (see Chapter 5, this volume, for a discussion of their petrography). Herzog and Singer-Avitz (2004:215–216) note the appearance of Cypriot imports in Judah during the Late Iron Age IIA. Although predominant in the northern sites of Israel, they are also found in the Shephelah at *Tell Beit Mirsim II* Stratum B (Albright 1932:Figure 51:9), *Lachish* Stratum IV (Figure 25.5:16), and the desert regions to the south—Kadesh Barnea Stratum 4b (pl. 11.11:11), Beersheba Strata VII–IV (*Beersheba II*: Figures 24:7; 30:8–9; Herzog and Singer-Avitz 2004:218), and other sites (see Schreiber 2003 for a recent discussion and parallels). Herzog and Singer-Avitz (2004) identify these Cypriot juglets as significant markers of the Late IA IIA, and their context at KEN with the wheel-made vessels supports this dating. This evidence supports the relative and absolute dating found at KEN, which dates it to the tenth to ninth centuries BCE.

During the 2002 excavations at KEN, a total of 32 Qurayyah painted ware sherds were found in both Areas A and S.[12] These painted wares are often referred to as *Midianite* pottery and related to perceived Iron Age Arabian mining communities (Rothenberg 1998; Rothenberg and Glass 1983). A more objective term for these unique ceramics is *Qurayyah*—named after the site in northern Arabia where petrographic and morphological studies place them (Parr 1982, 1992). In the following 2006 and 2009 excavations at KEN, Qurayyah ware sherds were found but in smaller quantities (Area A, $n = 1$; Area M, $n = 2$; Area R, $n = 3$; Area W, $n = 5$). A single example was also found at RHI Sounding A. The association of this pottery found at KEN with Qurayyah ware is corroborated by its petrographic signature (see Chapter 5, this volume), stylistically unique decoration, and morphology, which was compared in a previous publication (Smith and Levy 2008) to Qurayyah ware found at Timna (Rothenberg 1998). Combined with the recent petrographic analysis in Chapter 5 (this volume), these data suggest that the Qurayyah ware found at KEN is indeed an import from the vicinity of Qurayyah in northwest Arabia (De Maigret 1999).

Although mostly painted body sherds were found, a few semi-complete jar and bowl sherds were identified with known Qurayyah painted ware vessel types. Based on the analysis here, the Qurayyah ware from KEN can be divided into two main groups: fine ware with a cream slip and bichrome painted exterior surface that was burnished and a medium to fine ware that was much coarser, having only bichrome painting designs on the exterior.[13] Qurayyah ware core fabrics are unlike any other wheel-made vessels in the KEN assemblage as they have a pink to light red color matrix with red, brown, and black shale inclusions. When compared with similar vessels with bichrome paint and fabrics, these can be tentatively dated to the thirteenth to twelfth centuries BCE. However, the precise chronology of this ware and its variants is still not clearly defined, and Bawden (1983:40–49) has noted that tenth- to ninth-century BCE painted wares were found at Qurayyah.[14] Whether there are distinctive differences between these two periods is not known.

Qurayyah ware ceramics are found in largest quantities at the Qurayyah and Tayma sites in Saudi Arabia and from surface collection throughout the northwestern corner of the Arabian Peninsula or Hijaz region (Bawden 1983:38; Eichmann et al. 2006). Qurayyah ware has been found in Edom at Barqa el-Hatiye (Fritz 1994:Abb. 12:1–12), Ghrareh (Hart 1989b:pl. 25:4), Tell el-Kheleifeh (Bawden 1983:39), and Tawilan (Rothenberg and Glass 1983:84). In Israel, these sherds have been identified at Timna (Rothenberg 1988, 1998), Jedur (Ben-Arieh 1981), Tel Masos (Fritz and Kempinski 1983; Rothenberg and Glass 1983:81), Yotvata (Meshel 1990:20–23), Tel el-Far'ah S (Rothenberg and Glass 1983:82), Lachish (Rothenberg and Glass 1983:81), and *Kadesh Barnea* (pls. 11.6–11.7) in northern Sinai. As is the case for

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both KEN and Barqa el-Hatiya, handmade wares and Qurayyah ware are found together at other Early Iron II period Negev sites mentioned above (see Cohen et al. 2007; Meshel 1990; Rothenberg and Glass 1983).

The presence of Qurayyah ware at Tell el-Kheleifeh and Tawilan, both dated to the Late Iron II, has led to various interpretations. Rothenberg and Glass (1983:76), who found a parallel form at Timna in a stratified thirteenth- to twelfth-century BCE context associated with Egyptian New Kingdom cartouches, argue that these examples represent earlier occupations not reflected in the excavations. The Qurayyah ware from KEN is found in Early Iron II contexts (Levy et al. 2004; Levy et al. 2005). Unlike one stray sherd found at Tawilan and Tel al-Kheleifeh, the Qurayyah ware is found at multiple areas at KEN (Areas S, A, R, T, M, and W), many of which are from good contexts (e.g., on floors or production layers just above a floor). Similarly, at RHI Sounding A, which has been identified as a single-period short occupation at the site, a Midianite sherd was found associated with the handmade and wheel-made forms. Sounding A was radiocarbon dated to the tenth century BCE (Levy et al. 2008), further corroborating what is witnessed concerning the Qurayyah ware at KEN. This evidence suggests that the presence of Qurayyah ware in these later contexts does not include intrusions from other strata but rather indicates the later tenth-century BCE activities of these Qurayyah potters at Tayma or some nearby area in the Hijaz (cf. Eichmann et al. 2006). The dates from ELRAP and L2HE and stratified data necessitate a more extensive study of pottery that has come to be called "Qurayyah"[15] and the importance of relating it to future stratigraphic excavations at its origin in Qurayyah, Taymah, and the other identified sites in the Arabian Peninsula.

Quantitative and Qualitative Comparison of Decoration and Surface Treatment over Time

A study of Iron Age vessel surface treatment in Edom reveals a number of important aspects of the chronological differences between KEN and the later Iron Age II sites. Specifically, surface treatment at the early lowland sites (primarily KEN) varies from the later period sites at RHI Sounding B and the L2HE sites. For the study presented here, surface treatment has been grouped into four classes: painted, applied decoration, slip, and burnish (see table in Figure 4.41). Although burnish is often associated with a red slip, this distinction is not made in the table in Figure 4.41. Where multiple types of surface treatment occur on the same vessel, a count was tallied for each type, and thus the totals for each stratum are larger than the actual MNI.

Painting

Painting is relatively rare in the Early IA ceramic assemblages of Edom. At KEN, painting of local wheel-made pottery consists primarily of black painted strokes applied as bands along the rim, interior, and/or exterior. Black strokes on the rim either without bands or crossing bands are commonly seen. White slip was usually applied first; it is quite common to see bowls with the black concentric circles painted directly onto the unslipped vessel. Red and white paint occur occasionally on bowls, especially the triangular-sectioned rim bowls (BL3). Painted black crosshatch patterns or other designs are seen rarely on the exterior of jugs, jars

Table 4.41 Comparison of surface treatment and decoration of vessel families by site.

Site	Painted		Decorated		Slip		Burnish		Total*
KEN	220	10.4%	82	3.9%	1,004	47.7%	90	4.3%	2,106
KEN09	11	2.7%	2	0.5%	184	44.6%	2	0.5%	413
KAJ06	0	0.0%	6	5.9%	19	18.6%	1	1.0%	102
KAM	66	19.0%	7	2.0%	121	34.8%	34	9.8%	348
KIJ	16	12.9%	4	3.2%	13	10.5%	0	0.0%	124
KIS	41	36.0%	5	4.4%	17	14.9%	3	2.6%	114
TW	94	13.3%	5	0.7%	169	23.8%	41	5.8%	709

The surface treatment data were recorded differently for RHI A/B, so they are not included.
*Normalized by all vessel families, including undecorated.

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Figure 4.41 KEN 2002–2009, Study 1—distribution of antecedent bowls: BL3a, BL3b, BL12a, BL17, BL21a, BL21b, BL22a, BL23, BL30a (Strata I–III, ninth-century BCE)

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(Figure 4.5:11), and kraters (Figure 4.3:12). In Area R, the monumental tenth-century BCE building at the center of the site, painting was found on well-preserved surfaces of several of the eight complete and restorable small cups (cf. Figure 4.1:24; see also Chapter 2, this volume). These all had a white slip with vertical black painted stripes. The petrographic analysis revealed that these were not imports from outside the region but were produced within Edom. Their association with other fine-ware vessels (e.g., Qurayyah ware and Cypriot juglets) suggests that a small collection of delicate vessels were left in situ within one of the chambers of the building at Area R when it was abandoned. Similar shaped small cups, but lacking decoration, were found in Areas T ($n = 2$) and M ($n = 1$).

The quantitative analysis for the integrated phases at KEN (see table in Figure 4.41; Figure 4.39) is not particularly informative, but several observations can be made. First, all the areas contain painted pottery. Area M, which had a large horizontal exposure and deep vertical probe, yielded significantly less painted pottery. In general, Area M's ceramic repertoire has a much higher amount of simple or crude bowls and jars. This may reflect the more industrial nature of this part of the site where both the deep stratigraphy (thirteenth to tenth centuries BCE) and ninth-century BCE building complex were closely linked to copper smelting activities. Area A, the fortress gatehouse, possesses the largest percentage of painted sherds, but it was also excavated for two seasons, which is not represented in the normalization of the tables. Painted sherds are predominant in all of the main stratigraphic phases of each area. Therefore, the data do not show any significant disparities in distribution across the different stratigraphic periods of occupation.

At the L2HE sites and RHI Sounding B, painting is common (cf. table in Figure 4.41) but stylistically is more elaborate than what is found at Early Iron Age II KEN, which probably reflects temporal differences in the application of paint. Painted black bands on the rim and (interior/exterior) surfaces continue to be the dominant style, but a host of new paint colors and thicker bands becomes popular. Red paint specifically used as thick (3–5 cm) bands below the rim on the interior or exterior is most commonly seen. There is also a greater occurrence of white painted bands on red slip or these on the red bands. Numerous examples have multiple sets of horizontal black or red paint bands (cf. Figure 4.29:22).

The most highly decorated vessel types found among these sites are BL12c and BL20, where a thick red slip with a set of polychrome colors or plain black horizontal bands occurs. BL20, similar to BL21, are painted only on the exterior, while BL12c are painted on both sides. A number of archaeologists working in the southern Levant (Bienkowski 2002; Bienkowski and van der Steen 2001; Cohen et al. 2007; Levy 2009b; Na'aman and Thaerani-Sussely 2006; Singer-Avitz 1999, 2002, 2004; Whiting 2007) have noted the distinctive difference found among this type of painted pottery, which has come to be called "Busayra ware," even though the data here (e.g., the local production of the pottery coming from L2HE sites and RHI Sounding B) suggest it was produced throughout Edom rather than radiated out from the "capital," Busayra. Thus, the new data and analysis presented here show that these painted wares were produced throughout Edom and represent a shared cultural tradition.

Overall, a large percentage (13.3–36.0 percent; see table in Figure 4.41) of the vessels (predominately bowls) are painted at these sites, which can be immediately contrasted with the smaller percentage found at KEN. This evidence suggests that the discrepancy in painted wares between KEN and the later period sites should be associated with chronological differences.

Applied Decoration

Applied decoration, which refers to many different ways of adorning the exterior of vessels with grooving or clay attachments (e.g., knobs, bar handles, "buttons"), is common in all the ELRAP–L2HE ceramic assemblages in this study. The most common decoration technique employed at KEN was grooving on the exterior of vessels. Heavy storage jars and kraters as well as smaller vessels are typically grooved at or below their shoulders. Among bowls, the only grooving occurs on the medium to fine bowls (BL15) and the large bowls. Another applied decoration that occurred around 8 percent of the time among handmade wares was the attachment of small knobs running horizontally around the vessel.

At RHI (Sounding B) and the L2HE sites, applied decoration is similar to KEN but with several new vessel types where grooving played a central role. First, several of the late pithoi rims described above (PT17–PT21, PT23) were finished with one or several grooves. These pithoi are distinguished by the various

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finishing techniques involved in grooving. The grooving on the numerous pithoi and jars is very similar to the technique described for KEN above. In general, the comparison between KEN and the later sites suggests that grooving remained a standard practice throughout the Iron Age II sequence. Finally, at RHI Sounding B, we see the introduction of a new bowl vessel type (BL43; $n = 6$) that has as a distinctive feature two to three large concentric grooves found at mid-section.

Slip

Slip refers to a liquid form of clay occurring in different colors that is applied as decoration or a sealant to the surface of an unfired clay vessel. Although slip is regularly seen on vessel types at all of the ELRAP–L2HE sites, it is a predominant feature at KEN (e.g., 47.7 percent of the assemblage; cf. table in Figure 4.41). Bowls, kraters, and jugs are the most common vessel classes with slips. The slip was applied in different examples on the interior, exterior, and rim. Sometimes the slip can be identified only on the rim. Although slip is found primarily on wheel-made pottery, there are a few examples at KEN of handmade ware sherds with slip. At KEN, slip is primarily white, but cream also occurs on a regular basis. In very few examples are other slip colors found such as brown, black, and red. Red slip is rare in the assemblage. When it is found, it is accompanied by different types of burnishing and limited to specific vessel types (e.g., BL3, BL12). The common application of white slip differs from similar vessel forms that had red slip with or without hand burnish, as seen by the imports found at KEN deriving from Cisjordan.

The distinctively different slip decoration style found at KEN from its contemporary western neighbors (e.g., at *Tell Beit Mirsim III* or *Tel Batash*) is intriguing. It is clear from the petrographic study (Chapter 6, this volume) that KEN interacted with the sites found in the Negev and even imported their pottery. However, this interaction did not lead to the appropriation of red-slipped burnished ware. Rather, the technological styles of the potters reflected in the KEN assemblage were unaltered by this interaction and suggest that strong motivational schemas inhibited this adoption as theorized in Chapter 5 (this volume). It cannot be directly inferred that this occurred on a conscious level (e.g., ethnic markers), but it is clear that the indigenous potters of KEN had specific technological styles that persisted throughout the occupation at KEN that were foreign to their western neighbors. Moreover, these same styles of white slip and painting (as discussed above) become more elaborated in later periods. At the L2HE sites and RHI Sounding B, white slip continues to persist, but in the Late IA assemblages, red slip equally (ca. 50 percent) becomes a common medium on which painting (all predominately among bowl types) occurred. In these later period sites, slip regularly occurs with painting.

Burnishing

Burnishing is rare during both periods of the Iron Age II. At Early Iron Age II KEN, most examples are primarily on body sherds. There are many different types of burnish, including irregular hand burnish, continuous burnish, and horizontal or possibly wheel burnish. Surface color as a result of burnishing has a range of different hues of red and dark reddish brown. Painting rarely occurs with burnishing, and if it does, it is restricted to bowls. Burnishing is also uncommon at RHI Sounding B and the L2HE sites. When it does occur, it is specifically found on the ultra-fine BL20 examples (cf. discussion of Ware A6 in Chapter 3, this volume, and BL20 above). Therefore, burnish is uncommon during both periods in the lowlands and highlands, at least according to the ceramic assemblages recovered from these soundings (Busayra specifically appears to have had a number of its vessels burnished; see Bienkowski 2002). This evidence implies that there was a distinctive cultural difference in the production of pottery in the region of Transjordanian Edom from the neighboring Negev sites to the west. How this relates to social boundaries will be discussed below.

Intrasite Spatial Analysis of Ceramics from Khirbat en-Nahas

To fully understand the spatial distribution of the ceramic types, we conducted an intrasite spatial analysis. Ten case studies are presented below to investigate various hypotheses concerning the differences between the ninth- and tenth-century BCE stratified ceramic assemblages. Four areas (A, T, R, and M) were selected as the main focus of the study, with several other maps presenting Areas W and S.[16] The maps were constructed in ArcGIS using the "field-recorded" locus polygons and the joined KEN 2002–2009 ceramic database from the

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Pottery Informatics Query Database (PIQD; Smith et al. 2012). The ceramic typological database was quantified by creating a matrix of loci to counts of each vessel type. By this technique, we are able to get the MNI for each type within each locus and display it spatially as a dot density plot within the loci polygons. Each dot or symbol displayed can then be color-coded according to what vessel type/subtype it represents. The only disadvantage to this technique is that the each dot (representing one diagnostic sherd) is plotted randomly within the boundary of the locus. However, its original location would not be recoverable since most diagnostic sherds were collected in baskets representing the whole locus rather than recorded with individual coordinates (*x*, *y*, *z*), as was done for the special finds. Nevertheless, the dot density plots enable us to see spatially the general location of each diagnostic sherd and analyze the maps to determine whether any significant pattern emerges in the ceramic assemblage distributions.

A total of 1,692 diagnostic sherds from the ceramic typology database were joined to the loci of all the excavated areas in our Geographic Information System (GIS) spatial database. To elucidate types that may be specific to the tenth or ninth century BCE, all the studies below present two maps of the four main areas (A, T, R, and M). It is important to note that in the tenth century, approximately 50 to 70 percent less diagnostic sherds were recovered compared to the ninth century BCE (e.g., Area A: ninth century [n = 222], tenth century [n = 97]; Area M: ninth century [n = 132], tenth century [n = 36]; Area T: ninth century [n = 161], tenth century [n = 52]; Area W: ninth century [n = 268], tenth century [n = 109]). At Area S, almost all diagnostic sherds were associated with the main occupation in the ninth century, with very few sherds recovered below these strata (e.g., ninth century, n = 267; tenth century, n = 9). The only exception to the norm is Area R, where around 70 percent of the assemblage was recovered from within the earlier tenth-century BCE strata (e.g., ninth century, n = 79; tenth century, n = 260). These differences may be due to the fact that the fill above the floors of Area R was primarily devoid of ceramic remains in comparison to Area T or Area A and that areas such as M, W, and S had their main architectural occupation phase in the ninth century BCE. Finally, although 1,692 diagnostic sherds may appear as a statistically adequate number for analysis when broken down into areas, stratigraphic phases, and vessel types, the significance of the observations made must be held tenuously.

Case Study 1: Distribution of Antecedent Bowls: BL3a, BL3b, BL17, BL21a, BL22a, BL23, and BL30a

This first study investigates whether there is any recognizable difference in the distribution of bowls found to have contemporary and later parallels with sites excavated in Edom and Cisjordan. They are called antecedent bowls because many of the most popular forms in the Late IA II resemble their morphological form (see discussions above for each type).

Ninth-century BCE spatial distribution (Figure 4.41). At Areas A and T, BL3a, one of the most common bowls found at KEN, dominate the distribution in this period. At area M, only one example is present. When comparing BL3a to BL3b, it is clear that BL3b are quite rare. This is important since BL3b are the most common at RHI Sounding B and all the L2HE sites later. BL21a are also common at Areas A, R, and T. Only two occurrences of BL30a occur (Area A, Area R), which is in stark contrast to the abundance of this form, identified as BL30b above, for all the later eighth-century BCE sites in this study.

Tenth-century BCE spatial distribution (Figure 4.42). Despite the reduced amount of diagnostic sherds for the tenth century, BL3a remain the predominant type in Areas A, R, and T. Only one example of BL3b is found at Area T. All the remainder of the forms with the exception of BL17 and BL21a become rare.

Case Study 2: Unparalleled Bowls: BL9, BL14, BL15, BL31, BL33, BL34, BL36, BL37

By plotting bowls with no parallels outside of KEN, this study allows us to investigate whether there are any distinctive patterns between the ninth or tenth centuries BCE.

Ninth-century BCE spatial distribution (Figure 4.43). BL36 and BL37 occur at Areas A, R, and M only in the metallurgical waste layers. They are never found in Area R or T buildings for both periods. The remaining bowl types occur in both periods at all areas.

Tenth-century BCE spatial distribution (Figure 4.44). With the exception of one occurrence at Area M, BL37 and BL36 do not occur in the tenth century and appear to be associated with the intense metallurgical waste layers. Area A contains only BL15 in the tenth century BCE; this type is more common at the other areas during both periods.

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Case Study 3: Imports and Rare Fabrics: BL16a, BL24a, BL24b, BL25a, BL25b, BL29a, BL29b, JT21, JT22, and Qurayyah Sherds

This ceramic distribution highlights the known vessel types with imported/foreign fabrics. JT21 are the black-burnished juglets. JT22 are the Cypriot juglets. The western Negev loess soil bowls are BL16a, BL24a, and BL25a. BL25b and BL29a belong to Ware A10, possibly originating from a clay source south of KEN. Their morphology resembles more closely the western Negev imports. BL24b and BL29b are included for comparison but are local fabrics. Also, all diagnostic rim sherds and painted sherds identified as Qurayyah ware are depicted in these plots.

Ninth-century BCE spatial distribution (Figure 4.45). The western Negev bowls BL16a and BL24a appear at Areas A and R outside the buildings in the metallurgical waste areas. Qurayyah sherds are found at Areas A, R, and M. The black-burnished juglets are found only in Areas A and T. The Cypriot juglets also are found at Areas T and R.

Tenth-century BCE spatial distribution (Figure 4.46). In the tenth century, the western Negev imports continue to be found outside the buildings in Area A. The one example of BL25a occurs at Area T within the building. The black-burnished juglets continue to be found at Area T. The Cypriot juglets similarly are present at Areas R and T. It may be significant to note that Area M during both periods had only Qurayyah sherds as imports. In general, a division of western Negev imports and Qurayyah ware can be seen in the ninth- and tenth-century metallurgical waste areas and black-burnished juglets and Cypriot ware only in the elite structures. This irregularity may reflect differences in social stratification and the decision of elites to have access only to the more distant and finer imported ware.

Case Study 4: IA IIA Western Parallels: BL15, BL22, BL34, BL36, KR4, KR8, PT5, JG4, JG15, JT17, JT19, JT21, JT23, and JT26

Beyond the imported west Cisjordan vessel types, many types found at KEN share IA IIA with parallels in the west.

Ninth-century BCE spatial distribution (Figure 4.47). During this period, JG15, KR8, JG4, and PT5 can be found at most areas. The only type that appears to be primarily a ninth century type is BL22, which occurs in abundance in Area A but also at Areas R and M in the metallurgical depositions.

Tenth-century BCE spatial distribution (Figure 4.48). With the exception of JG4 at Area T, similar distributions of the types in this study were also present in the areas during the tenth century BCE. JG4 occur at Areas A and R but are found in much higher counts in many of the rooms at Area T. PT5 also appear to be quite common at Area T, especially compared to Area R, where none were found, and Area A had only one example.

Case Study 5: IA IIA Unparalleled Kraters: KR3, KR5, KR6, KR8, KR11, KR12, KR13, and KR29

This study plots the majority of kraters found at KEN that have almost no known parallels.

Ninth-century BCE spatial distribution (Figure 4.49). KR12 and KR29 appear to primarily be a ninth-century phenomenon and are quite common at Area M in comparison to the other types. KR3 are found in abundance in the same loci at Area A where many of the other common vessel types are found. However, they occur regularly at all other areas. KR6 were found only at KEN.

Tenth-century BCE spatial distribution (Figure 4.50). This earlier period has KR3 and KR8, but their distribution is not uniform. KR3 are found only at Areas T and R and are now absent at Area A. KR8 continue to be found only at Areas R and T. KR6 occur in this earlier period again only at Area A but in small amounts. It appears that Area A's ceramic assemblage of kraters was different from that of the southern settlements. However, the small sample size makes drawing conclusions tenuous.

Case Study 6: Most Common Bowls: BL3a, BL3b, BL13, and BL34

These three bowl types represent the three most abundant bowls. This study allows us to investigate if their distribution differs between the two stratigraphic periods.

Ninth-century BCE spatial distribution (Figures 4.51, 4.53). BL3a are common during this period and occur predominately at Areas A, T, and R. BL3b are found in similar contexts but in smaller amounts. BL13, a crude simple bowl, occur at all areas, often with similar amounts compared to BL3a. Area W, which is primarily associated with ninth-century BCE occupation, has a dominant amount of BL13 in its rooms. The presence of this course, plain bowl type appears to be typical for the less monumental or elite-based architecture found at Area W or Area M compared to Areas A, T, and R.

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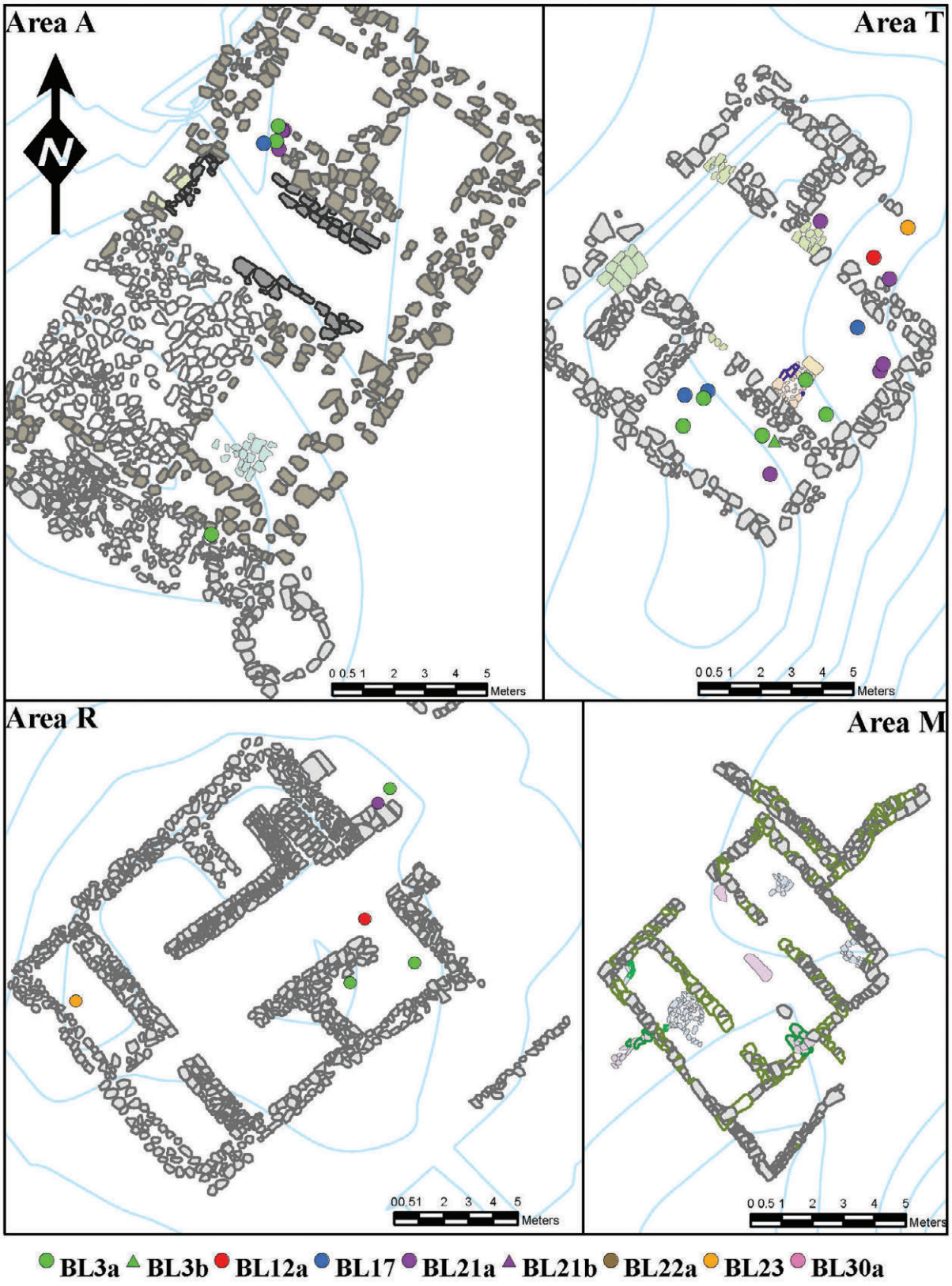

Figure 4.42 KEN 2002–2009, Study 1—distribution of antecedent bowls: BL3a, BL3b, BL12a, BL17, BL21a, BL21b, BL22a, BL23, BL30a (Strata IV–V, tenth century BCE).

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Table 4.42 Distribution of predominant vessel types that occur more than (n = 10) bowls.

Type	KEN	KAJ06	RHI04-A	KAM	KIJ	KIS	TW	RHI04-B	Total
BL1	15	1		2			8	13	39
BL2				1		4	3	5	13
BL3a	70		2	6	1	1	6	17	103
BL3b	18		1	3	2		5	6	35
BL3c	1			6	4		6	28	45
BL3d					1			19	11
BL4				3			5	11	19
BL5				1			9	6	16
BL8	5			1	1	2	7	21	37
BL9	12								12
BL12	10								10
BL12c				8	2		6	2	18
BL13	49		1						50
BL14	10								10
BL15	21								21
BL16	17	1					1	1	20
BL17	17							2	19
BL20				5	2	18	9	30	64
BL21a1-2	23			1	1		1		26
BL21a3			2	13	5	1	5	13	39
BL21b	1			4	1		3	64	73
BL21d				7	1		11	1	20
BL22	17			2	2		5		26
BL23	18			2	1	2	9	8	40
BL26	11	2							13
BL29	8								8
BL30	6			1		1		2	10
BL30a2-3				2			3	8	13
BL30b			1	11	3	6	16	7	44
BL30c				3	5		5	4	17
BL30d							1	6	7
BL34	11								11
BL36	7								7
BL37	8								8
BL42								16	16
BL51				8			1		9
BL53				1	1		26	1	29
BL56				4	1	4	1		10

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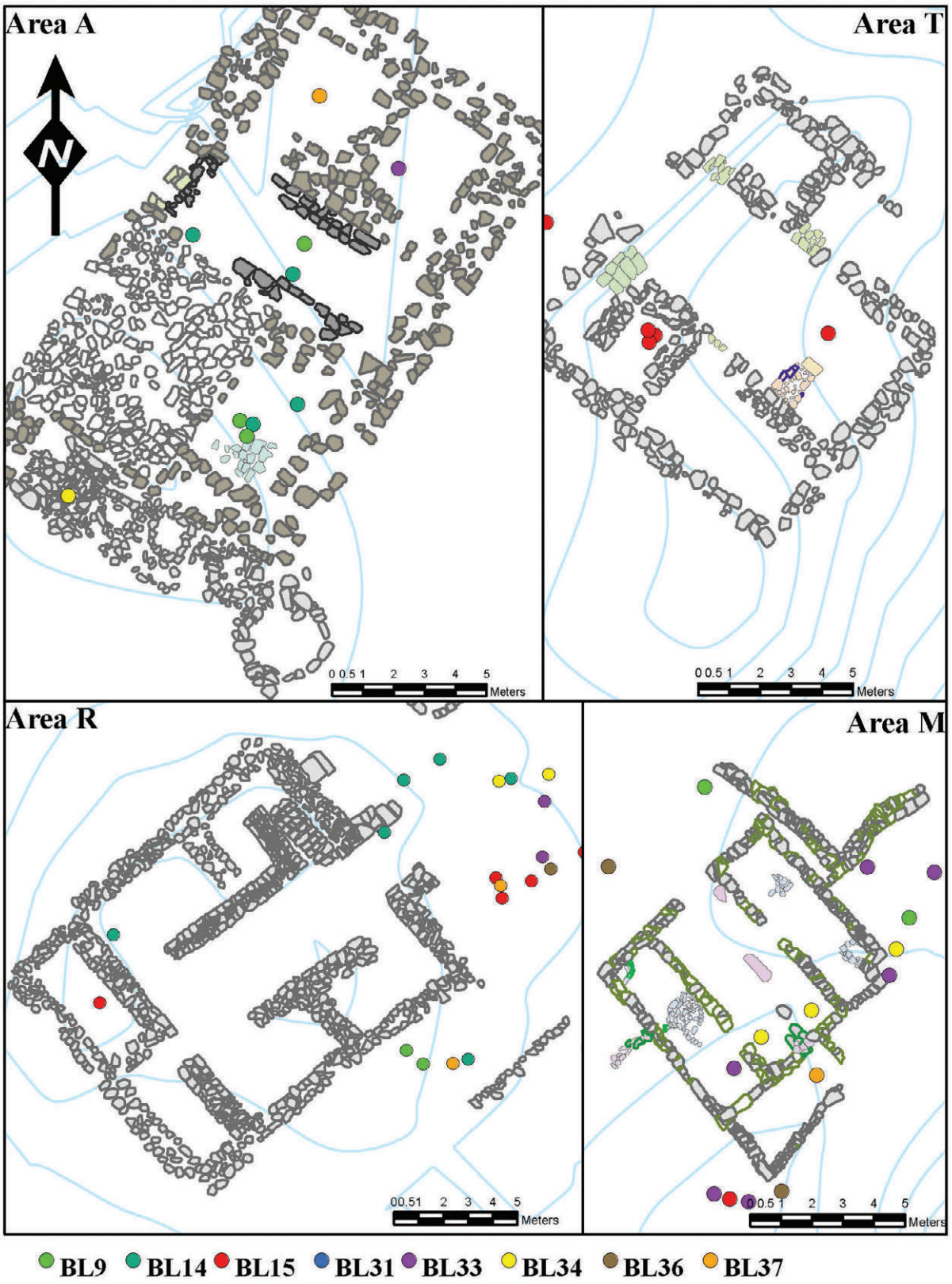

Figure 4.43 KEN 2002–2009, Study 2—unparalleled bowls: BL9, BL14, BL15, BL31, BL33, BL34, BL36, BL37 (Strata I–III, ninth century BCE).

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Table 4.43 Distribution of predominant vessel types that occur more than (n = 10) KR and JG.

Type	KEN	KAJ06	RHI04-A	KAM	KIJ	KIS	TW	RHI040B	Total
KR3	28		1					2	31
KR4	3							4	7
KR8	23	1							24
KR10	7						1	2	10
KR11	10								10
KR12	9						1		10
KR13	7								7
KR15				11	4		36	15	66
KR16								25	25
KR17				3				11	14
KR18	2						7		9
KR26	1	11							12
KR27		7							7
KR29	12								12
JG3	15				1		7		23
JG3d				5	4	2	17	11	39
JG4	19	1	3	1		3	11	23	61
JG4d	14			1			1		16
JG6	22			4	1		5	2	34
JG15	13								13
JG26	12	10							22
JG28						3	3	10	16

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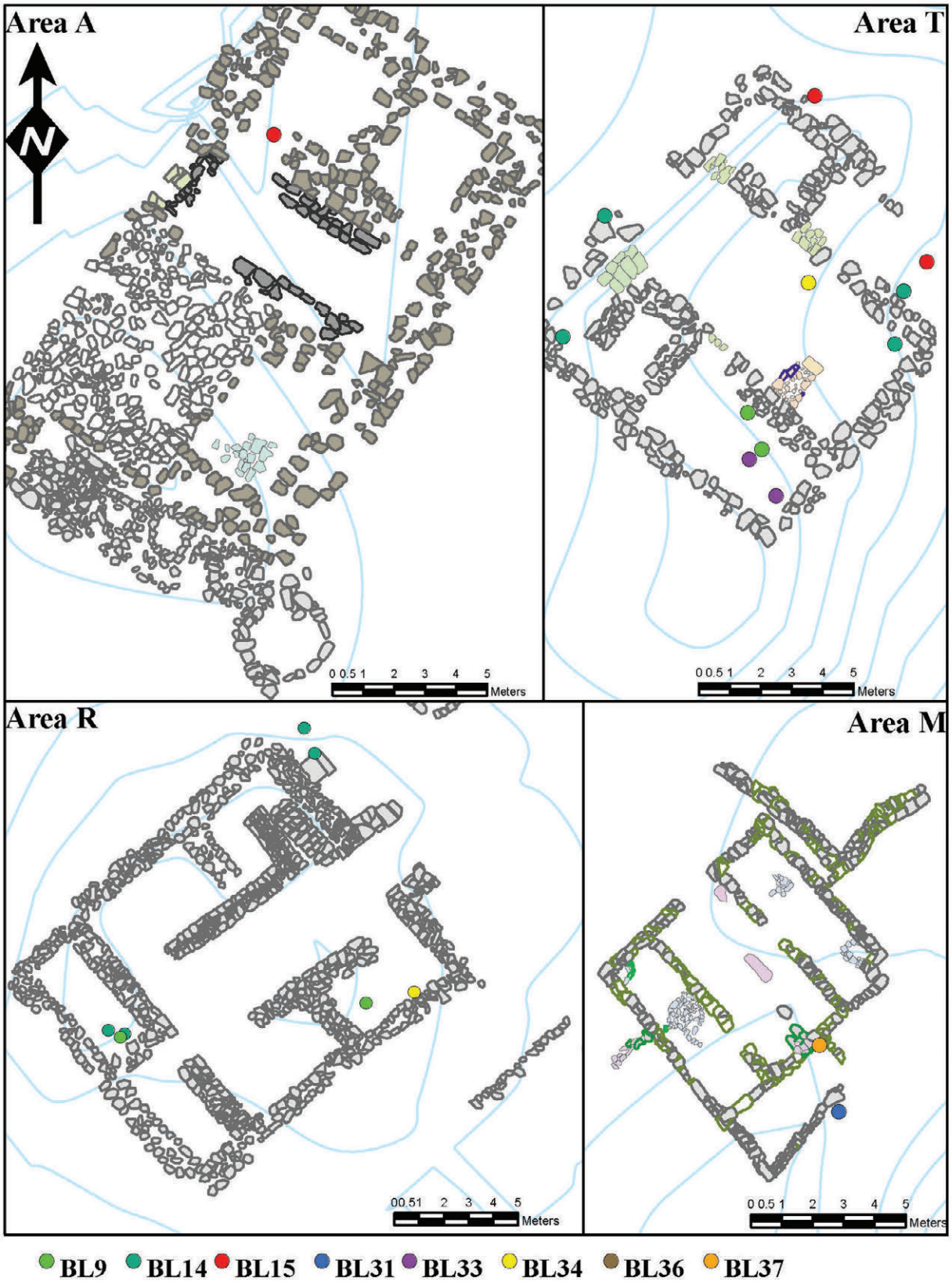

Figure 4.44 KEN 2002–2009, Study 2—unparalleled bowls: BL9, BL14, BL15, BL31, BL33, BL34, BL36, BL37 (Strata IV–V, tenth century BCE).

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Table 4.44 Distribution of predominant vessel types that occur more than (n = 10) PT and CP.

Type	KEN	KAJ06	RHI04-A	KAM	KIJ	KIS	TW	RHI04-B	Total
PT3	2		1				1	4	8
PT5	22								22
PT10	13					1			14
PT15	1			2	2	1	1	4	11
PT18				4	1	4	4	4	17
PT20	1			1	2		6		10
PT22				4	1	2	5		12
PT23					1		7		8
PT24							7		7
CP25								12	12
CP30				14			12	5	31
CP31								8	8
CP32								18	18
CP33				1	2	3	7	30	43
CP34								13	13
CP36				7	6		7		20
CP37				7			6		13
CP38				5	1		7		13
CP39				6	1		3		10
CP40							8		8
CP46				1		4	2		7
JT3	7							2	9
JT26	5	3							8
Midianite	17		1						18
Total	1,125	53	24	219	78	78	437	579	2,593

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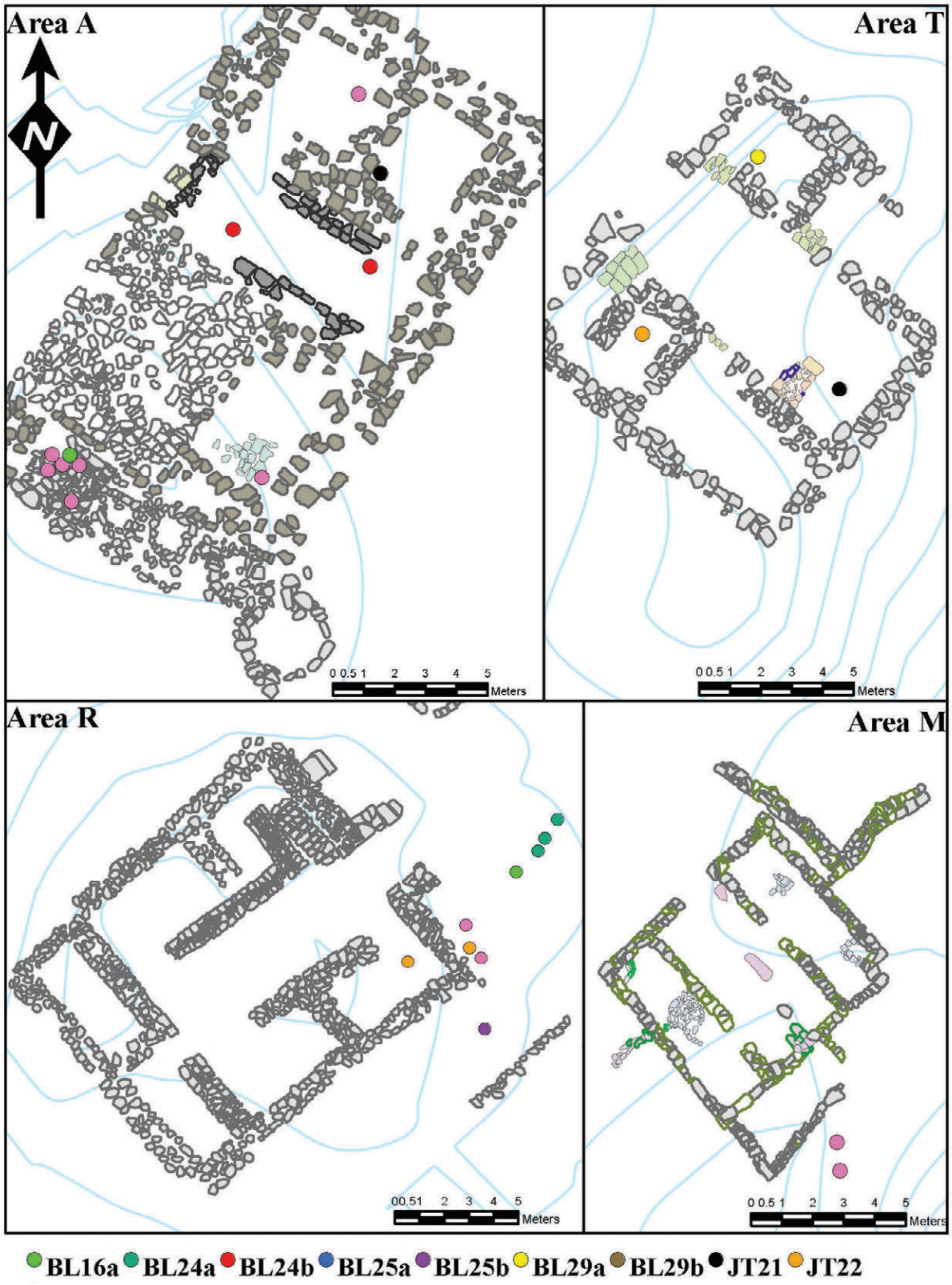

Figure 4.45 KEN 2002–2009, Study 3—imports and rare fabrics: BL16a, BL24a, BL24b, BL25a, BL25b, BL29a, BL29b, JT21, JT22, Qurayyah sherds (Strata I–III, ninth century BCE).

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Table 4.45 Comparison of BL22 from Khirbat en-Nahas, L2HE sites and Busayra.

#	Site	Reg#	Locus	Basket	Str.	IP	Vessel	Type	Ware	Description/Reference
1	KEN	700	1809	16136	R2a	III	Bowl	BL22	A1	
2	KEN	325	21	1418	A2a	II	Bowl	BL22	A1	White slip (int/ext.)
3	KEN	329	21	1418	A2a	II	Bowl	BL22		
4	KEN	450	61	1451	A2a	II	Bowl	BL22		Burnished interior
5	KEN	460	21	1452	A2a	II	Bowl	BL22		
6	KEN	558	76	1710	A2b	II	Bowl	BL22		White slip (int./ext.), ring burnished
7	KEN	561	76	1710	A2b	II	Bowl	BL22		
8	KEN	553	77	1717	A2b	II	Bowl	BL22		Ring burnishing (int./ext.)
9	KEN	620	62	1623	A2b	II	Bowl	BL22		White slip (int./ext.)
10	KEN	808	331	7228	S2a	II	Bowl	BL22	A1	Burnish (int./ext.)
11	KEN	34	263	5076	S1	I	Bowl	BL22	A1	White slip (int./ext.), fine horizontal grooves below rim and above carination
12	KAM-B	38	3038	10280			Bowl	BL22d	B1	Black horizontal bands, red slip and burnish
13	KIJ	748	6017	13129			Bowl	BL22d	B1	Black red ring burnish
14	Busayra	R1015	B3.2m				Bowl	K1		Bienkowski 2002:Fig. 9.26:13
15	Busayra	R106	B1.2.2c				Bowl	K1		Bienkowski 2002:Fig. 9.26:14
16	Busayra	R1210	B3 balk				Bowl	K1		Bienkowski 2002:Fig. 9.26:15
17	Busayra	R1277	C21.3.12				Bowl	K2		Bienkowski 2002:Fig. 9.26:16
18	Busayra	R327	B2.4.2				Bowl	K2		Bienkowski 2002:Fig. 9.26:17
19	Busayra	R885	A27.1.8				Bowl	K2		Bienkowski 2002:Fig. 9.26:18
20	Busayra	TS191	C1.3.1				Bowl	K2		Bienkowski 2002:Fig. 9.26:19

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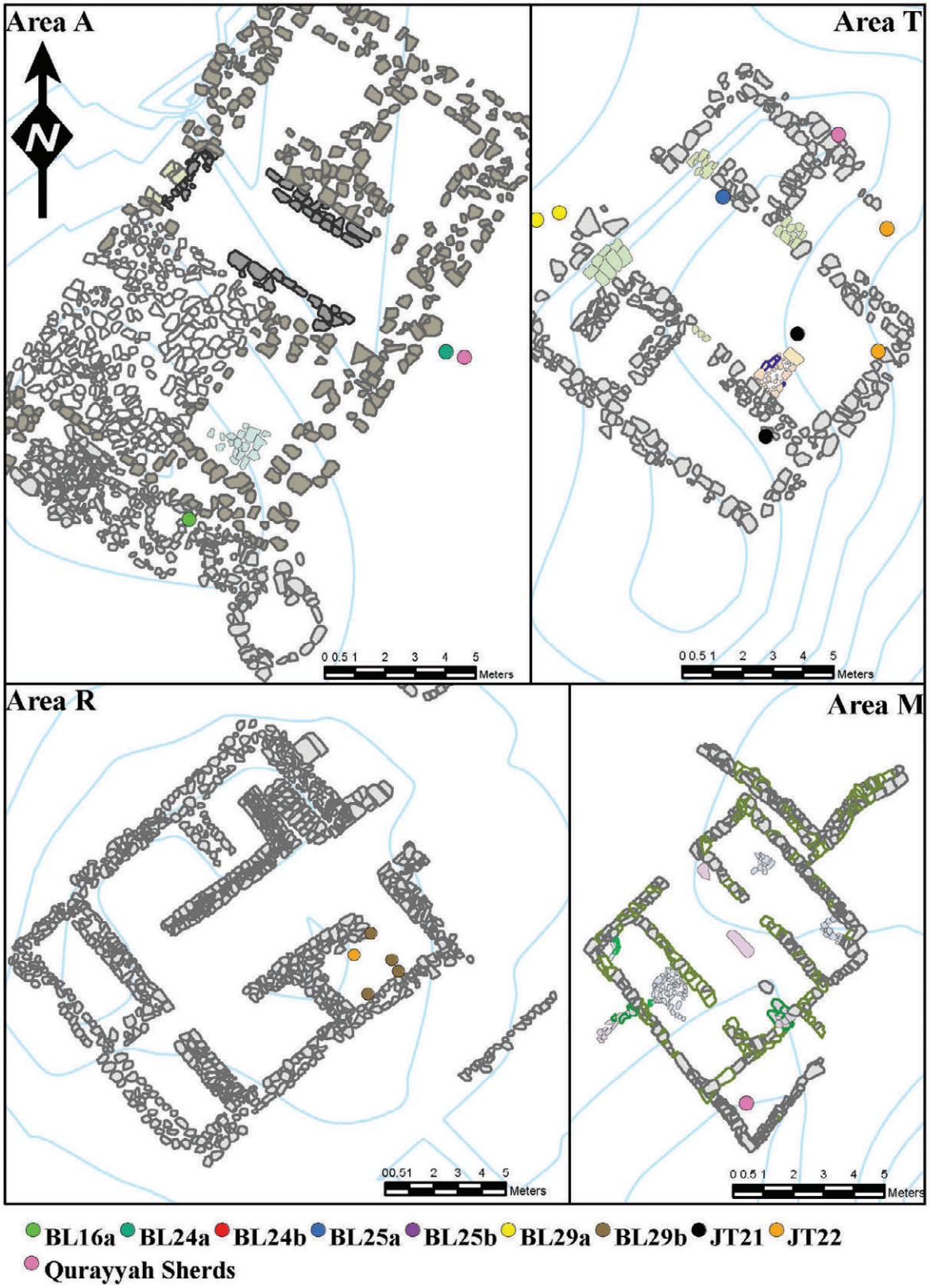

Figure 4.46 KEN 2002–2009, Study 3—imports and rare fabrics: BL16a, BL24a, BL24b, BL25a, BL25b, BL29a, BL29b, JT21, JT22, Qurayyah sherds (Strata IV–V, tenth century BCE).

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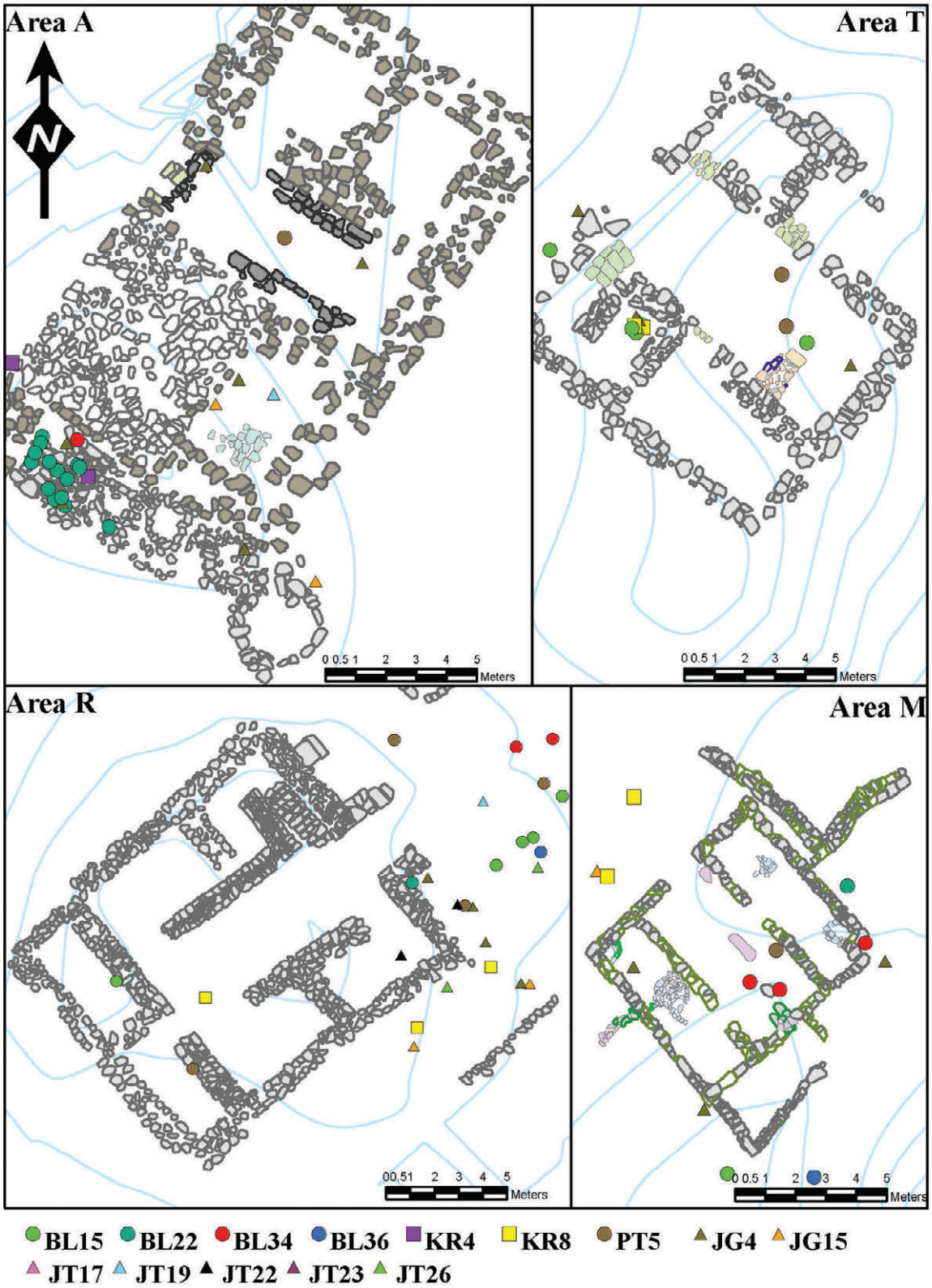

Figure 4.47 KEN 2002–2009, Study 4—IA IIA western parallels: BL15, BL22, BL34, BL36, KR4, KR8, PT5, JG4, JG15, JT17, JT19, JT21, JT23, and JT26 (Strata I–III, ninth century BCE).

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Figure 4.48 KEN 2002–2009, Study 4—IA IIA western parallels: BL15, BL22, BL34, BL36, KR4, KR8, PT5, JG4, JG15, JT17, JT19, JT21, JT23, and JT26 (Strata IV–V, tenth century BCE).

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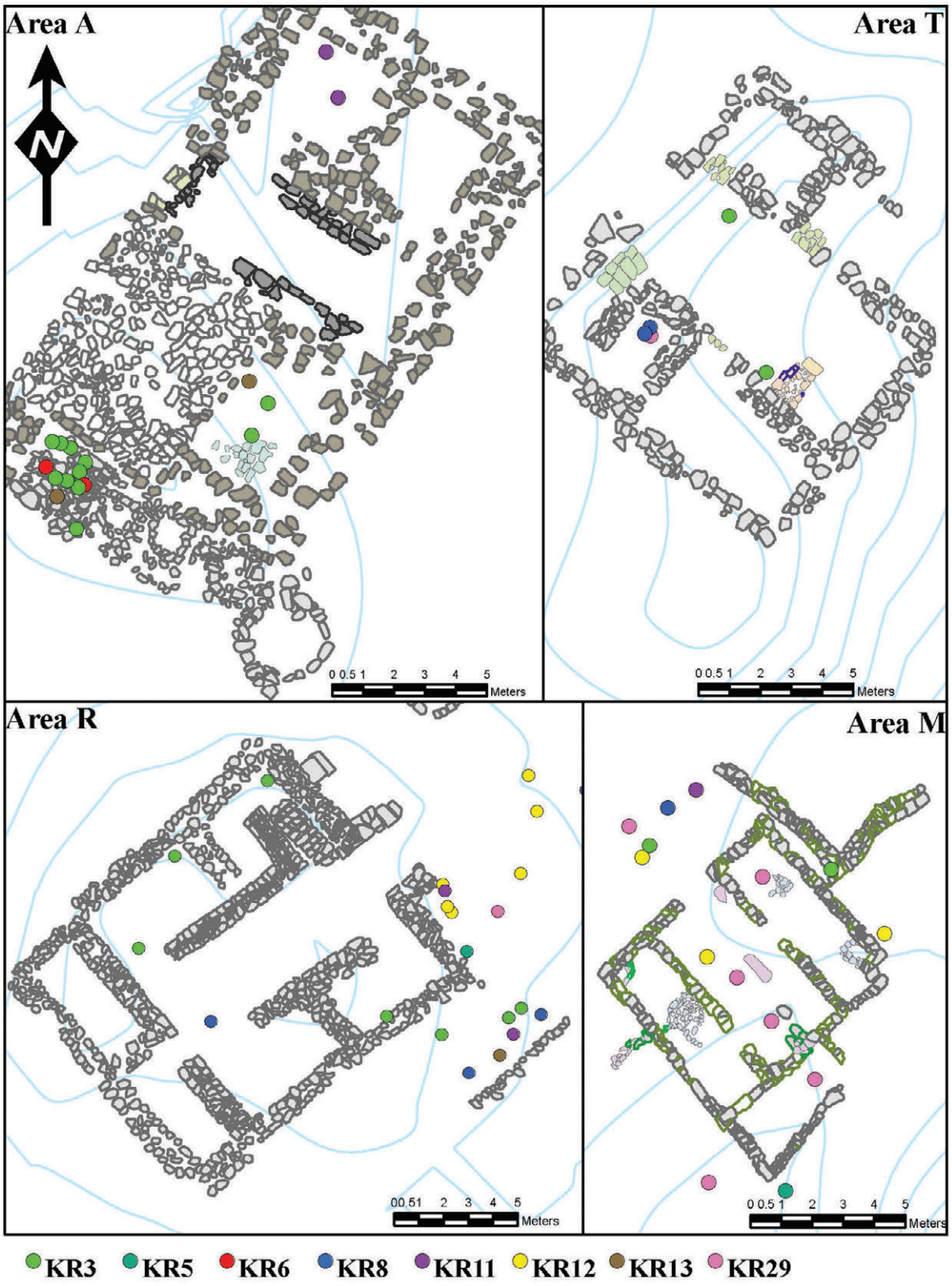

Figure 4.49 KEN 2002–2009, Study 5—IA IIA unparalleled kraters: KR3, KR5, KR6, KR8, KR11, KR12, KR13, and KR29 (Strata I–III, ninth century BCE).

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Figure 4.50 KEN 2002–2009, Study 5—IA IIA unparalleled kraters: KR3, KR5, KR6, KR8, KR11, KR12, KR13, and KR29 (Strata IV–V, tenth century BCE).

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BL34 are found only at Areas R and T during this period. The distribution of BL3a and BL13 may support the idea that these represent ration bowls associated with the less prestigious architectural units at Khirbat en-Nahas.

Tenth-century BCE spatial distribution (Figures 4.52, 4.54). In this period, BL3a do not appear to be as significant in comparison to the later ninth century BCE. This is quite apparent at Areas A and R, where they are minimally represented. Similarly, BL13 are also minimal in the tenth century BCE, and perhaps its later increase is related to intensification of metallurgical activities in the areas.

Case Study 7: Most Common Jugs: JG3, JG4a, JG4d, JG6a, and JG6d

This plot illustrates the most common jugs found at KEN.

Ninth-century BCE spatial distribution (Figure 4.55). In general, these jugs appear at all the areas during this period.

Tenth-century BCE spatial distribution (Figure 4.56). Although the sample size is much smaller in the tenth century BCE, all of these types are found during the earlier period as well.

Case Study 8: Unparalleled Jugs, Juglets, and Jars: JT3, JT19, JG15, JG26, JR7, JR14

These closed vessels have no clear parallels outside of KEN. Unfortunately, the overall small sample size of this study makes it difficult to draw any significant conclusions.

Ninth-century BCE spatial distribution (Figure 4.57). Although all types are represented at the site during this period, the areas lack uniformity in distribution.

Tenth-century BCE spatial distribution (Figure 4.58). In this period, the sample size is low for these various forms, with only JT3, JG15, and JR14 represented. Whether this is a product of poor recovery of ceramic assemblages from this period or these closed vessels were not as heavily used during this period is not entirely clear.

Case Study 9: Distribution of Pithoi: PT2, PT3, PT4, PT5, PT6, PT7, PT8, and PT10

This study plots all pithoi found at KEN that occur more than once.

Ninth-century BCE spatial distribution (Figure 4.59). PT4 occur only in small numbers (n = 3) and only at Area A. Area A has many of the types of pithoi represented during this period in comparison to the other areas. PT10 occur at Area A in both the side rooms and middle chamber during the ninth-century BCE occupation. One occurrence was found at Area R for PT10. In contrast, Areas T, R, and M contain a higher proportion of PT5 and PT6. The remaining pithoi have poor sample sizes, making any inference difficult.

Tenth-century BCE spatial distribution (Figure 4.60). The earlier phases of these areas contain PT5, PT8, and, to a lesser degree, PT10. PT10 are more uniformly distributed in Areas A, R, and M during this period. The distribution of PT5 appears to be similar to its later distribution at the areas. During this period, it is most common in several of the rooms of Area T.

Case Study 10: Distribution of Cooking Pots: CP1–CP21

All cooking pots found at KEN are plotted in this study. Since not one cooking pot was similar to another, they all have been grouped as a single symbol to highlight their primary occurrence.

Ninth-century BCE spatial distribution (Figure 4.61, 4.63, 4.65). During this period, cooking pots are found regularly at Areas M, W, and S. Three examples were found at Area T, but at Areas A and R, none were found. This sharp contrast appears to be related to the different function of the buildings. By comparison of architectural styles alone, it is clear that Areas A, R, and T were built as public or elite residences in comparison to the domestic-looking dwellings of Areas M, W, and S. The absence of cooking pots at the public/elite residences corroborates the theory that some form of social stratification occurred at the site, which also involved the speration of domestic production from these elite residences.

Tenth-century BCE spatial distribution (Figure 4.62, 4.64, 4.66). Since Areas M, W, and S are all primarily ninth-century BCE occupations, the small sample size of cooking pots for this period is understandable. At Areas R and T, cooking pots are found but in smaller numbers compared to what was found at the ninth-century BCE domestic/metallurgical buildings.

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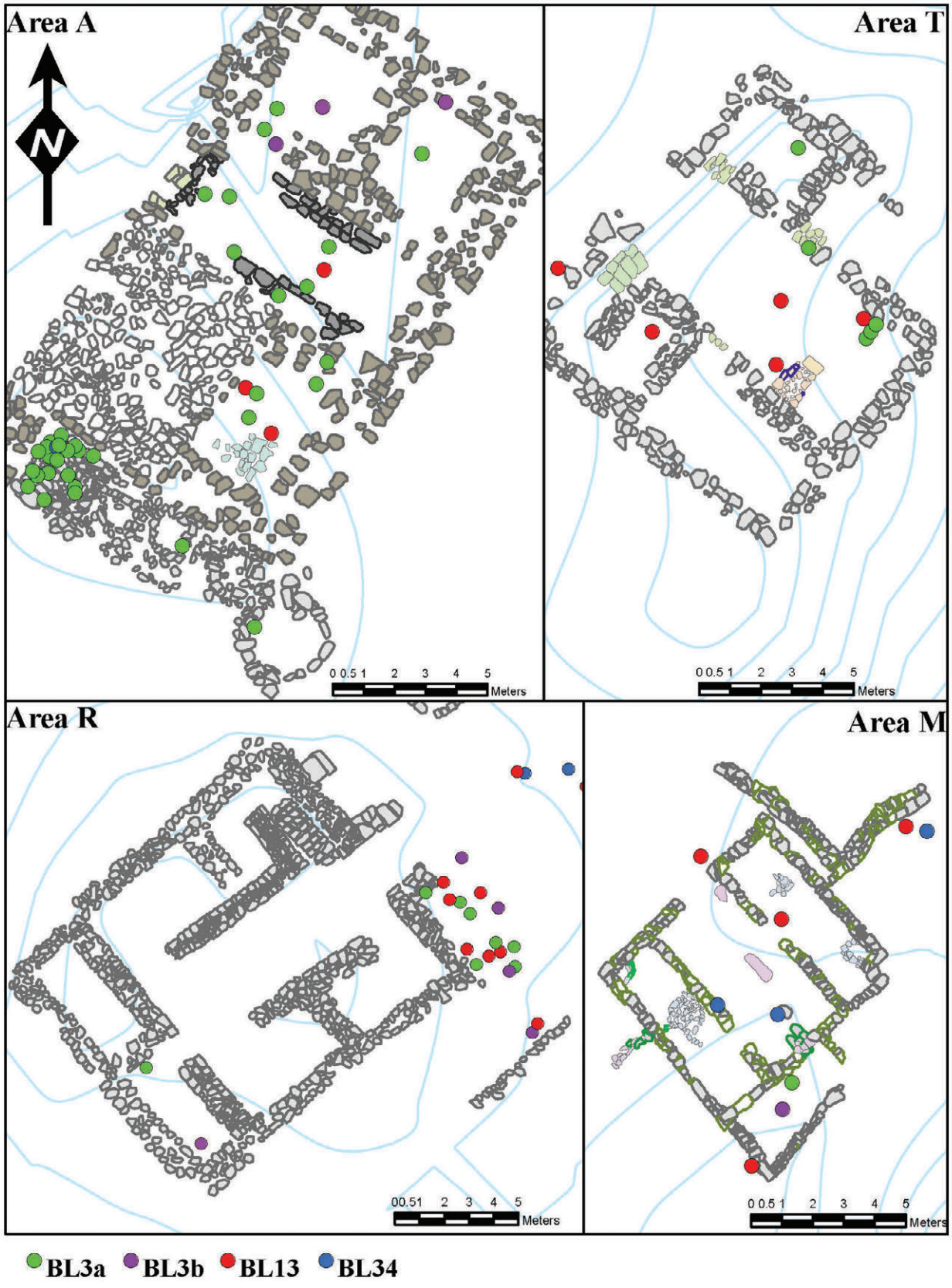

Figure 4.51 KEN 2002–2009, Study 6—most common bowls: BL3a, BL3b, BL13, and BL34 (Strata I–III, ninth century BCE).

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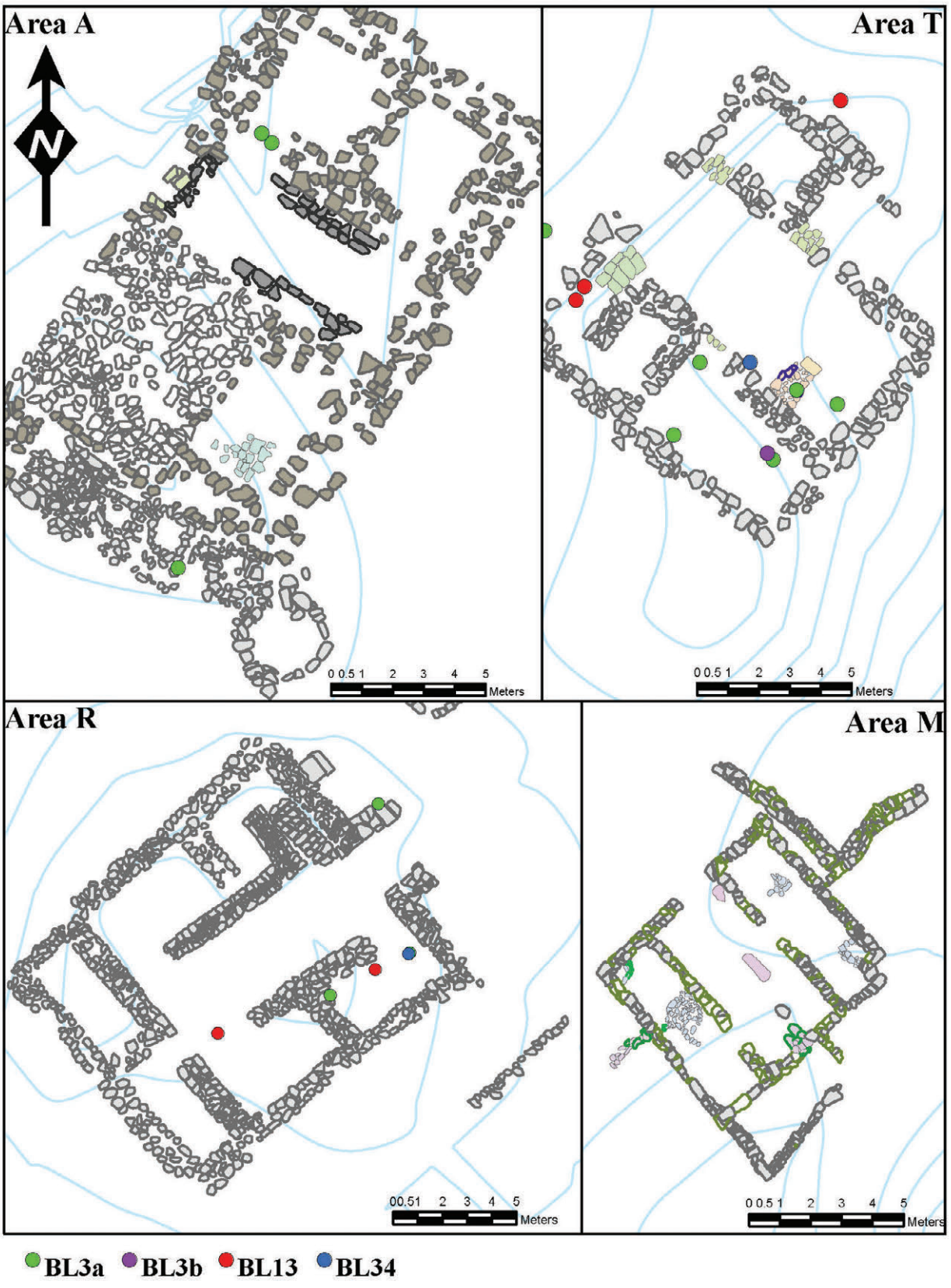

Figure 4.52 KEN 2002–2009, Study 6—most common bowls: BL3a, BL3b, BL13, and BL34 (Strata IV–V, tenth century BCE).

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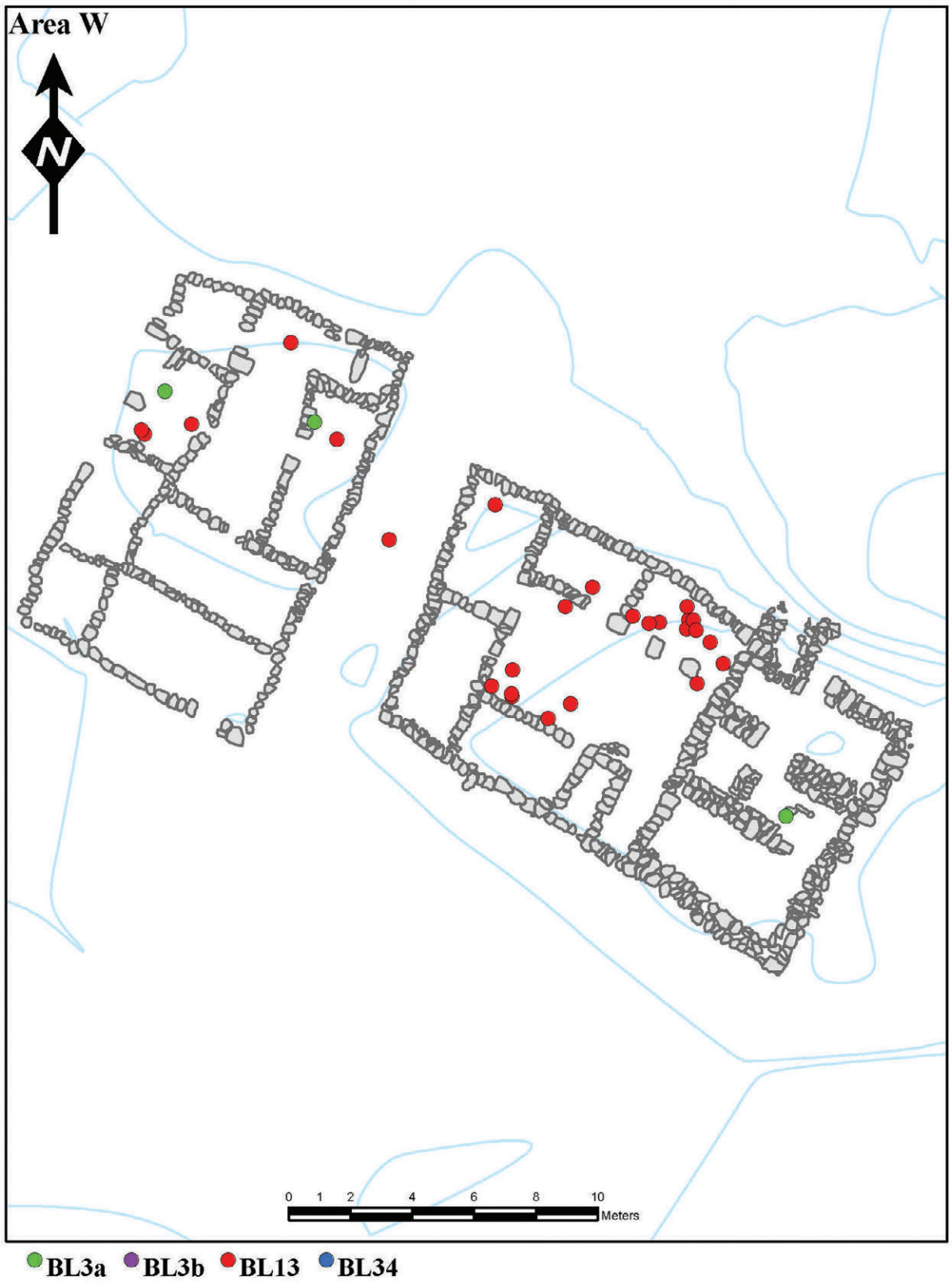

Figure 4.53 KEN 2002–2009, Study 6—most common bowls: BL3a, BL3b, BL13, and BL34 (Area W (W1a–W2a), ninth century BCE).

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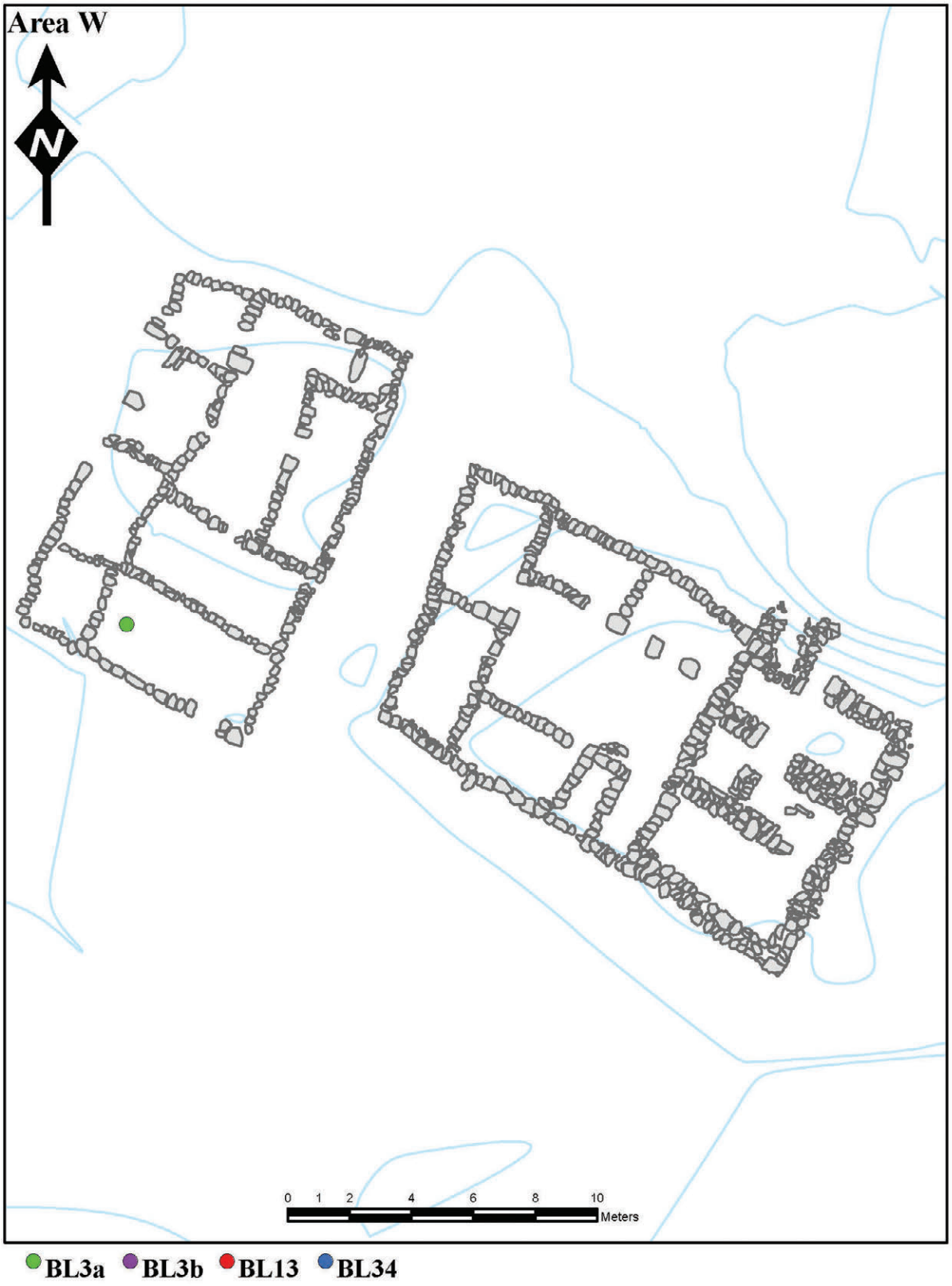

Figure 4.54 KEN 2002–2009, Study 6—most common bowls: BL3a, BL3b, BL13, and BL34 (Area W (W2b–W3), tenth century BCE).

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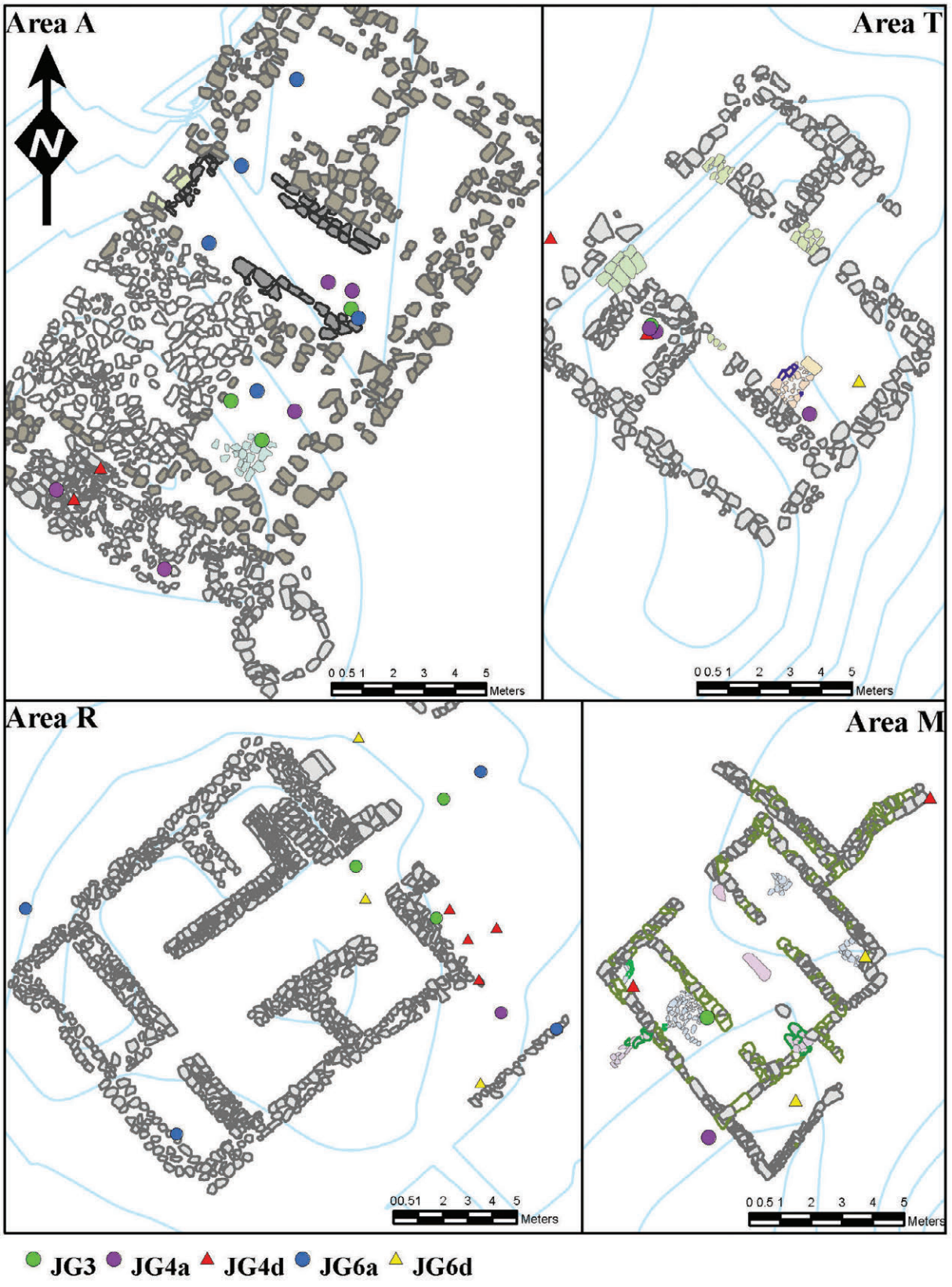

Figure 4.55 KEN 2002–2009, Study 7—most common jugs: JG3, JG4a, JG4d, JG6a, and JG6d (Strata I–III, ninth century BCE).

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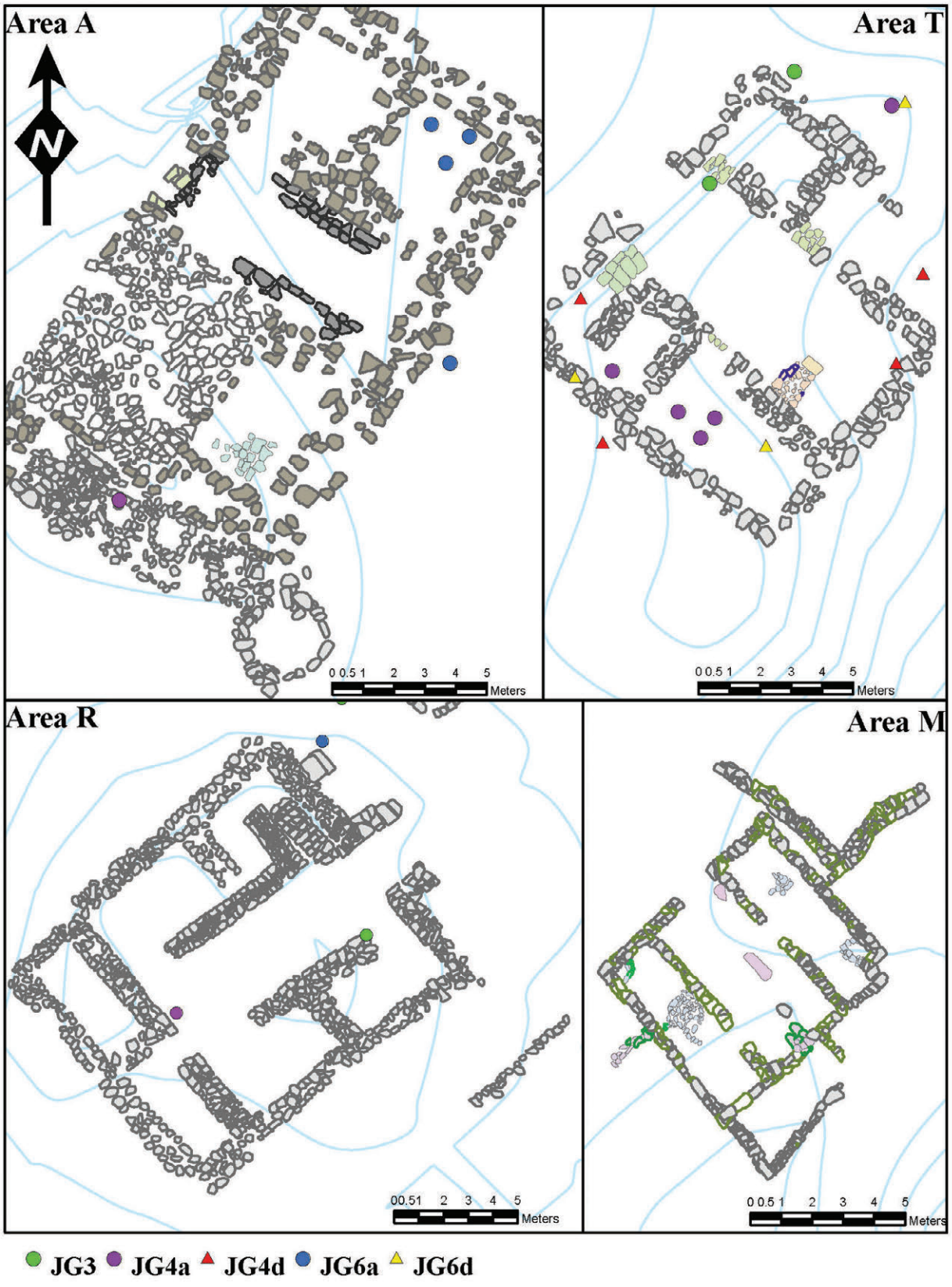

Figure 4.56 KEN 2002–2009, Study 7—most common jugs: JG3, JG4a, JG4d, JG6a, and JG6d (Strata IV–V, tenth century BCE).

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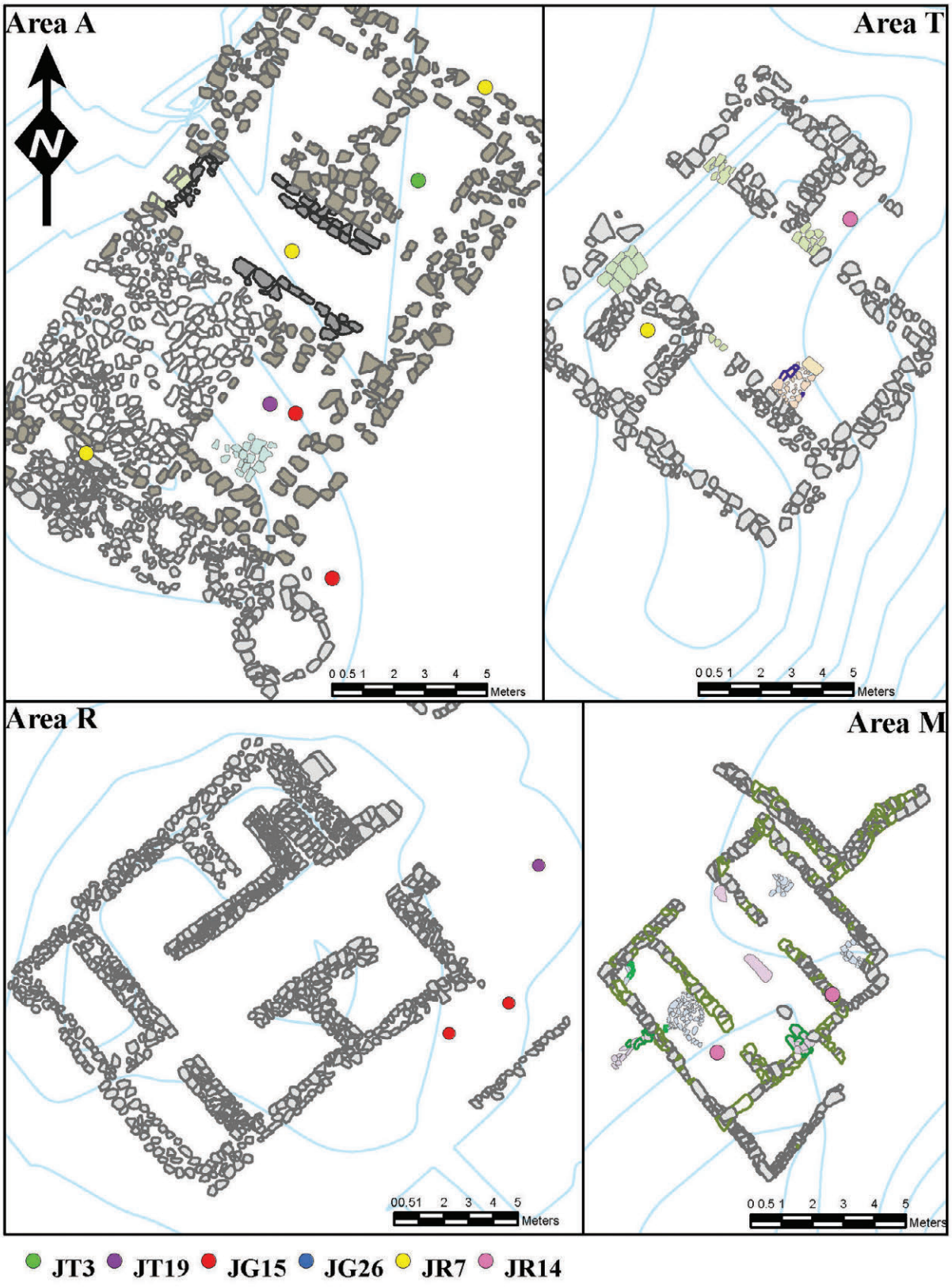

Figure 4.57 KEN 2002–2009, Study 8—unparalleled jugs, juglets, and jars: JT3, JT19, JG15, JG26, JR7, JR14 (Strata I–III, ninth century BCE).

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Figure 4.58 KEN 2002–2009, Study 8—unparalleled jugs, juglets, and jars: JT3, JT19, JG15, JG26, JR7, JR14 (Strata IV–V, tenth century BCE).

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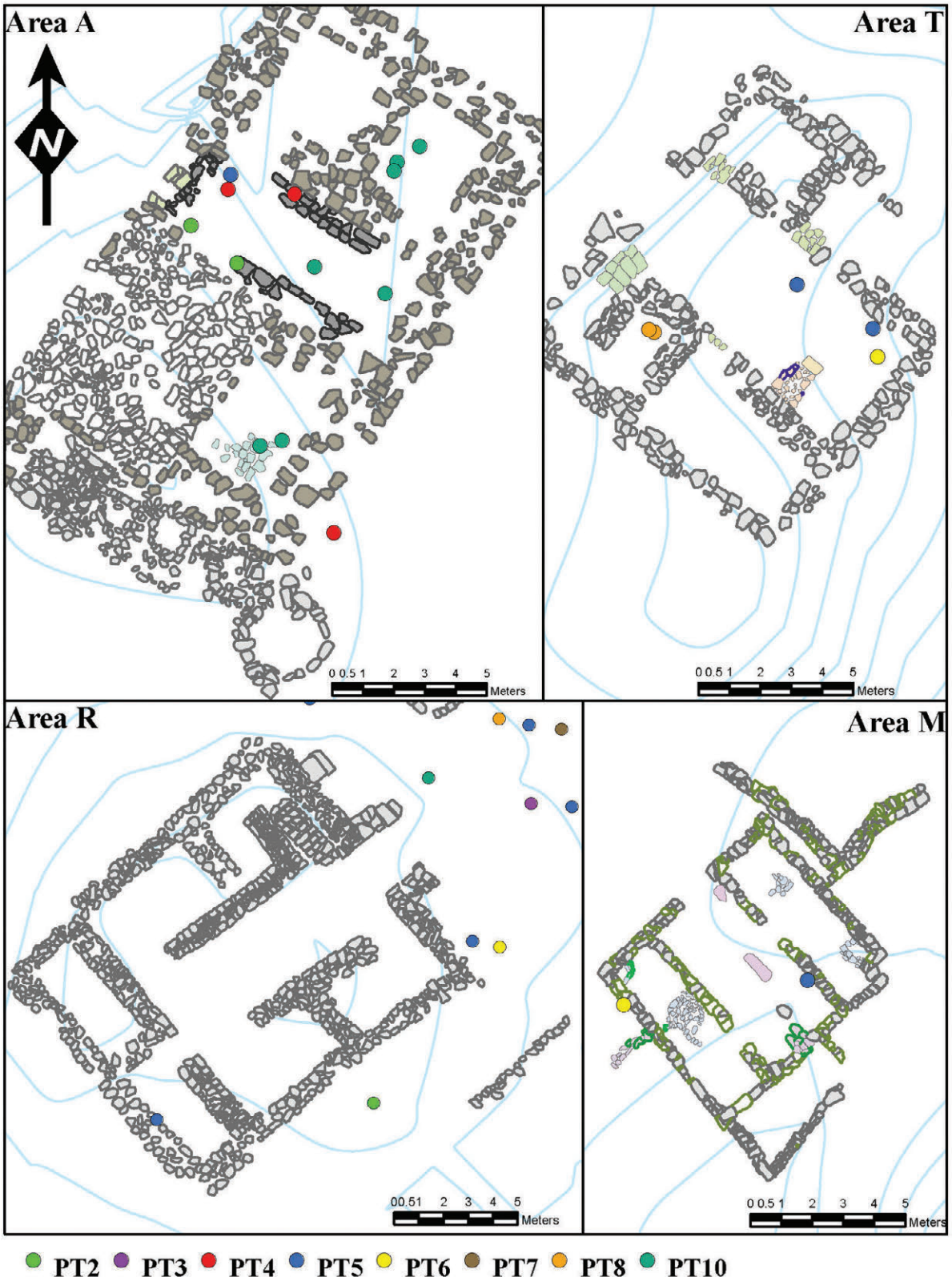

Figure 4.59 KEN 2002–2009, Study 9—distribution of pithoi: PT2, PT3, PT4, PT5, PT6, PT7, PT8, and PT10 (Strata I–III, ninth century BCE).

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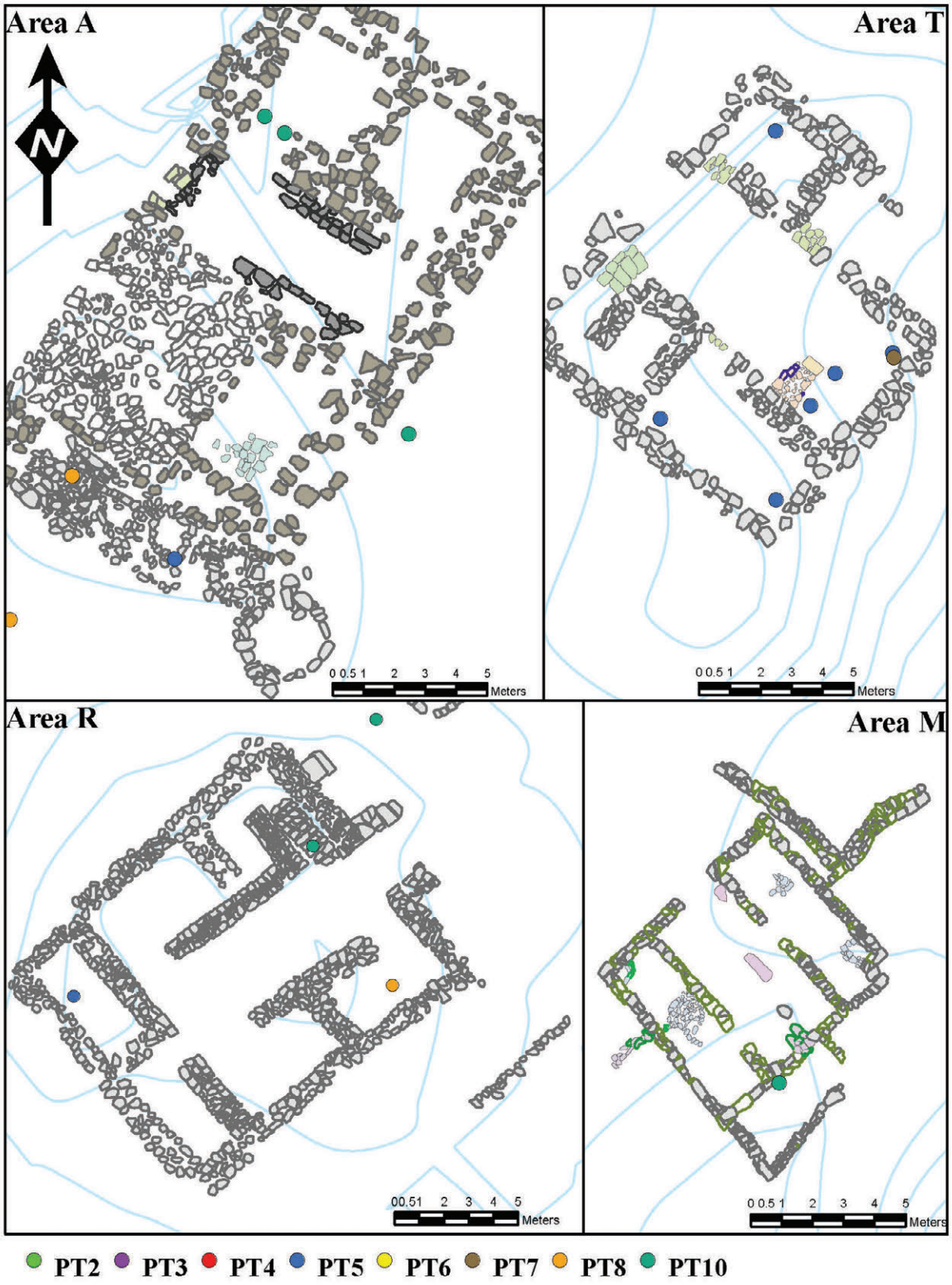

Figure 4.60 KEN 2002–2009, Study 9—distribution of pithoi: PT2, PT3, PT4, PT5, PT6, PT7, PT8, and PT10 (Strata IV–V, tenth century BCE).

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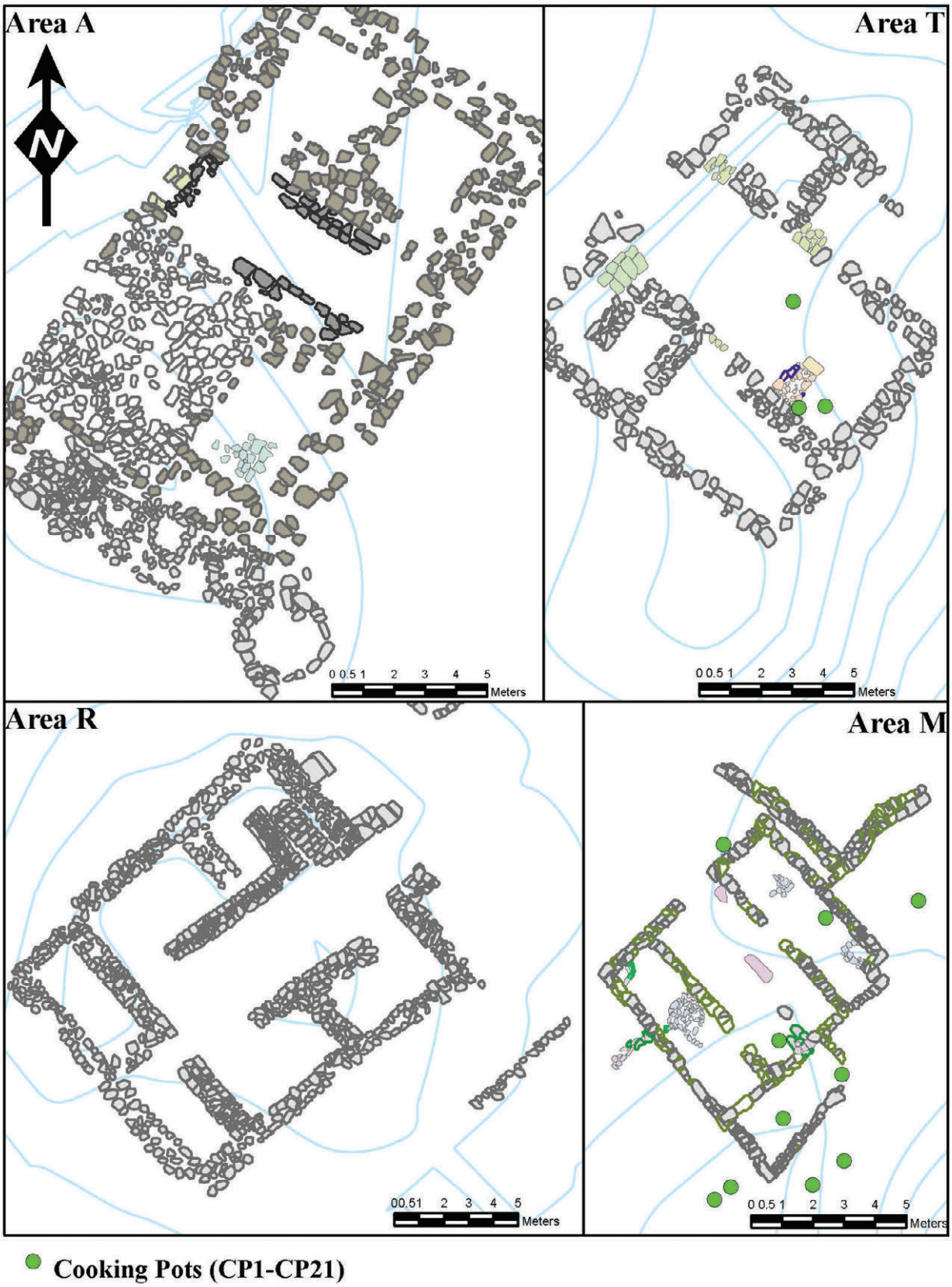

Figure 4.61 KEN 2002–2009, Study 10—distribution of cooking pots: CP1–CP21 (Strata I–III, ninth century BCE).

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Figure 4.62 KEN 2002–2009, Study 10—distribution of cooking pots: CP1–CP21 (Strata IV–V, tenth century BCE).

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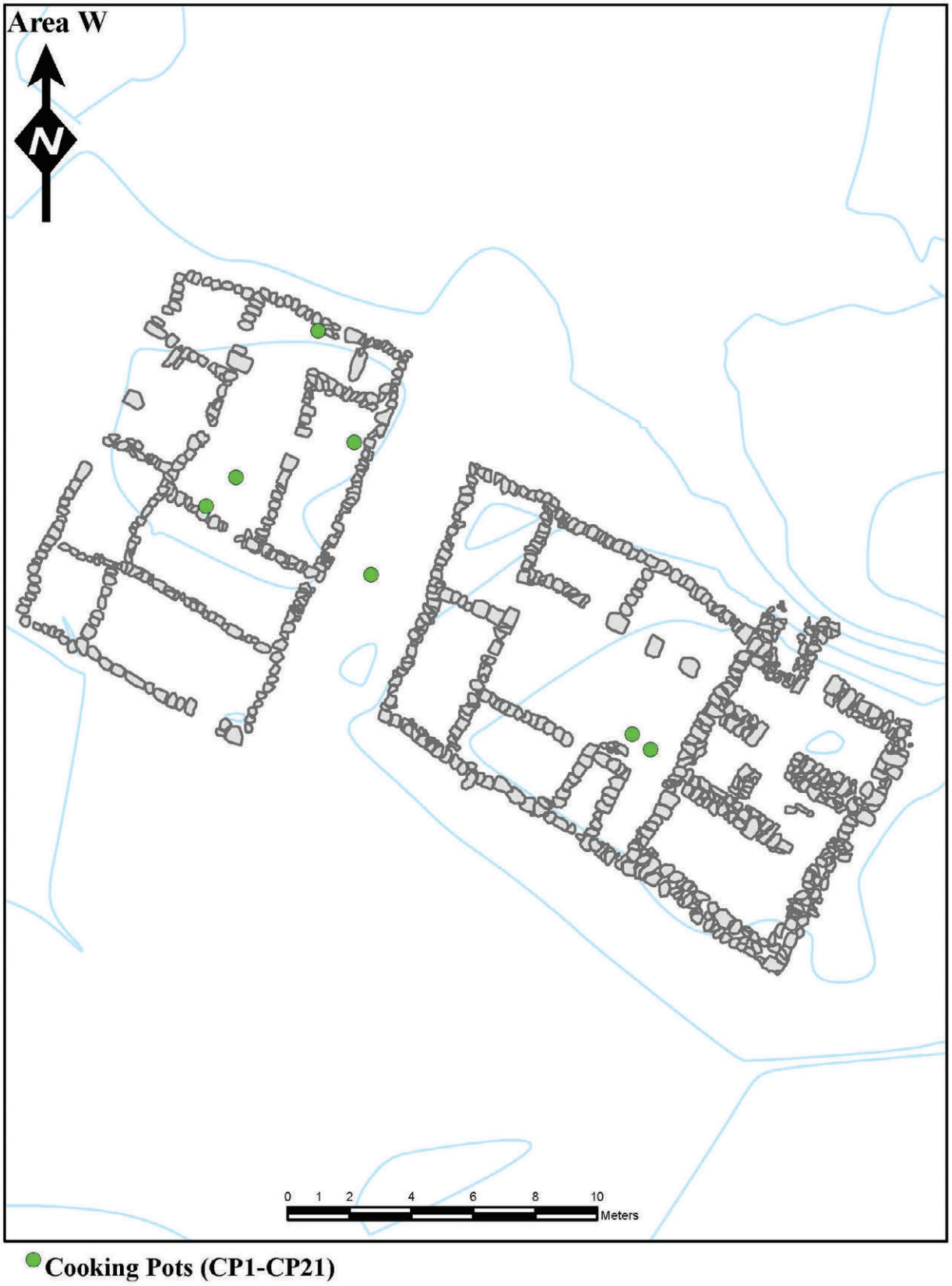

Figure 4.63 KEN 2002–2009, Study 10—distribution of cooking pots: CP1–CP21 (Area W [W1a–W2a], ninth century BCE).

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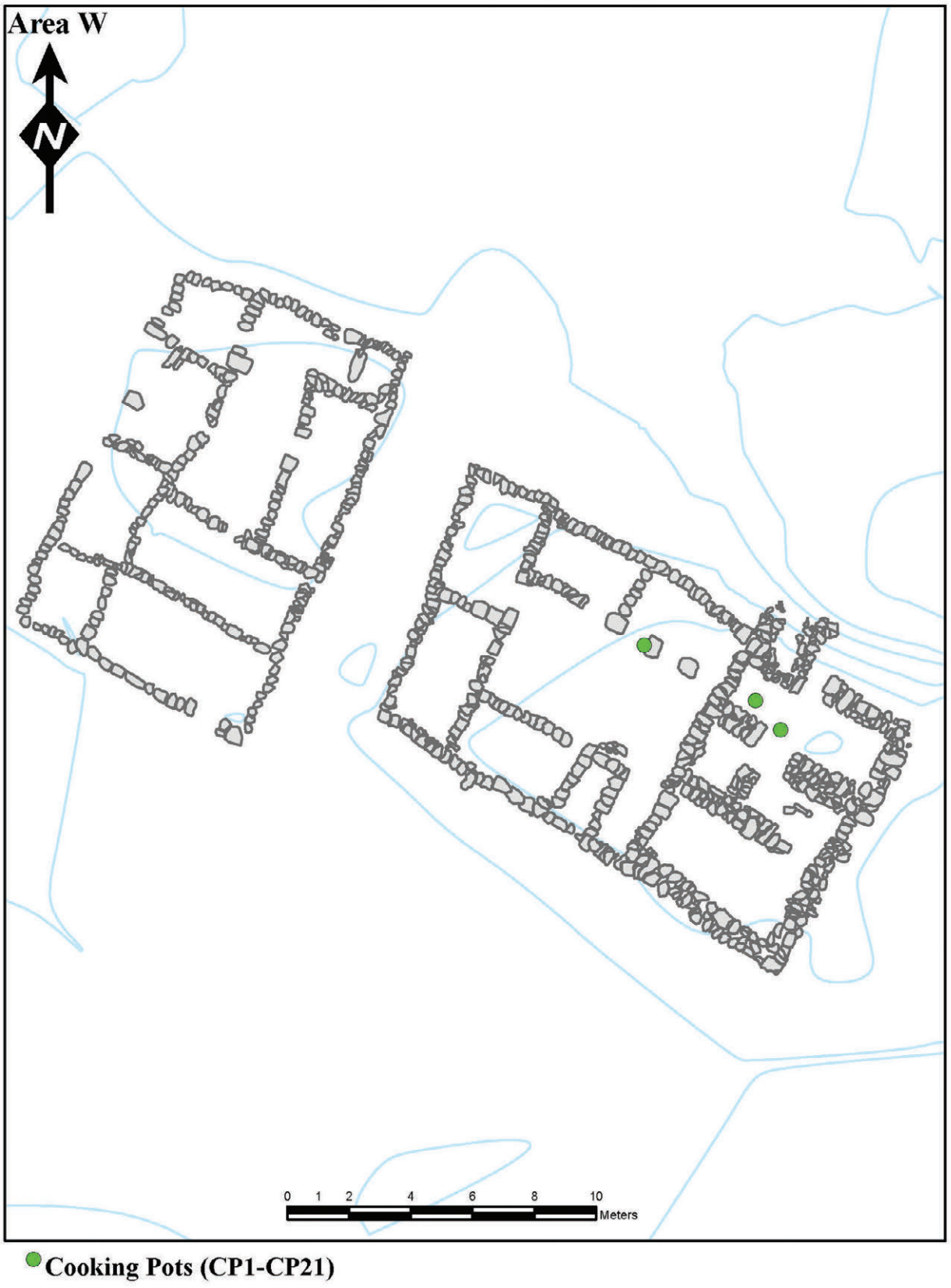

Figure 4.64 KEN 2002–2009, Study 10—distribution of cooking pots: CP1–CP21 (Area W [W2b–W3], tenth century BCE).

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Figure 4.65 KEN 2002–2009, Study 10—distribution of cooking pots: CP1–CP21 (Area S, Strata I–III, ninth century BCE).

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Figure 4.66 KEN 2002–2009, Study 3—imports and rare fabrics: BL16a, BL24a, BL24b, BL25a, BL25b, BL29a, BL29b, JT21, JT22, Qurayyah sherds (Area S, Strata I–III, ninth century BCE).

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General Observations from the Spatial Analysis

Several general observations can be made by comparing the 10 GIS spatial case studies presented here:

1. All of the general vessel families (BL, JR, KR, JG, JT, PT) were present at all areas during both periods (tenth and ninth centuries BCE) of study—the one exception being the cooking pots. This evidence suggests that, with the exception of domestic production, consumption and storage of food products and liquids occurred at all areas. Eating and drinking were not segregated from the same rooms where metallurgical production or other activities occurred.
2. The discovery that cooking pots were not present at the monumental architectural buildings supports the theory that these buildings may have housed elites and that the intent of their design was to be separated from domestic production and possibly even metallurgical production (see Chapters 2 and 13, this volume). Also, cooking pots (more specifically, the ridged rim holemouth cooking vessels) were found primarily during the ninth century BCE. The greater occurrence during this period may be related to evolutionary changes in the local inhabitants' cooking ware that may have developed from plain-rimmed open-mouth jars that were found to contain a similar fabric. In addition, BL13 show a strong correlation with the domestic/metallurgical buildings of Areas M, S, and W. If the cooking pots were used at these buildings for domestic food preparation, then BL13 would appear to have served as the main serving vessel when consumed within these buildings. BL3a, a finer and often decorated bowl, showed a higher correlation with the elite buildings but also occurred in smaller numbers at these domestic/metallurgical areas.
3. Although many vessel types are represented in small numbers at every area, Area A frequently had either different types of vessels (e.g., BL15, PT4, KR6) or larger sample sizes when comparing vessel families with the other areas (e.g., KR3, BL22, PT10). In contrast, Areas R, T, and M shared types not found at Area A (BL34) or higher quantities than Area A during the tenth century BCE (e.g., PT5 and PT6). The reason for this asymmetry is not clear.
4. In many of the studies, a significant distinction between the ninth- and tenth-century BCE ceramic distributions could not be made. Many of the forms found in small numbers in the tenth century BCE were also found in the ninth century BCE but with larger sample sizes. In cases where specific types were found to occur in only one period, it was in the later ninth century BCE. However, due to the smaller sample size of the tenth-century BCE ceramic assemblage, these types may have been underrepresented only in the earlier levels.
5. The distribution of the imported pottery provides two important inferences. First, as mentioned above, distinction between the ninth and tenth centuries BCE could not be drawn even with the imports. However, this may be expected since black-burnished juglets, Cypriot ware, and the western Negev forms are attested in both centuries in Cisjordan sites (see above). Second, the fine ware imports (black-burnished juglets and Cypriot juglets) were found inside the elite buildings, while the medium fine to course Qurayyah sherds and western Negev imports were found only outside these buildings or in the ninth-century domestic/metallurgical buildings. It was suggested from Case Study 3 that this discrepancy may reflect the social hierarchy between the elites who controlled the metallurgical production and the laborers who lived and worked for them and lived in the more domestic structures. It is important to note that other crude vessel types (e.g., BL22, BL36, BL37, KR12, and KR29) were associated only with the metallurgical areas.

Summary of Ceramic Analysis Results: Implications for Understanding Social Boundaries and Change in Iron Age II Edom

The seven ELRAP–L2HE excavations from southern Jordan used for the ceramic analysis in this study enable, for the first time, an authoritative comparison of the ceramics of Iron Age II (ca. 1200–500 BCE) Edom. The analysis has been drawn from both the lowlands and highlands of this region over time and space based on quantification of these assemblages from stratified excavations. The ceramic typology developed in this chapter classifies types based on the discovery of similar morphological and petrographic attributes. The study shows that when an intersite comparison is conducted according to the types defined here, the differences between the Early Iron Age II occupation at KEN, KAJ, and RHI Sounding A and the Late Iron Age II sites (RHI Sounding B, KAM, KIS, KIJ, TW) become readily apparent. When these ceramic assemblages are tied to published radiocarbon chronologies from the recently excavated sites and new dates presented (Chapter 2, Appendix 1, this volume), the study gives us a better chronological picture for the whole

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region of Edom concerning what is clearly early (ca. eleventh to ninth centuries BCE) and what is unmistakably late (eighth to sixth centuries BCE), as well as several insights concerning the technological styles that enable us to distinguish social boundaries within the region. Thus, the intersite morphological quantitative comparison (cf. tables in Figures 4.42–4.44)[17] presented here demonstrates significant inferences that can be drawn from these data based on the models and hypotheses presented in the previous chapters i.e., Chapters 1 and 3, this volume; see also Chapter 9 and Levy 2009a.

(1) The comparative study conducted for all the dominant vessel types found at Khirbat en-Nahas overwhelmingly shows that this ceramic assemblage has strongest parallels with those found in surveys and excavations on the plateau of Edom at sites such as Busayra, Tawilan, Umm al-Biyara, and Ghrareh (e.g., vessel types BL3, BL21, BL30, KR19, PT5, JG3, and JG4) rather than sites in Cisjordan. While the assemblage from KEN is earlier (ca. tenth to ninth centuries BCE) than the highland sites, each of the KEN vessel types has their specific later derivatives on the plateau of Edom. In addition, the painting styles and decoration found at KEN are most similar to those found at the highland sites of Edom, although not as developed (see above). This demonstrates a much longer local Iron Age potting tradition than that assumed by earlier researchers in Edom (e.g., Bienkowski 1992, 2000, 2002; Bienkowski and van der Steen 2001; Oakeshott 1978, 1983; Porter 2004; Pratico 1993).

Our study has worked under the assumption (corroborated by radiocarbon dates at all sites; see Chapters 2, 3, and 10, this volume) that KEN is significantly earlier than RHI Sounding B and all the L2HE sampled sites. This also has important implications for interpreting previous Iron Age excavations on the plateau of Edom. The ceramic analysis does not suggest that the similarity between ceramic types from KEN and the highland sites indicates that they should be redated to an earlier Iron Age II phase. Rather, our ceramic analyses demonstrate that many of the Late IA II sites had a number of technical styles of vessel shape and rim form with earlier lowland antecedents. These clearly later forms are the product of minor deviation or adaptation from earlier forms throughout the entire Iron Age II period in southern Jordan. Just as some late fifth millennium Chalcolithic vessel style types, such as the V-shape bowl, were produced over a long period with very little change (ca. +500 years; cf. Burton and Levy 2011), the fact that it happens in the Iron Age over an approximately 300-year tradition is not remarkable. This not only is a common scenario during the Chalcolithic period or the Iron II period in Edom but also has been shown at many Iron Age II sites in Israel and other regions that have well-stratified deposits and well-developed typologies (e.g., *Tel Batash*, *Lachish*, *Beersheba*, and other sites—for bibliography, see site references in ceramic descriptions below). In fact, many of the types defined here (e.g., BL3, BL13) have parallels at Tel Batash Stratum IV–II and Lachish V–II, which span the entire tenth- through seventh-century BCE sequence. This is highlighted by comparing type JG3 from KEN with Beersheba II Stratum IX (Figure 19:6) and also Beersheba I Stratum II (pl. 68:18). This form cannot be pigeonholed to only the Iron IIB–C period, as argued by Finkelstein and Singer-Avitz (2009:210), unless a more refined distinction of subtypes within JG3 is made, as done in this study. Thus, our analysis does not claim that the entire Edomite pottery assemblage lasted intact and unchanged for around 300 years. Rather, a few forms from this assemblage have "short-use horizons" (ca. 50 years) while other forms have "long-use horizons" (ca. 100–150 years) during the Iron Age II sequence (ca. 1000–500 BCE). The styles that continued over a period longer than 50 years contain only minor variants in morphology, typically not considered relevant by researchers but, in light of the research presented here, must now be considered. Moreover, the detailed morphological and petrographic subattributes defined here for these groups help to distinguish between the different phases of the Iron Age II (Iron IIA, IIB) as well as identify significant changes over time (e.g., better controlled firing techniques, new decoration techniques, or deviating minute rim treatments or body shapes). These distinctions need to be taken into consideration when comparing sites based on morphological attributes of pottery alone in order to test social models.

The ethnoarchaeological concept of technological styles proposed in this study and other chapters (Chapter 13, this volume) helps us understand this common phenomenon found across time and space. Specifically, ceramic studies that depend on morphology must recognize that the styles found within potting communities represent *chaînes opératoires* that are taught by elder potters of a community to younger generations. These technical choices are internalized

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as durable models that are highly resistant to change and are passed down from one generation to the next. When these forms are found on the Edomite plateau, it does not mean they are early but rather that the technological style continued in use with little drift (i.e., transformation) over time. What is important to consider is that specific styles that outsiders might distinguish as "Edomite" pottery reflect widespread technological styles specific to the subregion. Thus, the general tenth- to ninth-century Iron Age ceramic assemblage from KEN should be considered a local regional Transjordanian ceramic tradition, deeply rooted in time, specific to Edom that developed in parallel to the many different technological styles found in Iron Age Cisjordan. The ceramic industry at KEN reflects a strong local Iron Age tradition that begins in the lowlands of Edom and continues into the eighth and seventh centuries BCE in the lowlands and flourishes in the highland sites noted above. Assuming that local ceramic production traditions reflect in some way the communities where they are situated (van der Leeuw 1977), any attempt to model the relationship of the late second and first millennium BCE historic ethnic groups to the control of tenth- and ninth-century BCE metal production at KEN must factor in the dominance of the local Iron Age potting tradition for the people who worked at this site during these centuries.

(2) Despite a few ceramic forms that demonstrate "long-use horizons" of stylistic choice, the comparative ceramic study here strongly supports the assertion argued in Chapter 1 (this volume) that the stratified KEN ceramic assemblage dates from the tenth to the late ninth centuries BCE. Many of the forms discussed in the Iron Age Edom ceramic typology presented here are related to similar vessels from strata found at contemporary sites in the Negev and Shephelah (e.g., KEN vessel types: BL15, BL22, BL34, BL36, KR4, KR8, PT5, JG4, JG15, JT17, JT19, JT21, JT23, and JT26). It is important to note that compared to the Negev and Shephelah, many of these Transjordanian Edom types are not morphologically identical, and more important, the fabric and surface treatment is completely different.

The ability to find approximate ceramic "parallels" between the region of Edom and its southern Levantine neighbors indicates the existence of a social "interaction sphere," where structural homologies emerged between these regions as they began to share a number of common features such as architecture, ceramics, iconography, measurement systems, language, writing, religious beliefs, and political institutions. As polities of equal or unequal status interact, they must develop a lingua franca of not only language but cultural norms that facilitate the clear communication of the two groups. Michael Schiffer (2010:129) refers to the agents of technological transfer as belonging to "techno-communities"—that is, a group whose members take part in one or more activities that incorporate variants of a particular technology. We believe interactions of some kind between Iron Age potting communities may have helped drive some of the similarities observed in ceramic assemblages on both sides of the Wadi Arabah during this period.

In addition, elites who sought to interact at an equal level with neighboring peer elites helped drive the pursuit to adopt other similar traits and behaviors (see Porter 2004; Smith 2009). The evidence of various imported fine wares, especially in the large walled structures of Area R and T at KEN, may be reflective of this model. Most important, the rough similarity in ceramic types that enables comparative studies with contemporary regions is ultimately a product of these interaction spheres with nonelite members of these societies. Thus, at present, there is no visible evidence in the ceramic record that would suggest that KEN was subordinate to a larger polity residing outside Transjordan or immediately bordering the traditional region known as Edom (Avishur 2007). How this relates to other realms of material culture from the new excavations described here remains to be determined. As argued in Chapter 1 (this volume), Khirbat en-Nahas was one of the largest sites during this time period in the southern regions of Edom and the Negev. It can be suggested that metallurgical activity at KEN was organized and run by an indigenous leadership at certain phases of the Iron II period—such as the ninth century BCE. Control during the problematic tenth century BCE remains a research question still open to investigation.

(3) Despite the high degree of interaction between KEN and its neighboring polities, the ceramic assemblage also contains a number of Early Iron Age II vessel types that are unique to the lowlands of Edom. These vessels are found in large numbers at KEN and do not have parallels outside the region (e.g., KEN vessel types: BL31, BL33, BL37, KR3, KR5, KR6, KR12, KR13, PT4, JR7, JR14, JG16). Similarly, the

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surface treatment is specific to KEN at this period (see above). This is an indicator of both KEN's local production but also its earlier date compared to sites such as RHI Sounding B, the L2HE sites, Busayra, Umm al-Biyara, and Tel el-Kheleifeh. Whether these unique forms are specific to the industrial nature at KEN or the time period is as yet undetermined, since the only other excavated Early IA II sites (KAJ and RHI Sounding B) yielded only small amounts of diagnostic ceramic sherds.

(4) This chronological inference is corroborated by the complete absence of the many dominant Late Iron Age II ceramic types identified at the highland sites and RHI Sounding B. These types have a short life ceramic horizon and date to the late eighth to the sixth centuries BCE, and they are found at all the late sites but completely absent at KEN, KAJ, and RHI Sounding A (e.g., bowls: BL2, BL4, BL5, BL12c, BL20, BL21b, BL30, BL39–BL45, BL51; kraters: KR15–KR17; and pithoi: PT18–PT24; see also *Busayra*, *Tawilan*, and *Tell el-Kheleifeh*).

The complete absence of later vessel types at most lowland sites is most clearly seen at RHI, where the early and late period occupations are found within close proximity. RHI serves as a litmus test for comparing these two phases of the Iron Age II. RHI Sounding A's ceramic assemblage is similar to KEN and lacks all of the ceramic types discussed above that predominate in the later Iron Age phases. On the other hand, RHI Sounding B's ceramic assemblage strongly parallels the plateau sites, has been dated with high-precision radiocarbon dates (Levy et al. 2008), and has large quantities of Late Iron Age II vessel types. These are not just fine wares but also include kraters, jugs, and pithoi. If there were intrusive later seventh- to sixth-century BCE period material at the areas excavated, it would be expected that the abundant quantities of large pithoi and kraters found at KEN would at least contain one of these later forms, but they do not. Thus, the absence of these types at KEN should not be considered due to its industrial nature of the site but rather due to the chronological factors demonstrated by the site's well-defined stratigraphic record. To date, no radiocarbon dates place KEN later than the ninth century BCE, and not a single typical late vessel type has been discovered at the site. This is not to preclude the possibility that in other areas at the >10-ha site, there was later occupation; however, seven large excavation areas have been opened at the site, and this should put to rest any doubt that there was a mixing of later periods within the ceramic assemblages discussed in this study.

(5) These chronological distinctions (Chapters 1 and 2, this volume) are further corroborated by the study of Iron Age handmade wares made above. The percentage of handmade wares to wheel-made wares is significantly higher in the Early Iron Age lowland ceramic assemblage than in collections from the plateau of Edom and RHI Sounding B. When considering the distribution of handmade wares in both the highlands and lowlands of Edom, there is a significantly higher percentage of these wares (50 percent compared with less than 2 percent) produced in the earlier than in the later periods.

(6) The presence of numerous Early Iron Age II imports such as Qurayyah painted ware (sometimes referred to as Midianite ware), Cypro-Phoenician juglets, amphora, and western Negev bowls provides a *terminus post quem* that coincides with the dating of the local Iron Age ceramic assemblage discussed above, the high-precision radiocarbon dates, and the 1200–1000 BCE New Kingdom–Third Intermediate period Egyptian scarabs found at Iron Age ELRAP sites in lowland Edom (Chapter 11, this volume). Thus, the radiocarbon dated stratified sequence at KEN, KAJ, and the two soundings at RHI helps to identify the developmental trend of the ceramic seriation for the lowlands of Edom from the eleventh to sixth centuries BCE.

(7) The so-called Busayra painted bowls (BL20, BL21, B12c) were found in this study to be locally produced in both the highland L2HE region and lowland RHI Sounding B, rather than imported from Busayra. This has important implications concerning Iron Age trade and social boundary models when ceramic style is used as a key variable for such determinations. This was validated by the presence of B4 ware found at RHI belonging to these bowl types (see Chapter 3, this volume). However, it was also discovered in the petrographic analysis that a second type of more finely sorted ware (B6) occurred among BL20 and BL12c vessels. These bowls are the thinnest and most heavily decorated of all the examples. They also commonly have burnish that does not occur on any of the standard Ware B1 bowls. They are found at both RHI Sounding B (see especially Figures 4.28–4.31) and the plateau sites (Figures 4.32, 4.33, 4.34, 4.35) but represent a small minority in comparison to the Ware B1

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bowls. Overall, they are very standardized, reflecting a high degree of craft specialization. This evidence suggests that these vessels were a mass-produced form; however, this conclusion must be held tentatively since they need to be compared to other regions of Edom.

(8) In the quantitative morphology study (see tables in Figures 4.42–4.44), it was also noted that of the plateau sites, KIS had finer ware bowls than did the other sites. The high preservation of ceramic vessels at KIS may be reflected in this circumstance, but considering that other types common at other sites are rare at KIS, there may be another mechanism behind this (e.g., potters living within each community who specialized in only a few forms). Similarly, KAM has a significantly larger count of BL21 bowls than witnessed at all the other sites. These have a brighter light red (orange) color compared to the other sites.

(9) The ware analysis and morphological analysis has enabled a distinction to be made between the ceramic assemblage found at the lowland site of RHI Sounding B and the various highland sites excavated by the L2HE project. For instance, a number of vessel types are specific to RHI (e.g., BL43; KR16; CP25, CP31, CP32, CP34, PT17); types that are predominant at RHI but rare at L2HE (e.g., BL21b, BL30a3); Ware B4 (see Chapter 3, this volume), which predominates at RHI but is absent at the plateau sites; and slag-rich temper in pithoi found only at RHI. On the other hand, vessel types dominant at the L2HE sites but absent at RHI include BL51, BL53, KR15b/c, PT19, and PT20–PT25. One notable example is PT20; the double-grooved rim creating three ridges is ubiquitous on the plateau and found among numerous published parallels around the vicinity of Petra, but it does not occur at RHI.

These observations support Bienkowski and van der Steen's (2001:26) suggestion that a number of ceramic forms are circumscribed within separate regions in Edom. The study here shows that this is seen not just morphologically but also in surface treatment and ware type found in different parts of Edom. In contrast to RHI, the L2HE sites are very similar across the board in their ceramic technological styles. This similarity has enabled this study to refer to them as a group when comparing them to other areas. These settlements are situated along the edge of the highland plateau of Edom and were most likely a close-knit community that may have intermarried and resided within the different settlements over their lifetime.

This evidence should also be interpreted according to the models developed in the first three chapters of this study. RHI was not isolated from the highland sites, and thus it can be assumed that intense interaction occurred between them. The circumscription of the morphological and fabric styles here should be related to specific mimetic models that differed between these two subregions of the highland and lowland. As hypothesized in Chapter 3 (this volume), if technological styles associated with motor habits (i.e., morphology and fabric) are found circumscribed within an area, it connotes that a social boundary existed. This is because a complex technological style related to motor habits can be passed only from teacher or community to an apprentice potter through repeated observation and correction throughout one's life. Technological styles in the case of RHI or the L2HE sites are not circumscribed by geographical boundaries but rather to the extent that groups intermarry and exchange marriage partners. A marked social boundary can be inferred between the lowland inhabitants of the Faynan region and the neighboring eastern sites in the highlands of Edom. Currently, this inference must remain tentative until more archaeological data can be recovered from these two little explored subregions of Edom. The models presented in this study point the way forward for enriching our understanding of social boundaries throughout the Iron Age II sequence and how these may be related to community, tribal, or ethnic identities.

In summary, the ceramic analysis presented here has highlighted the importance of the lowlands of Edom in the early development of Iron Age complex societies in this part of the southern Levant. Earlier assumptions concerning the very short length of the Iron Age (Iron Age IIC) based on excavations at sites in the highlands of Edom and the Negev have incorrectly influenced both the historical and anthropological reconstructions of social change in this area. Now that a detailed view of the ceramic data from the stratified excavations at KEN and six soundings at other sites in the lowland and highland zones has been conducted, a more comprehensive picture can be extrapolated: (1) Edom had a rich occupation spanning the late thirteenth to sixth centuries BCE. During the earlier period, metallurgical production within the Faynan district was at its peak (tenth to ninth centuries BCE). Interaction between the lowlands and neighbors to the west and north was vibrant. KEN was not just exporting raw resources but also imported prestige goods for elites residing at this copper production center, evidenced by fine-ware ceramics as witnessed by the

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numerous imports. (2) During the later Iron Age phase, more sites appeared in highlands than in the lowlands. All the late settlements excavated for this study were small villages, which, in contrast to KEN, lacked any evidence of imported ceramics. These small villages interacted on a regional level but defined their social boundaries sub-regionally. These social boundaries may be related to local tribal identity, but this inference must be teased out through more nuanced excavations and studies of various other material cultures in the future.

Abbreviations

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Notes

1 This typology expands on a preliminary publication of the 2002 excavations at Khirbat en-Nahas (Smith and Levy 2008).

2 Two inexpensive 3D scanners were tested on the ceramics before the decision was made to purchase the NextEngine scanner. We found the NextEngine scanner to fit within the budget of any archaeological project and provide the quality and streamlined processing needed to conduct large 3D scanning projects. The NextEngine HD scanner was used for scanning all the 3D derived sherds in this study.

3 Unfortunately, at the time of the plate publications, digital illustration of painted bands and burnish was not illustrated.

4 Levy served as co–principal investigator on the NSF IGERT TEECH grant when this project was carried out.

5 For further definition and justification of this term, see Adams and Adams (1991:169), Clarke (1968:139), Gifford (1976:9), and Rice (1987:275).

6 See the discussion in Chapter 3 (this volume) on these concepts. This definition has been similarly defined by Chilton (1999:47–48). See also Dobres (1999) for a discussion of the importance of *chaînes opératoires* for investigating ancient technologies.

7 The exception, of course, are the few cases where there is highly controlled firing and selection of pastes to create a uniform color, but these are often also associated with specific morphological types (see below: JT21, KR8, etc.).

8 For certain unique vessel types, northern Israel and Phoenicia are included in the discussion of parallels.

9 The one exception is KIS, which had a high level of preservation with nearly completely reconstructible vessels. Unfortunately, most of these vessels could not be restored before the completion of this dissertation. In the future, it is planned to return to this site for a full-scale excavation with one of the goals to recover a large collection of restorable vessel forms with pertinent information on their spatial in situ locations at the site.

10 Only through petrographic analysis was it possible to identify the shales common to the Edomite region in BL22b.

11 Few handmade wares were found at RHI Sounding B and only on the surface.

12 The petrography of the 2006 sherds was analyzed by Y. Goren and N. Smith at UCSD and Tel Aviv University. The 2002 sherds were analyzed by A. Hauptmann and R. Adams at the Deutsches Bergbau-Museum in Bochum. As the 2002 work is incomplete and the sherds are currently stored in Canada, the Qurayyah ware could not be commented on in greater detail here. In the figures, the 2002 Qurayyah ware was not assigned a ware group since it was not studied by Smith (2009).

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13 The latter may not originate from Qurayyah and be local since the fabric is different, but the petrographic analysis has not been completed as of yet (see note 5).

14 A date of the eighth to seventh century BCE for Qurayyah ware has been suggested according to one fragment found at Tawilan (Bienkowski 2000; Rothenberg and Glass 1983:84; van der Steen and Bienkowski 2006:15). Unfortunately, this sherd was never published to determine whether it was truly Qurayyah ware, and its original context at Tawilan cannot be confirmed. The high frequency of Qurayyah ware at many sites dating much earlier would suggest assigning the eighth to seventh century BCE based on one sherd from an unknown context, and lack of modern investigation is premature.

15 A study of Qurayyah ware in Singer-Avitz (1999) suggests that not all Qurayyah ware originates from the Arabian Peninsula (see Chapter 3, this volume) but actually was local, from Edom. This is another indicator that the typology and chronology of this pottery are not as refined as some scholars may suggest.

16 The very small amount of diagnostic sherds recovered from Area F makes any intrasite analysis of the area difficult. Therefore, this area was left out of the final spatial study presented in this chapter.

17 Tables in Figures 4.42 to 4.44 represent all vessels that occur more than 10 times.

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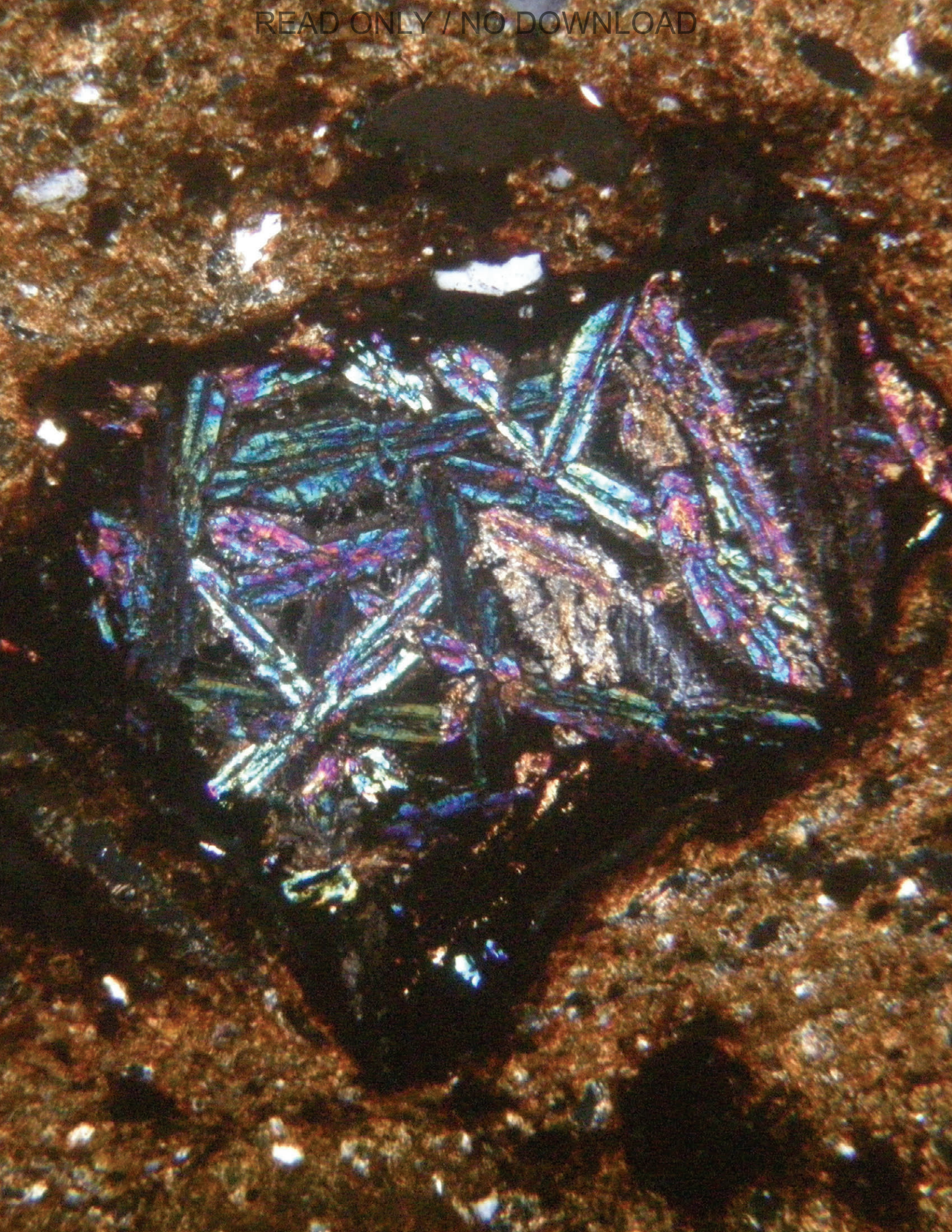

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5 The Petrography of Iron Age Edom
From the Lowlands to the Highlands

Neil G. Smith, Yuval Goren, and Thomas E. Levy

The identification of social interaction is one of the primary reasons archaeologists embark on the petrographic examination of ceramic and stone artifacts. For archaeology, petrography is a laboratory method that aims at identifying the mineralogical and microstructural composition of artifacts. It is based on the use of a polarizing light microscope to recognize minerals and their structural arrangement to carry out provenance and technological studies of artifacts. Because each geographic region has its own unique lithography, it is often possible to identify where artifacts that have undergone pyrotechnological change have their origin. Pottery is one of the most ubiquitous artifacts found on ancient Near Eastern sites, and as the preparation of petrographic thin sections is relatively inexpensive, the petrographic analyses of ceramics have proven to be a low-cost and expedient way of making general assessments concerning the production locales for ceramics and the role in trade and exchange. There have been very few petrographic studies of Iron Age ceramics from stratified sites in the Transjordanian region of Edom. The results presented here for the first time contribute to understanding cultural evolution and socioeconomic exchange during this approximately 500-year period.

The results of optical mineralogy (petrographic) and ware analysis are presented for three lowland and four highland sites in Edom recovered from the University of California, San Diego (UCSD) Edom Lowlands Regional Archaeology Project (ELRAP) and Lowland to Highlands of Edom Project (L2HE). This broad sampling strategy enables a fine-grained study of the various ceramic assemblages recovered from multiple stratified excavations across the lowlands and highlands of southern Edom. These data show that ceramics were produced across different subregions of Edom. The petrographic makeup of the ceramics also shows a diachronic distinction between the earlier pottery assemblages and later. In the case of the later period (Iron Age IIC) where five sites were compared, it is argued that it is possible to distinguish different technological styles for the two subregions—the highlands and lowlands of Edom. The circumscription of these technological styles suggests that a social boundary existed even though intense interaction may have occurred between these communities.

Opposite: Color thin section of an Iron Age pottery vessel containing slag inclusion with center glass slag inclusion. From a large pithos at Khirbat en-Nahas Area S.

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Introduction

To help establish the analytical framework for the Iron Age ceramics retrieved in the excavations and surveys conducted by ELRAP and L2HE in southern Jordan, a petrographic study was conducted to further refine various inferences made concerning their typology, origin, and production. The petrographic analysis conducted here allows an independent verification of the provenience of all the significant vessel types, setting the stage for the detailed analysis of the Iron Age pottery assemblages discussed in Chapter 4, this volume. The petrographic analysis presented here is important for a number of reasons. First, locally produced ceramic forms from Transjordanian Edom can be distinguished from imports transported from neighboring areas or from further distances throughout the southern Levant and eastern Mediterranean. This is of great value for identifying patterns of trade and exchange. Second, this study enables the provenience, composition, and morphology of the vessels to be correlated in a multivariate typological analysis, serving as a refinement of the more subjective grouping of ceramic sherds into specific wares and morphological types at the various sites studied (see Chapter 4, this volume). Third, technical choices related to clay and temper selection and firing can be identified for the various ceramic assemblages. By identifying these various technical choices, the study provides an analytical method for examining the "technological styles" of these ancient potters that can help determine their relationship to specific pottery-producing communities (cf. Childs 1991; Deal 2007; Dietler and Herbich 1994, 1998; Goselain 1998; Lecthman 1977; Stark 1998; Stark et al. 1998; van der Leeuw 1993). The present study examines by means of optical mineralogy (OM, commonly dubbed *petrography*) the ceramic assemblages from the Early Iron Age II sequence from Khirbat en-Nahas, Khirbat al-Jariya, and the Rujm Hamra Ifdan Sounding A and the later Iron Age IIC period sites—Khirbat al-Malayqtah, Khirbat al-Kur, Khirbat al-Iraq, Tawilan, and Rujm Hamra Ifdan Sounding B. Consequently, the technological implications of the results can be used as a tool to identify possible patterns of diachronic change that occurred in ceramic production over these periods. This will aid in the chronological inferences already made based on morphological form, site stratigraphy, and radiocarbon dating conducted at all these sites.

Past Petrographic and INAA Ceramic Studies of Iron Age Edom

A number of ceramic provenience studies using petrography and instrumental neutron activation analyses (INAA) have been conducted with regard to the region of Edom. As is alluded to in Chapter 4 (this volume), the presence of "Edomite" and other assumed foreign ceramic styles in the Negev sites has sparked a number of such studies to determine the provenience of these vessels.

The first such study, including several unrelated pottery assemblages from Israel, was carried out by Slatkine (1974), who studied petrographically the pottery of Tel Dan, Tel 'Erani, Metzer, and Timna. In the latter site, three pottery wares were identified (in terms defined by Slatkine): type "Timna" (namely the "Negbite" pottery), type "Midian" (the Midianite pottery), and type "Normal" (common Judahite wares). In a later publication, Slatkine (1978) discussed in more detail the technology of these three pottery wares from Timna, alongside the description of pottery from Sinai and some comparative material from Nelson Glueck's survey in Edom, from Teleilat Ghassul, and from Egypt. Slatkine's observations, although being highly descriptive, failed in most cases to define the possible provenience of the three "types" of pottery from Timna. Although some of his petrographic observations were misleading (for example, he misidentified the variegated shale fragments of the Midianite pottery as fragments of crushed brick), his detailed descriptions present enough data for reinterpretation today in light of the results of recent studies.

Another petrographic study of the Midianite pottery was carried out by Glass (Rothenberg and Glass 1981, 1983), who examined samples from sites in the northern and southern Negev (especially Timna), southern Jordan (including Tawilan), and Saudi Arabia (Qurayyah). Glass's report is an outstanding example of a prominent presentation of the data and a logical discussion that leads to firm conclusions. On the basis of its mineralogy, Glass identified the fabric of the Midianite pottery as originating from the shale member of the Paleozoic sandstone sequence. The uniformity of the pottery from all sites led him to the conclusion that it was all produced in one production center. Through a process of elimination, he concluded that the only possible origin of the Midianite pottery could have been in the site of Qurayyah. This conclusion has been reinforced more recently by Gunneweg et al. (1991) on the basis of INAA studies, where Glass's conclusions were neither mentioned nor cited in the references.

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From the mid-1980s, three studies, concerned with Iron Age pottery from the Negev and Sinai, were conducted using INAA (Gunneweg and Balla 2002; Gunneweg and Mommsen 1990, 1995; Gunneweg et al. 1991). In a comparative INAA study of Edomite, Negbite, and Midianite pottery, Gunneweg et al. (1991) found that Late Iron Age II Edomite painted bowls and other vessel forms were produced locally in the northeastern Negev. Edomite sherds were sampled from the Negev at the sites Horvat Qitmit, Horvat Rogem, Qadesh Barnea, and Givat Parsa. Three cooking pots from Tel el-Ghrareh and a jug from Busayra were used for control. Out of a sample of 40 Edomite sherds, only one example from Givat Parsa was found to be local to the Petra region. These results corroborate an earlier study by the same research team (Gunneweg and Mommsen 1990:10) that showed that the pottery found in Petra was local, and a comparison of pottery from Um al-Biyara and Tawilan and wasters from Nabatean Petra was found to be highly similar at <1 χ^2 correlation.

Although the sample size was small, these data suggest that the Edomite-style pottery found at the Late Iron Age II Negev sites may either have been produced locally by Edomite potters (Gunneweg and Mommsen 1990, 1995) or imitated by local inhabitants (cf. Singer-Avitz 1999:34; Whiting 2007). L. Singer-Avitz's (1999) petrographic provenience study (made by Y. Goren) found a similar pattern as Gunneweg and Mommsen (1990, 1995) for Edomite-style cooking pots being imported to the Negev sites. These results further corroborate the assertion that Edomites were exporting their wares (most clearly cooking pots) to the Negev. The extent to which these potters interacted with the Negev inhabitants is still underdetermined. Most likely at every site, the level of interaction varied from the exchange at trade centers, the presence of trade-diaspora at a site (e.g., Aroer), or even a predominant Edomite population inhabiting a Negev site (e.g., Horvat Qitmit).

It is important to note that Singer-Avitz (1999) found that Tel Beersheva, which had a small amount of Edomite sherds, not only had locally produced forms but also had many from the Shephelah region to the north of the Negev (see discussion of BL21 below, where it is argued the northern forms should be considered imitation or local innovations). Tel Beersheva's function as a possible gateway town suggests this small quantity of atypical sherds reflect imports, possibly even from neighboring Negev sites that had a larger contingent of Edomites living at some capacity within them.

In a later study focusing specifically on Edom, Gunneweg and Balla (2002) conducted an INAA provenience study on 18 samples of pottery from Busayra and 12 samples from Umm al-Biyara. Although the samples taken from Umm al-Biyara have not been published, the authors mention in their report that they were a different composition from Busayra (Gunneweg and Balla 2002:484). Of the 12 samples, the painted Edomite bowls were found to be local to Busayra on the high plateau of Edom. Several other samples (n = 5) reflecting different types (e.g., one jar, three bowls, and one krater) were found to originate in the Petra region. What is important about this study for the analyses presented here is that it shows that the ceramics from the Petra region can be distinguished from the Busayra region using INAA even though petrographically, they all belong to the Lower Cretaceous shale clay composition.

All of these studies have relied on only small samples of sherds from the plateau sites of the Late Iron Age II and the Negev. While the final publications of Iron Age sites on the Transjordanian plateau are admirable, petrographic analyses of the ceramic assemblages did not play an important role in helping to solve problems concerning the evolution of Iron Age ceramic traditions or exchange patterns during this period. In this chapter, the results of our petrographic study of Iron Age ceramics from both the lowlands and highlands of Edom and sites from both the Late Iron Age and Early Iron Age II are presented. These new data present a new perspective on the provenience of Edomite pottery and its implications for understanding the social interaction spheres during the Iron Age II in the southern Levant.

Method

Sampling Methods

Out of 5296 registered indicative sherds representing all six lowland and highland sites in the study, 306 thin sections were made. The approach to sampling the ceramic assemblages taken here was to focus on the most dominant vessel types and any other sherds that appeared to be of foreign import. This would allow us to determine the variability within the most common vessel forms to determine if they showed a high degree of variability in their fabrics or

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more standardization. To sample the most dominant vessel types, a quantitative study was conducted, and each vessel type was ranked according to abundance for each site. Each dominant type was allotted a minimum of two thin sections. If a type was found at several sites, at least one thin section was taken from each site so that the fabric of the type could be compared across all the representative sites. The most abundant types (e.g., BL21, BL30, or BL3—see Chapter 4, this volume) were sampled extensively. Once general numbers were determined for all the dominant types, a preliminary grouping within each type of fabric was conducted to aid in selecting a variety of examples from each type. If there were no major distinguishing fabric differences within a type, one to two samples were selected; vice versa, if there were a higher variety of fabrics within a type, more than two samples were taken. In this way, an informed sampling of the significant types and fabrics from each site could be carried out (see Table 5.10a–c for a distribution of types thin sectioned). The samples were used to produce standard (30 mm thick) thin sections in the R. A. Petrographic Laboratory at UCLA. The following sites were sampled for the petrographic study: Khirbat en-Nahas (KEN), Khirbat al-Jariya (KAJ), Rujm Hamrat Ifdan (RHI), Khirbat al-Malayqtah (KAM), Khirbat al-Kur (KIJ), Khirbat al-Iraq Shmaliya (KIS), and Tawilan (TW) (see Table 5.11 for samples collected from each site).

Petrographic Analysis

The petrographic analysis was conducted at the Laboratory for Comparative Microarchaeology (LCM) at Tel Aviv University (TAU) by N. G. Smith and Y. Goren using standard petrographic techniques and a Zeiss Axiolab-POL polarizing microscope. The samples were divided into petrographic groups according to typical petrographic attributes and correlated with specific geological environments as carried out in previous studies (cf. Goren 1991, 1995; Goren et al. 2004; Porat 1989). Geological mapping was used to locate the closest geological environment representative of each thin section's composition (cf. Goren et al. 2004:21). The thin sections were then compared to the large database of thin sections stored at the LCM-TAU that had many representative samples taken from sherds in Cisjordan and Transjordan. Publications related to similar geological environments were consulted for comparison.

After the geological locale was determined for each thin section, they were correlated with information on vessel typology, site, and period. These data enable a refinement of the ceramic typology (presented in Chapter 4, this volume), determination of what types may have been imports, and association of ware groups identified within and across vessel types.

Ware Analysis

After the petrographic analysis was completed, a more comprehensive ware analysis was performed on the ceramic assemblages stored at UCSD. The insights from the petrographic study enabled a more refined delineation of the wares identified at the site. This knowledge of petrographic provenience especially helped in understanding the extent of variability in color that was possible within the ceramic fabrics. The sherds not thin sectioned from each vessel type were compared with those thin sectioned of that type according to their visible properties of color, inclusions, hardness, and firing. In a number of circumstances, the petrographic analysis clarified the classification of several specific vessel types that had originally been differentiated only by morphology and surface treatment. For KEN especially, the comparison of fabric, thin-section data, and vessel type enabled a distinction to be made between on-site vessel types, those originating outside of the site, or represented as a separate subgrouping of pottery manufacture.

One of the goals of the ware analysis was to provide a more representative description of the fabric of the illustrated sherds that can be used for future research. This study agrees with the observations made by Mazar et al. (2001:15) that individual Munsell color definitions for each illustrated sherd can be very misleading since color is highly affected by firing and other aspects of pottery production and use, as well as by post-depositional processes such as surface enrichment or loss of carbonates or salt. Similarly, descriptions of fabric inclusions often are not detailed enough or too superficial and sporadic to necessarily help in making valid comparisons of fabric across site publications. As will be discussed below, a number of these ware groups derive from an identical geological context (at the level of precision of petrographic analysis) but, according to other factors such as firing methods and inclusion sorting, have produced objectively observable clusters of wares with specific types or regions. Thus, by analyzing sherds according to their observed ware groups, a more

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quantitative comparison of the vessel types can be achieved, and future petrographic and INAA studies can further refine these distinctions and draw correlations with studies conducted at other sites or in other regions.

The naming of the ware groups has been divided between those coming from KEN and RHI Sounding A (Ware Groups A) and the sites from L2HE and RHI Sounding B (Ware Groups B). As will be elaborated below, the ware found at the earlier sites of Group A, found to originate from a similar provenience, had distinctively different firing, resultant colors, and secondary inclusions than the later Group B ware. These characteristics suggest that to lump these wares together would be misleading and mask several significant distinctions between the wares. Where characteristics in specific wares are found to be similar, this is noted below. A ware group is also assigned to each imported fabric, since a number of imported sherds not thin sectioned are identical to this representative sample.

Within several ware groups, subtypes have also been defined according to their quality (i.e., fine ware—coarse ware). Two attributes are used in coordination to differentiate quality: (1) roughness: how smooth or coarse a vessel is, including aspects of surface treatment (e.g., burnishing and slip), and (2) sorting: visibility of inclusions, porosity, fibrosity, and evidence of organic material. Two other attributes that may play a role in determining quality but can occur across these are (3) fire control: hardness of vessel and consistency of fabric color and (4) precision of production: uniformity, thinness/delicacy of vessel walls, and method of construction (i.e., fast wheel, coil made). From these four variables, determinations of quality can generally be differentiated. Emphasis is placed on describing these attributes for each individual ware, but quality is described according to four descriptors:

1. Fine ware: smooth or soapy feel, no visibility of inclusions by naked eye, very well sorted, generally hard, thin, and delicate
2. Medium-fine ware: smooth, medium-size sand particles, well sorted, hard, can be thin or thick
3. Medium-coarse ware: coarse feel—inclusions and cavities can be felt, sand particles (quartz, shales, calcite, basalt, slag) clearly visible on surface, other attributes may be similar to other qualities
4. Coarse ware: rough, jagged feel, large inclusions (>2 mm) protruding out of the vessel, very poorly sorted, may also be poorly fired or overfired, is generally thick walled, and fashioned by hand

As analyzed in Chapter 4 (this volume), ware can cross several types and encompass different levels of quality often according to the specific type of vessel being created (e.g., small carinated bowl or large pithos).

Petrographic Groups

Petrographic Group 1: Lower Cretaceous Shales (Figures 5.1–5.5)

Matrix

This matrix is silty (ca. 10 percent), dark red to dark reddish gray in cross-polarized light (XPL), often nearly opaque, yellowish tan in plane polarized light (PPL), and optically active. The silt predominately consists of subangular to subrounded quartz grains. Ferruginous opaque bodies and rhombs of iron oxide are commonly identified.

Inclusions

A coarse mixture of subrounded to subangular mono- and poly-crystalline quartz sand and shale-rich minerals are the predominate inclusions. The shales vary significantly in color and roundedness. Ferruginous limestone is also regularly present. Appearing as rare accessories are plagioclase and orthoclase feldspars, arkose, chert, sandstone, calcite, and gypsum. Quartz-rich grog is rare but does occur in some examples. Besides these primary inclusions, slag and basalt were found in a number of thin sections and have been distinguished into their own ware types. Slag inclusions were either purposely added or belonged to a contaminated on-site clay source. They were found only at KEN, KAJ, RHI Sounding A, and among only a specific type of pithos at RHI Sounding B.

Geological Interpretation

Lower Cretaceous shales (LCS) occur in the southern Levant on the slopes of Mt. Hermon, the Upper Galilee, the Negev craters, and the southern part of Transjordan from Wadi Zarqa and southward. There are also smaller outcrops in eastern Samaria, Wadi Malih, and Wadi Farah (Glass et al. 1983:276). Extensive outcrops appear in the Lebanon and Anti-Lebanon mountains. Specifically, in southern Jordan, these outcrops are circumscribed on the eastern side of the Wadi Arabah rift fault line; the western Arabah and Negev are predominately covered with loess soils (see Petrographic Group 5, where loess soils are described in detail). These data suggest that the origin

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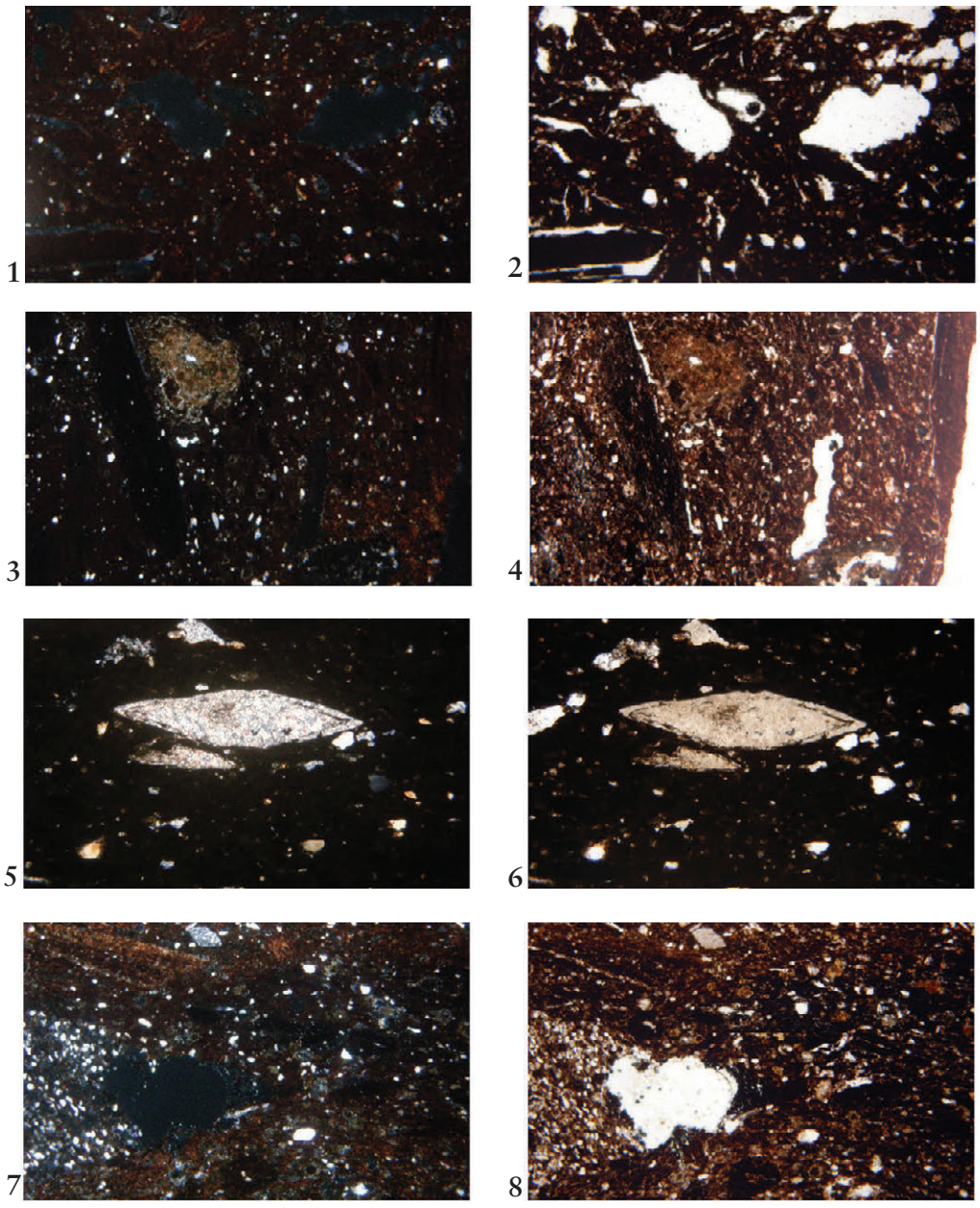

Figure 5.1
Petrographic Groups XPL/PPL (Ware A1).

Table 5.1 Petrographic Groups XPL/PPL (Ware A1) (Figure 5.1).

#	Reg#	Locus	Basket	Str.	Vessel	Type	PG	Ware	PL	Description
1	346	40	1234	A3	Jar	JR11	PG1	A1	XPL	Lower Cretaceous Shales
2	346	40	1234	A3	Jar	JR11	PG1	A1	PPL	Lower Cretaceous Shales
3	54	630	9266	M2a	Jug	JG6d	PG1	A1	XPL	Lower Cretaceous Shales
4	54	630	9266	M2a	Jug	JG6d	PG1	A1	PPL	Lower Cretaceous Shales
5	111	518	139		Bowl	BL3a1	PG1	A1	XPL	Lower Cretaceous Shales with Gypsum
6	111	518	139		Bowl	BL3a1	PG1	A1	PPL	Lower Cretaceous Shales with Gypsum
7	258	25	1315	A2a	Bowl	BL30	PG1	A1	XPL	Lower Cretaceous Shales with Lots of calcite
8	258	25	1315	A2a	Bowl	BL30	PG1	A1	PPL	Lower Cretaceous Shales with Lots of calcite

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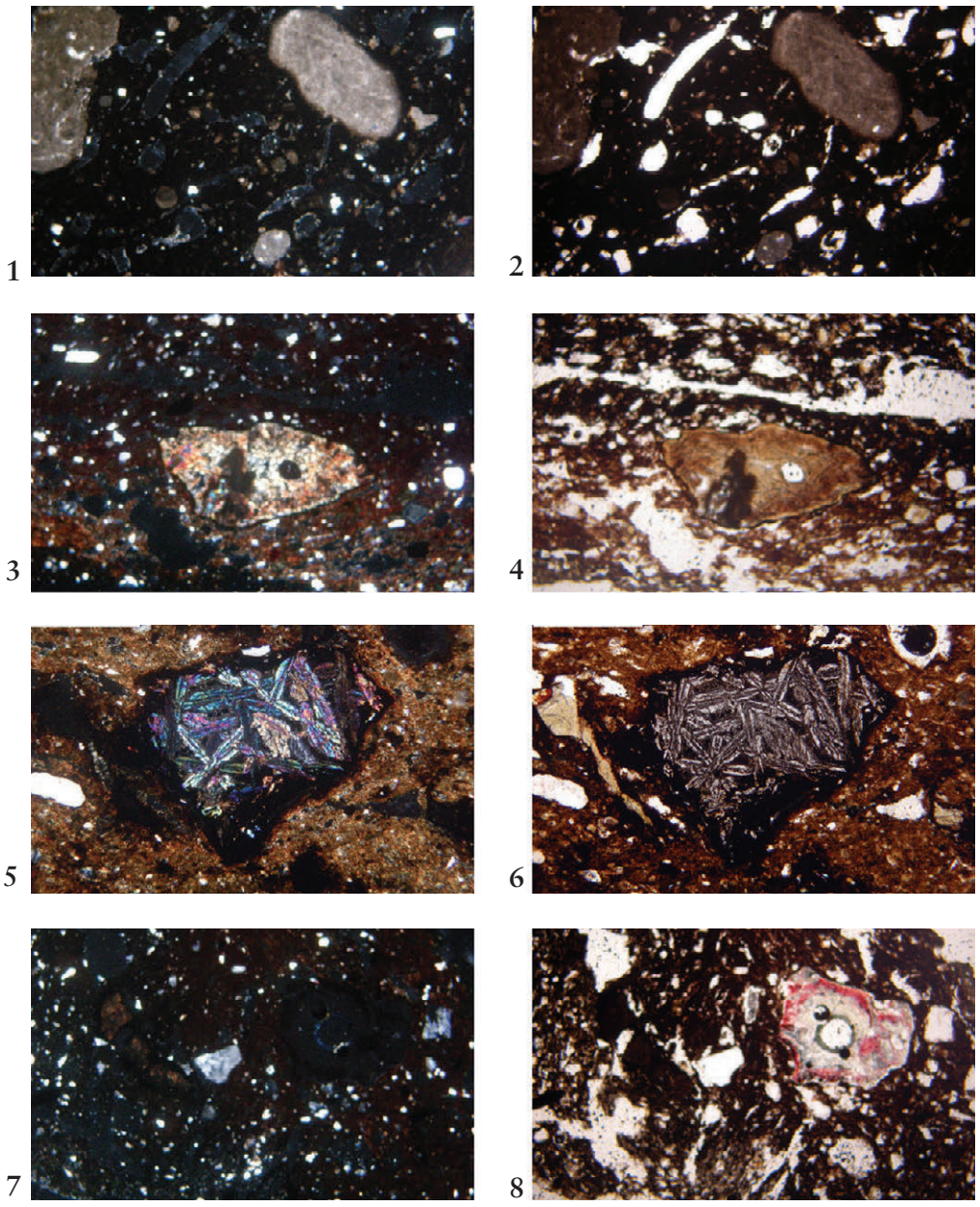

Figure 5.2 Petrographic Groups XPL/PPL (Ware A1b, A2, A2b).

Table 5.2 Petrographic Groups XPL/PPL (Ware A1b, A2, A2b) (Figure 5.2).

#	Reg#	Locus	Basket	Str.	Vessel	Type	PG	Ware	PL	Description
1	787	339	7377	S2b	Jug	JG14	PG1	A1b	XPL	Lower Cretaceous Shales with high fired black core
2	787	339	7377	S2b	Jug	JG14	PG1	A1b	PPL	Lower Cretaceous Shales with high fired black core
3	7	155	4014	A1b	Bowl	BL3a4	PG1	A2	XPL	Lower Cretaceous Shales with slag
4	7	155	4014	A1b	Bowl	BL3a4	PG1	A2	PPL	Lower Cretaceous Shales with slag
5	1379	1849	16415	R3a	Bowl	BL13b2	PG1	A2	XPL	Lower Cretaceous Shales with slag
6	1379	1849	16415	R3a	Bowl	BL13b2	PG1	A2	PPL	Lower Cretaceous Shales with slag
7	136	166	4128	A4	Pithos	PT8	PG1	A2b	XPL	Lower Cretaceous Shales with slag
8	136	166	4128	A4	Pithos	PT8	PG1	A2b	PPL	Lower Cretaceous Shales with slag

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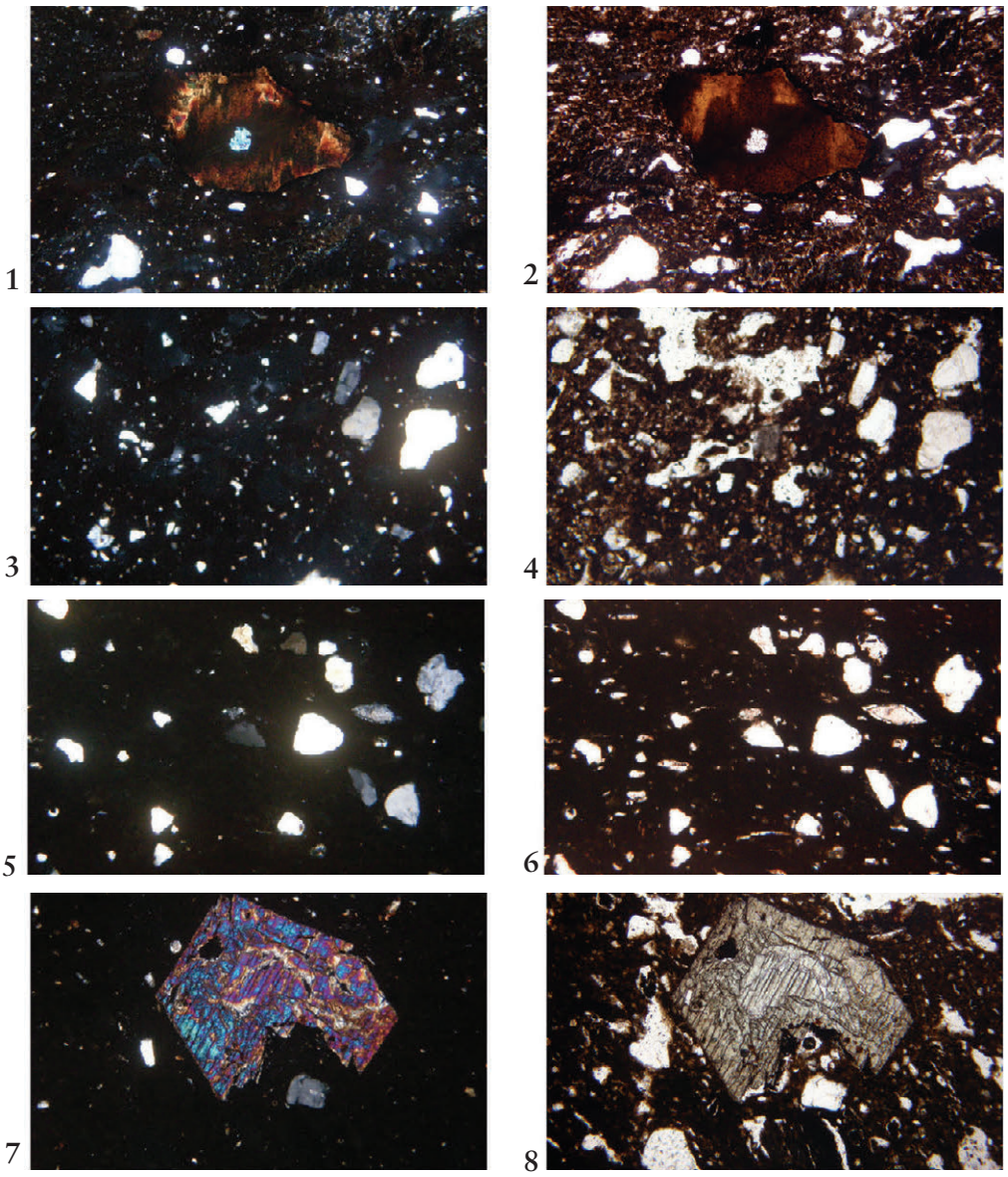

Figure 5.3 Petrographic Groups XPL/PPL (Ware A2b, A3, A4, A6).

Table 5.3 Petrographic Groups XPL/PPL (Ware A2b, A3, A4, A6) (Figure 5.3).

#	Reg#	Locus	Basket	Str.	Vessel	Type	PG	Ware	PL	Description
1	399	284	5645	S2b	Pithos	PT5	PG1	A2b	XPL	Lower Cretaceous Shales with slag (See also 62/63)
2	399	284	5645	S2b	Pithos	PT5	PG1	A2b	PPL	Lower Cretaceous Shales with slag (See also 62/63)
3	79	631	9195	M2b	Bowl	BL34	PG1	A3	XPL	Lower Cretaceous Shales with basalt
4	79	631	9195	M2b	Bowl	BL34	PG1	A3	PPL	Lower Cretaceous Shales with basalt
5	394	106	3105	A3	Bowl	BL18	PG1	A3	XPL	Lower Cretaceous Shales with calcite
6	394	106	3105	A3	Bowl	BL18	PG1	A4	PPL	Lower Cretaceous Shales with calcite
7	1074	717	10430	M2b	Cooking Pot	CP9	PG1	A5	XPL	Lower Cretaceous Shales with Pyroxene - cooking pot fabric
8	1074	717	10430	M2b	Cooking Pot	CP9	PG1	A6	PPL	Lower Cretaceous Shales with Pyroxene - cooking pot fabric

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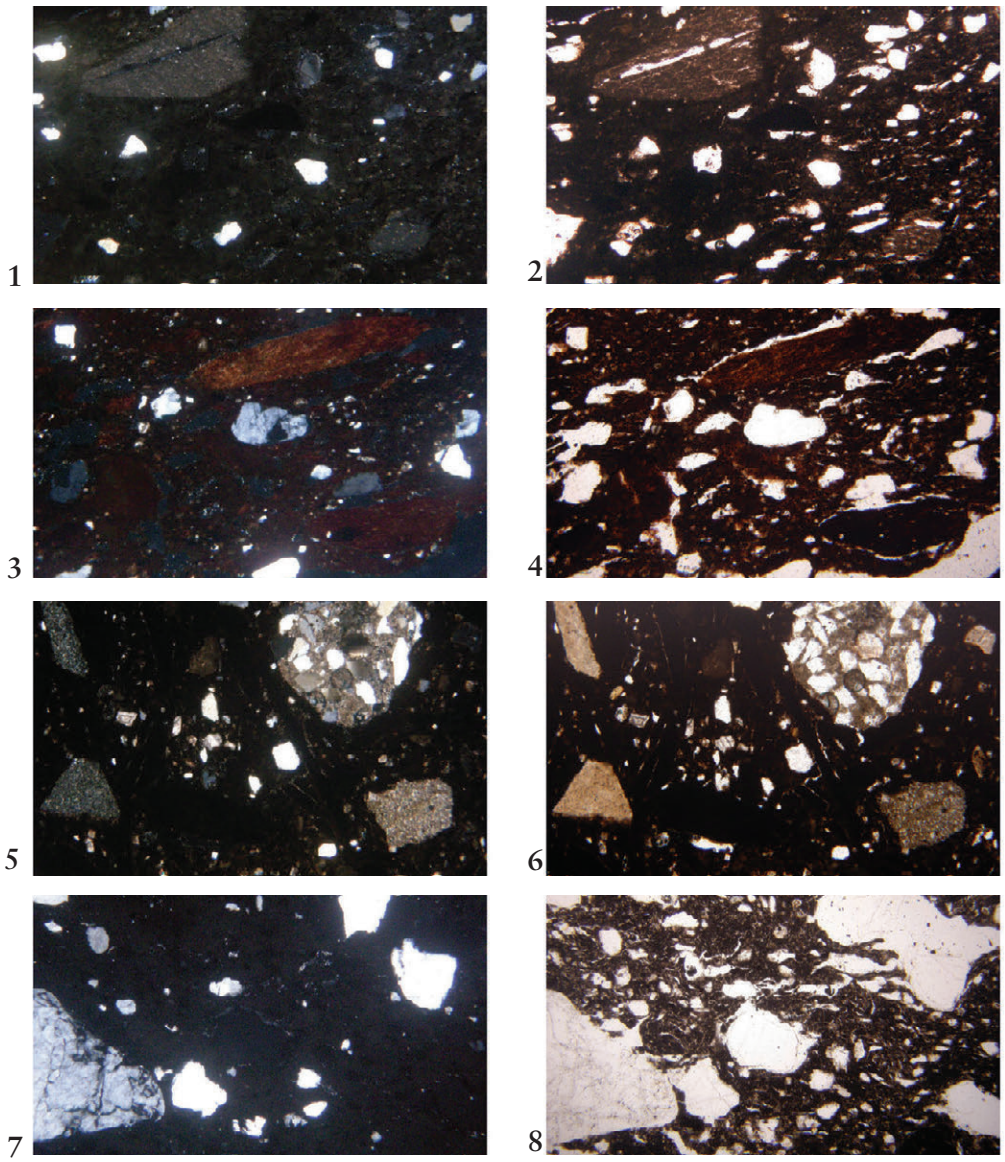

Figure 5.4 Petrographic Groups XPL/PPL (Ware A6b, B1, B1b).

Table 5.4 Petrographic Groups XPL/PPL (Ware A6b, B1, B1b) (Figure 5.4).

#	Reg#	Locus	Basket	Str.	Vessel	Type	PG	Ware	PL	Description
1	915	105	3027	A3	Cooking Pot	CP20	PG1	A6b	XPL	Lower Cretaceous Shales with fired gray - cooking pot fabric
2	915	105	3027	A3	Cooking Pot	CP20	PG1	A6b	PPL	Lower Cretaceous Shales with fired gray - cooking pot fabric
3	662	533	209		Pithos	PT3c	PG1	B1	XPL	Lower Cretaceous Shales
4	662	533	209		Pithos	PT3c	PG1	B1	PPL	Lower Cretaceous Shales
5	1171	5012	12037		Juglet	JT21	PG1	B1	XPL	Lower Cretaceous Shales with large silty grog inclusion
6	1171	5012	12037		Juglet	JT21	PG1	B1	PPL	Lower Cretaceous Shales with large silty grog inclusion
7	1392	5014	12110		Pithos	PT22	PG1	B1b	XPL	Lower Cretaceous Shales highly fired
8	1392	5014	12110		Pithos	PT22	PG1	B1b	PPL	Lower Cretaceous Shales highly fired

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of Petrographic Group 1 is local to the lowland and highlands of Edom. Since Lower Cretaceous shale outcrops originating from the Kurnub sandstone (KS) formation are found in both the lowlands (Figure 5.12) and highlands (Figure 5.13) of Edom, a more refined distinction between these areas is not possible with only petrographic analysis. As was argued above, INAA studies have been able to distinguish between sherd fabrics collected in the Petra region and the area of Busayra. Future INAA studies may find a similar scenario in distinguishing the lowland LCS from the highlands.

Ware: A Group (Figures 5.1–5.3)
Ware A1: This group has light red or gray shales. Fabric color ranges from light red to brownish red. Some examples have gypsum in the matrix that is visible throughout the fabric. The quality ranges from medium-fine to medium-coarse depending on vessel type.

Ware A1b: This group has a highly fired exterior and interior with a light gray core. It is medium-fine ware.

Ware A1c: This group has a very well-sorted fabric, with no visible inclusions other than shales. It has a smooth or soapy feel. It is a very thin-walled delicate pottery. It is fine ware.

Ware A2: This group is medium-fine to medium-coarse ware with slag inclusions; a majority of the time, slag inclusions are distributed on the surface and in the core of the sherd. Four important observations were made concerning this ware. First, out of the thin sections made, slag inclusions represented 50 percent of the samples made from KEN. This high proportion was further supported by the ware analysis that found a number of non thin-sectioned sherds possessing these visible slag inclusions. Second, some of the thin-sectioned examples that had slag had no visible trace of these inclusions under nonmicroscopic examination of the surfaces or core. If it was not for the thin section, we would not be able to distinguish these sherds from Ware A1. Third, several sherds with no slag visible in thin section had visible slag in the core seen using a ´10 magnification hand lens. This is understandable since the slag inclusions were not evenly distributed through the matrix of the sherds, but the thin sections were made from a single location on the sherd. Fourth, with the exception of the visible slag inclusions, the fabric with respect to color, firing, porosity, and other attributes appears identical to Ware A1. Thus, taking these four observations into account, sherds collected from KEN in which no thin sections were made were labeled as Ware A1/2 since it could not be ruled out that slag was still present if observed at the microscopic level. Sherds with visible slag inclusions were labeled Ware A2, including those that were thin sectioned but possessed no visible slag in the thin section but had obvious numerous examples of slag in the core or surfaces.

Ware A2b: These are coarse fabric sherds with granule-size (>5 mm) slag inclusions. The roughness is primarily a result of the dense large inclusions of jagged slag throughout the surface of the vessel. This coarser fabric was associated only with pithoi, large bowls, and handmade pottery.

Ware A3: This group has coarse to medium-coarse fabric with large basalt inclusions found regularly in thin section and visible on surface. No thin-section examples contained basalt with also slag inclusions. This discovery enabled us to compare these thin-sectioned vessels to identify distinctive visible characteristics between the black basalt and slag inclusions. Slag inclusions have sharp pointed edges and a reflective sheen when placed under direct light. In contrast, basalt inclusions are rounded and smooth and have a matte black to dark gray appearance.

Ware A4: This group is a medium-fine ware with only visible calcite inclusions on the surface and in core. Color is a consistent very pale brown and highly fired with a nonporous/smooth feel. The thin sections conducted on these sherds showed a high concentration (>50 percent) of calcite and limestone in comparison to quartz inclusions. Sample R956 (KAJ, L106) has visible red shales in the matrix, but the other two thin sections do not. Three thin sections with this fabric were found to come from KAJ.

Ware A5: This single example found at RHI has a predominant amount of fossiliferous limestone inclusions. Rounded yellowish brown shales also occur regularly. Within the matrix, iron oxide rhombs are visible as well. A very similar petrographic thin section was identified by Ian Whitbread for an Early Bronze sherd found in Wadi Faynan (Barker et al. 2007:773).

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Ware A6: This group represents the cooking pots that have a distinctively different brittle and flaky fabric with a number of voids and are often highly fired. The petrographic analysis revealed that all the cooking pots were made of the local Lower Cretaceous shale material. Ware A6b is designated for the cooking pots that have slag inclusions identified in thin section or in the core.

Ware: B Group (Figures 5.4–5.5)

Ware B1: This ware group has a well-sorted fabric but with calcite and quartz visible on interior surfaces and nonslipped exterior surfaces. Angular pale red and gray shales are frequent and visible in fresh-cut cores. Some examples have a predominant amount of calcite and limestone visible in thin section. Quality ranges from medium-fine to medium-coarse depending on vessel type. The sherd surfaces are smooth and evenly colored possibly due to the potting technique (purposeful smoothing and finishing)—wheel marks are also often visible on the interior and exterior of the sherds.[1] This ware is very strong and hard in comparison to that found at KEN. This was readily apparent during thin section preparation, during which all samples from KEN cut very quickly and easily using the diamond rotary blade, while Ware B was difficult and required slow grinding to avoid dulling the blade or creating sparks if not placed under running water. The larger kraters and pithoi were even harder, leading to the decision to break sections off from these sherds rather than spend the time to make clean cuts or use the larger diamond cutting saw in the petrographic labs.

Fabric color ranges from light red to reddish gray. However, on the plateau at KAM, KIS, KIJ, and TW, the predominant fabric color is a light red. At TW and KAM especially but also found infrequently at KIS and KIJ, a reddish gray fabric is also found across numerous vessel families and types, often in association with the light red fabrics mentioned above. Among pithoi and jugs only on the plateau sites, a gray 2.5Y5/1 fabric with large calcite inclusions was found. An analysis of the thin sections yielded no significant difference in the matrix between these various colored fabrics. It must be noted that this ware, although possessing similar geological composition, is visibly different from what is seen at KEN and RHI Sounding A as discussed above. It appears to represent a more advanced ceramic technology seen in the preparation of the clay, smoothing and finishing of the vessels' exterior and interior surfaces, and more efficient and consistent firing.

Ware B1b: This ware group has medium-coarse, very poorly sorted fabric with visible large-size quartz (1–2 cm), calcite, and shales on the interior and exterior surfaces and core. The surface is periodically rough due to the large inclusions, but the clay fabric remains smooth as seen among Ware B1. These are very hard sherds as alluded to above. Fabric represents all typical colors discussed above.

Ware B2: This group has a coarse, rough, poorly sorted fabric with large granule-size slag inclusions. Only one thin section sample was made from RHI, but numerous examples were discovered during the ware analysis, specifically among PT17/18 at RHI; no examples from L2HE sites were identified. Fabric color ranges from pale red to light pale brown (see B4). Ware B2 is not as strong or hard as the B1 or B4 wares. This fabric highly resembles Ware A2b with the exception of color. The morphological types found in this ware differ greatly from those with similar fabrics (i.e., A2 vs. B2).

Ware B3: This group has coarse, poorly sorted fabric with large granule-size basalt inclusions. Three thin sections—one from RHI (R183) and two from L2HE (KAM: R281; KIS: R1151)—are all large pithoi. After the determination of basalt inclusions, other examples from the L2HE sites and RHI could be distinguished into this group (see discussion of basalt inclusion for A3). All examples from L2HE resemble the medium-coarse B1b group due to the presence of large quartz and calcite in the matrix but a still smooth fabric otherwise. In contrast, the examples from RHI resemble B2 in all aspects except the slag inclusions.

Ware B4: This group has medium-coarse to fine-quality fabric with a consistent very pale brown color with large pale red or light gray shales. This fabric, found only at RHI Sounding B, is the predominant ware among all vessel types; B1 also is present at RHI Sounding B but represents the minority. The method of thin-section analysis conducted in this study did not reveal any significant petrographic difference from the B1 ware. The distinction between B4 and the standard Ware B fabric was based solely on its consistently distinctive color and fabric that became readily apparent when directly compared to the various vessel types found at the L2HE sites. Among

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the medium-fine to medium-coarse examples, poorly sorted large angular shales (often pale red) and quartz are visible on the vessel surface. Generally, where the shales or quartz are visible, they reflect a flaking off of clay originally covering these large inclusions. Therefore, on the exterior but especially interior, there are a number of indentations where the clay has flaked off, exposing these inclusions or perhaps air pockets or vegetal matter originally trapped prior to firing. This creates a much rougher surface than what is seen among the B1 ware fabric found at RHI Sounding B and L2HE sites on the plateau. Among the finer vessels (e.g., BL20, BL21, BL30—see Chapter 4, this volume), B4 ware is also found, but it is well sorted; thus, the surface is smoother and only periodically reveals a shale or quartz inclusion. This fabric is absent from the L2HE plateau sites, KEN, and RHI Sounding A. It is possible, without prior knowledge of site origin, to sort this fabric from the L2HE sites by appearance alone. Thus, this appears to be a local fabric specific to RHI but made from the same Lower Cretaceous shale clay. In future ware studies, it is hoped that other Late Iron Age sites from the lowlands will be examined to determine whether this fabric occurs throughout Late Iron II Faynan district or specifically only around the vicinity of RHI.

Ware B5: This ware group has a very fine, high-fired, well-sorted fabric. The matrix is light gray in XPL, is reddish brown in PPL, and consists of very fine micrometer size quartz particles. Inclusions still contain large, rounded gray shales and periodic subrounded large quartz inclusions. The core is black or gray with no visible inclusions. Since the exterior and interior are slipped and painted, it was not always possible to determine the external color. This ware is found only among a few vessel examples from BL12c and BL20 at RHI and L2HE sites. This ware is primarily distinguished from the B1 ware by their black cores. They are all intricately decorated, slipped, and burnished. They are the thinnest examples of the BL12c and BL20 bowls.

Ware B6: This group represents the cooking pots, which have a distinctively different brittle and flaky fabric with a number of voids and are often highly fired. The petrographic analysis revealed that all the cooking pots were made of the local Lower Cretaceous shale material.

Petrographic Group 2: Arkose Group (Figures 5.5, 5.6)

Matrix

This matrix is silty (10 percent), dark red in XPL, yellowish tan in PPL, and optically active, with elongated subangular and angular quartz-rich silt. Mica is predominant within the matrix as well.

Inclusions

Angular mono- and poly-crystalline quartz. There are no visible shale inclusions found in the thin sections. On the other hand, arkose derived from granitoids is the predominant inclusion next to quartz. Limestone is also regularly present with some occurrence of calcite. Appearing as rare accessories, angular plagioclase and orthoclase feldspars, chert, and sandstone are also present.

Geological Interpretation

The matrix and inclusions hint at a geomorphological provenience where arkose sediment has been mixed with alluvial wadi sands. The presence of Salib arkosic sandstone and other granitic rock formations around the vicinity of KEN (see Figure 5.12) and predominately further south in Aqaba and Sinai (cf. Porat 1989:174) suggests that this material was local to the southern lowland portions of this region. Since only a small sample of this Petrographic Group (PG) (n = 8) was identified throughout the whole assemblage, the petrographic group does not appear to be a regular clay source used for production at KEN. Arkose-rich silty fabric has been identified in the Faynan area in Early Bronze I ceramics (see E. Johnson in Barker et al. 2007:771). Since the arkose sediments could have been acquired locally, this PG should be considered, as of now, local to the vicinity of KEN.

Ware: A Group

Ware A7: This medium-fine ware is distinguishable by the naked eye from the predominant KEN assemblages. The lack of visible shales and very finely sorted red/gray core is readily different. The two examples found among the pithoi are even more striking since the regular pithoi found at KEN are riddled with visible slag inclusions (A2b). This fabric is smooth and is light red to yellowish red.

Ware A8: One thin section, R971, contains a similar angular quartz and mica-rich matrix with abundant arkose inclusions and lack of visible shales; however, it

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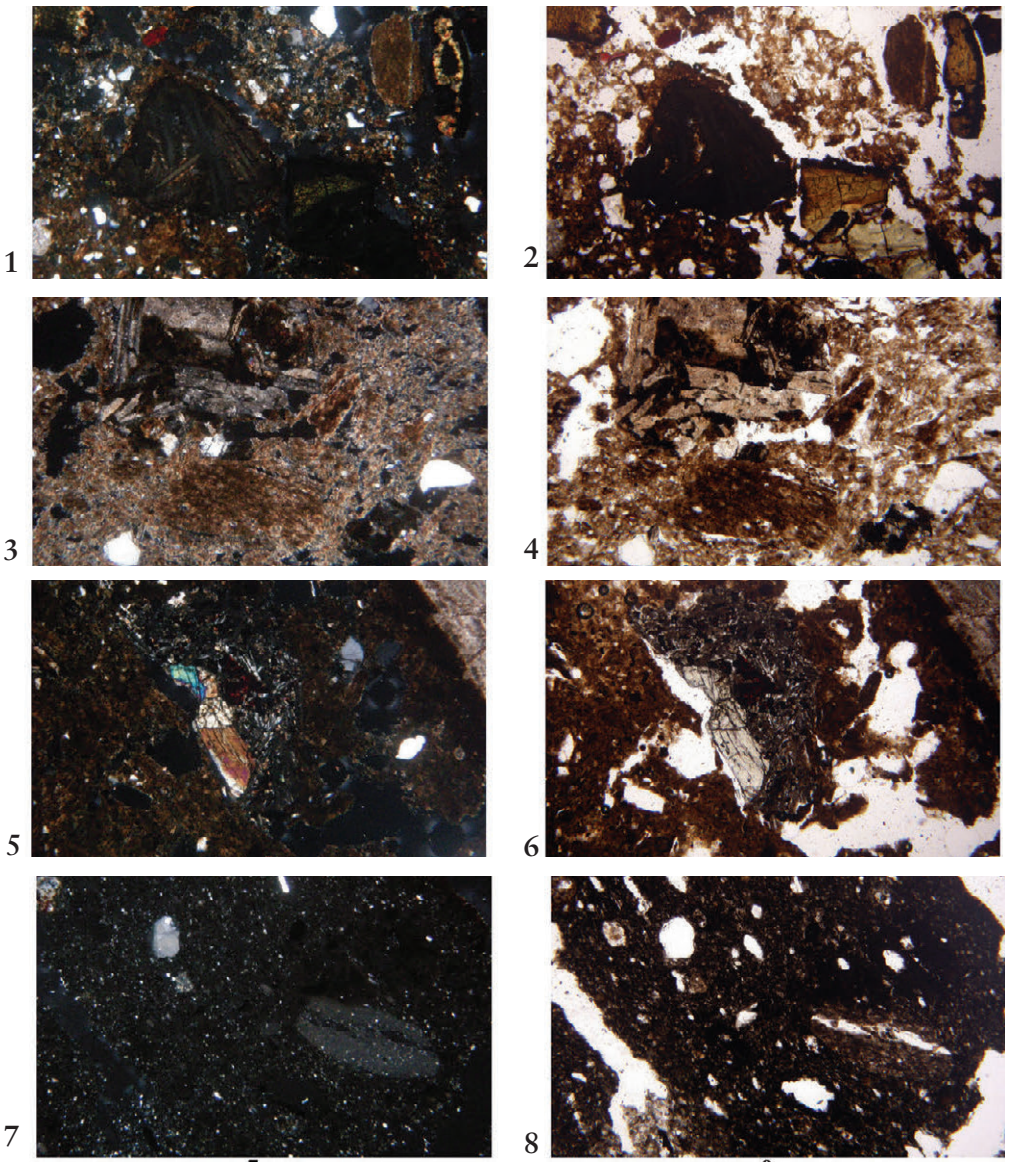

Figure 5.5 Petrographic Groups XPL/PPL (Ware B2, B3).

Table 5.5 Petrographic Groups XPL/PPL (Ware B2, B3) (Figure 5.5).

#	Reg#	Locus	Basket	Str.	Vessel	Type	PG	Ware	PL	Description
1	604	532	217		Pithos	PT18	PG1	B2	XPL	Lower Cretaceous Shales (See also 56)
2	604	532	217		Pithos	PT18	PG1	B2	PPL	Lower Cretaceous Shales (See also 56)
3	147	534	222		Pithos	PT15	PG1	B3	XPL	Lower Cretaceous Shales with basalt
4	147	534	222		Pithos	PT15	PG1	B3	PPL	Lower Cretaceous Shales with basalt
5	218	3009	10033		Pithos	PT19c	PG1	B3	XPL	Lower Cretaceous Shales with basalt
6	218	3009	10033		Pithos	PT19c	PG1	B3	PPL	Lower Cretaceous Shales with basalt
7	163	535	261		Bowl	BL12c	PG1	B5	XPL	Lower Cretaceous Arkose with pale brown fabric
8	163	535	261		Bowl	BL12c	PG1	B5	PPL	Lower Cretaceous Arkose with pale brown fabric

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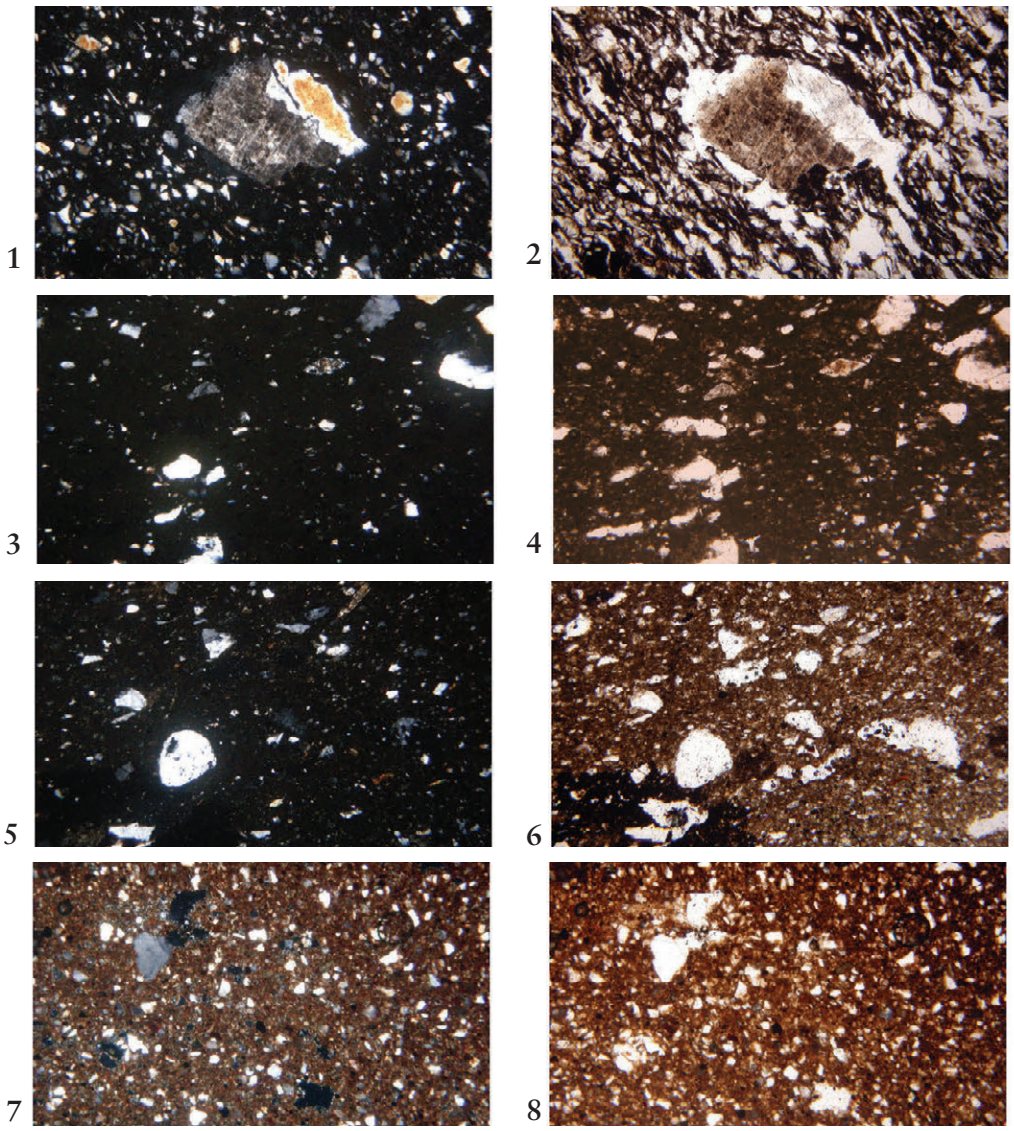

Figure 5.6 Petrographic Groups XPL/PPL (Ware A7, A9, A10, I1).

Table 5.6 Petrographic Groups XPL/PPL (Ware A7, A9, A10, I1) (Figure 5.6).

#	Reg#	Locus	Basket	Str.	Vessel	Type	PG	Ware	PL	Description
1	1364	1849	16520	R3a	Pithos	PT2b	PG2	A7	XPL	Lower Cretaceous Arkose
2	1364	1849	16520	R3a	Pithos	PT2b	PG2	A7	PPL	Lower Cretaceous Arkose
3	303	531	189		Jug	JG3b	PG3	A9	XPL	Lower Cretaceous Disi Formation Sandstone
4	303	531	189		Jug	JG3b	PG3	A9	PPL	Lower Cretaceous Disi Formation Sandstone
5	651	1524	13365	T2a	Bowl	BL15	PG4	A10	XPL	Paleozoic Micaceous Clay
6	651	1524	13365	T2a	Bowl	BL15	PG4	A10	PPL	Paleozoic Micaceous Clay
7	1279	1578	13698	T2b	Bowl	BL25	PG5	I1	XPL	Loess Soil
8	1279	1578	13698	T2b	Bowl	BL25	PG5	I1	PPL	Loess Soil

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also has slag inclusions in the core. This is a medium-coarse fabric with a pale yellow-brown color and flaky fabric resembling the identified cooking pot fabrics.

Petrographic Group 3: Lower Cretaceous Disi Formation Sandstone (Figure 5.6)

Matrix

This siliceous fabric, gray in XPL and white in PPL, is an isotropic, highly fired, almost vitrified clay. The matrix consists of quartz, feldspars, and small amounts of mica.

Inclusions

Angular mono- and poly-crystalline quartz. Appearing as rare accessories are chert, gypsum, and limestone. Small voids (<.2 mm) with a halo of calcite or limestone are found due to high firing.

Geological Interpretation

This is highly siliceous white sandy clay in which the grains are made up entirely of quartz. Other inclusions are minor or leached out due to high firing. White silica sand deposits are found exposed on the surface of Early Ordovician and Lower Cretaceous sandstone in the south of Jordan (Rabb'a 1994). The Disi sandstone formation found in Ras en-Naqab, the vicinity of Petra (see Figure 5.13), and sporadically in the Faynan district has been identified as a white sandstone material known for its high SiO_2 (>99 percent) content. This PG should be considered local within the southern region of Jordan and possibly was extracted from the large outcropping of Disi sandstone within the vicinity of Petra.

Ware

Ware A9: This ware with pure white fabric is immediately distinguishable from the typical A1/2 fabrics found at KEN. It is smooth, devoid of any visible inclusions, and well fired. It only occurs among several vessel types where it is the dominant form. These are kraters (KR8), jugs (JG3a), and fine-ware bowls (BL14)—see Chapter 4 (this volume) and below for a further discussion of these types and a correlation with morphological features and spatial distribution.

Ware B7: From RHI Sounding B, a thin section was made of a similar fabric (JG3a). Although under microscopic examination, this thin section shares similar characteristics with the A8, there are several notable differences. First, mica was not visible in the matrix, and larger (>.2 mm) subrounded to rounded quartz inclusions were visible. There were also a number of large voids visible under microscope and in the core. These voids, created through the high firing temperature, leached out the calcite or limestone, leaving a small remnant around their edges. The high firing of the ferruginous limestone left a visible red color to the edges of these voids that were visible to the naked eye during ware analysis. The fabric is a whitish green color that also deviates from A8.[2] The primary visible similarity it shares with A8 is the fine smooth whitish fabric and similar morphological type most likely originating from similar highly siliceous clay.

Petrographic Group 4: Paleozoic Micaceous Clay (Figure 5.6)

Matrix

This is a clayey micaceous matrix dark red in XPL and reddish brown in PPL, containing subangular to subrounded well-sorted quartz.

Inclusions

Larger inclusions of subrounded to rounded quartz. Large grog inclusions are also found in several samples.

Geological Interpretation

This PG represents a Paleozoic geological formation possibly from further south in Jordan, the Negev, or Sinai.

Ware

Ware A10: The fabric of this ware is discernable from the local A1/2 fabrics at KEN, especially when the core is examined. The core is pink and very well sorted with no visible inclusions. All the fabrics associated with this ware are fine in quality.

Petrographic Group 5: Loess Soil (Figures 5.6, 5.7)

Matrix

A mixture of clay and silt (10 percent). It is calcareous, pale red in XPL, yellowish tan in PPL, and optically active. The quartz silt is well sorted and angular. There are also accessory heavy minerals such as hornblende, augite, zircon, and plagioclase.

Inclusions

The inclusions are a coarse mixture of large subrounded quartz, vegetal material (straw), and micritic limestone.

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Geological Interpretation
This fabric is strongly associated with loess soil discussed within the petrographic literature (cf. Goren et al. 2004:112–113). *Loess* is a term that refers to Aeolian sediment formed through the accumulation of wind-blown silt and clay. It is located in the southern Levant, primarily in the northern Negev and southern Shephelah. The predominance of quartz as the main constituent suggests a western-northern Negev provenience (as far as the southern-central Beersheva valley) where littoral sands from the coast were swept inland (see Goren et al. 2004:112–113).

Ware: Imports (Abbreviated as Ware I for Distinction from Ware Groups A and B)
Ware I1: This loess fabric is a clear import from the Negev. The fabric is distinguishable from the standard A1/2 local fabrics. The core of PG5 is strong brown in color with no visible inclusions. All examples are a fine ware red slipped and hand burnished. Similar fabrics and surface treatment are found at Beersheva (Herzog 1984; Singer-Avitz 1999), Tel Arad (Singer-Avitz 2002), and other Early Iron Age II sites located in the western Negev (for further discussion, see Chapter 4: BL24).

Petrographic Group 6: Lower Cretaceous Shale with Micaceous Clay—Qurayya Ware (Figure 5.7)

Matrix
This micaceous clay with (10 percent) silt is greenish gray in XPL and yellowish tan in PPL. The silty quartz inclusions are very well sorted. The matrix is also highly fired with evidence of decomposed carbonates and secondary carbonates.

Inclusions
Large opaque primarily argilliceous shales (>4 mm) are common within the thin section. Several of the identified shales in thin section had horizontal fractures. To a further extent, these shales have become quartzo-feldspathic silts. A few subangular quartzes occur also.

Geological Interpretation
This highly micaceous clay, originating from Lower Cretaceous shale, has been examined petrographically by Rothenberg and Glass (1983:97) for Late Bronze Age (LBA) Timna. They argue that this painted ware originates from Qurayyah in northwestern Arabia (Hejaz). The painted designs, slip, and fabric traditionally have been associated with the "Midianite" culture known from the Hebrew Bible.

However, the Gunneweg et al. (1991) INAA analysis, discussed above, found that only two examples of "Midianite" sherds were strongly associated with Qurayyah, while the remainder studied appeared local. Since their study does not mention fabric, visible inclusions, or decorative styles, it is not clear whether these other sherds possessed a similar-appearing core fabric to the two examples that did originate from Qurayyah. Based on Rothenberg and Glass's (1983) detailed petrographic discussion, the PG discovered here should be associated strongly with this group.

Further investigation is required to compare the INAA sherds analyzed by Gunneweg et al. (1991) and the thin-section analysis conducted by Rothenberg and Glass (1983).

Ware: Imported
Ware I2: This PG is distinguishable from all other fabrics found at KEN. A fresh broken core is pinkish white with large red shales visible by the naked eye. Although the fabric is actually rough when exposed, this fabric is consistently coated with a thick cream slip and painted with black and dark reddish brown pigments. A number of dilapidated examples were identified where the painted slip had detached from the sherd, exposing the underlying fabric. These were also selected for thin sectioning and confirmed to be similar fabric. Thus, based on fabric, this ware can be distinguished from the other fabrics found at KEN and RHI Sounding A.

Petrographic Group 7: Moza Dolomitic Clay (Figure 5.8)

Matrix
This matrix is reddish brown in XPL and yellowish tan in PPL, consisting of dense calcareous clay material and dolomite-rich sand.

Inclusions
The inclusions are predominately poorly sorted, densely distributed single rhombs (.025–.25 mm) of clear idiomorphic dolomite.

Geological Interpretation
This PG is widely documented as Moza-'Amminadav clay material located within the vicinity of Jerusalem (cf. Goren et al. 2004:262–264; Porat 1989). This PG is a naturally occurring mixture of clay from the Moza

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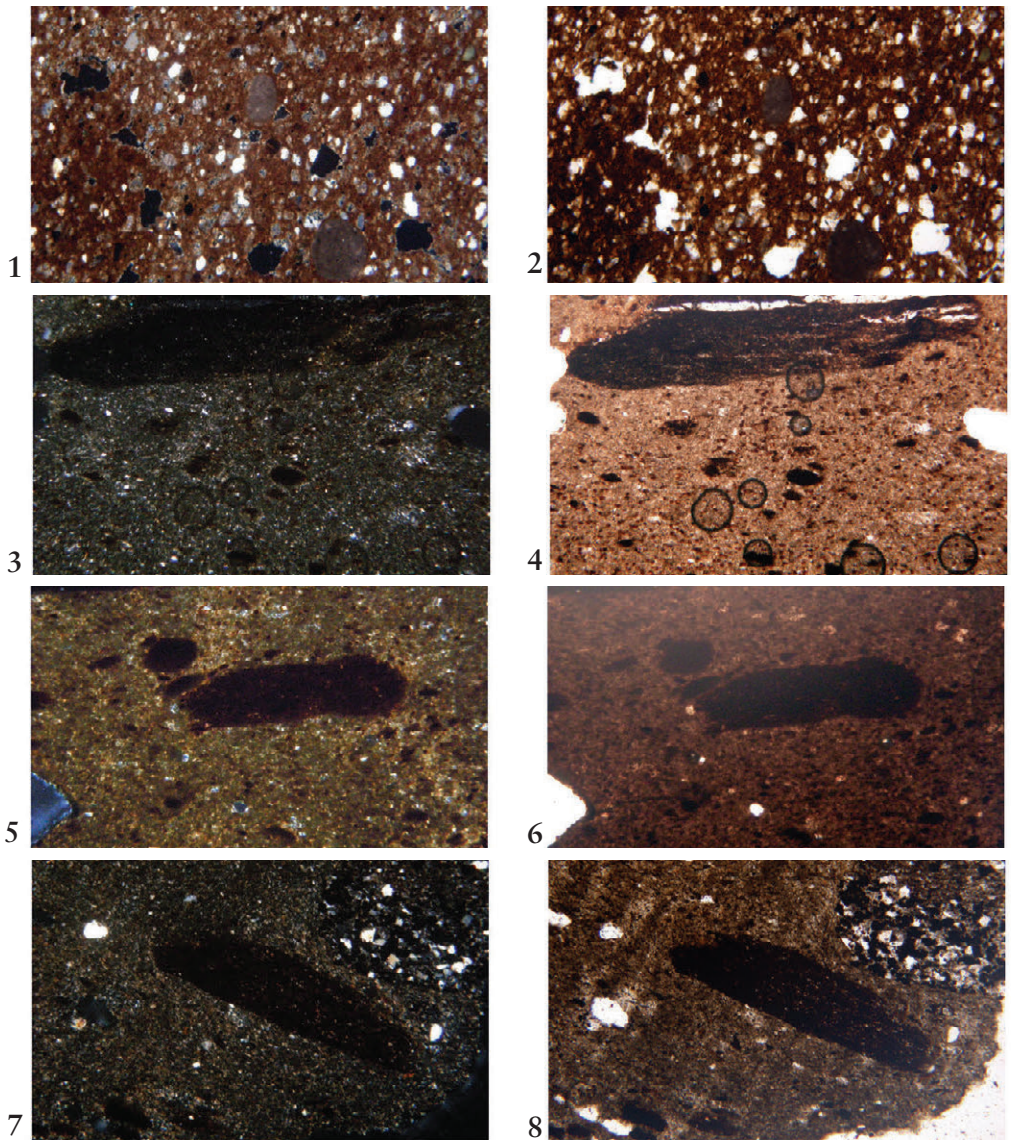

Figure 5.7 Petrographic Groups XPL/PPL (Ware I1, I2).

Table 5.7 Petrographic Groups XPL/PPL (Ware I1, I2) (Figure 5.7).

#	Reg#	Locus	Basket	Str.	Vessel	Type	PG	Ware	PL	Description
1	938	105	3196	A3	Bowl	BL16	PG5	I1	XPL	Loess Soil
2	938	105	3196	A3	Bowl	BL16	PG5	I1	PPL	Loess Soil
3	650	1827	16265	R2b		Midianite		I2	XPL	LowerWare Cretaceous Shale with Micaceous clay-Qurayya
4	650	1827	16265	R2b		Midianite		I2	PPL	LowerWare Cretaceous Shale with Micaceous clay-Qurayya
5	1321	1827	16378	R2b		Midianite		I2	XPL	LowerWare Cretaceous Shale with Micaceous clay-Qurayya
6	1321	1827	16378	R2b		Midianite		I2	PPL	LowerWare Cretaceous Shale with Micaceous clay-Qurayya
7	432	660	9754	M3		Midianite		I2	XPL	LowerWare Cretaceous Shale with Micaceous clay-Qurayya
8	432	660	9754	M3		Midianite		I2	PPL	LowerWare Cretaceous Shale with Micaceous clay-Qurayya

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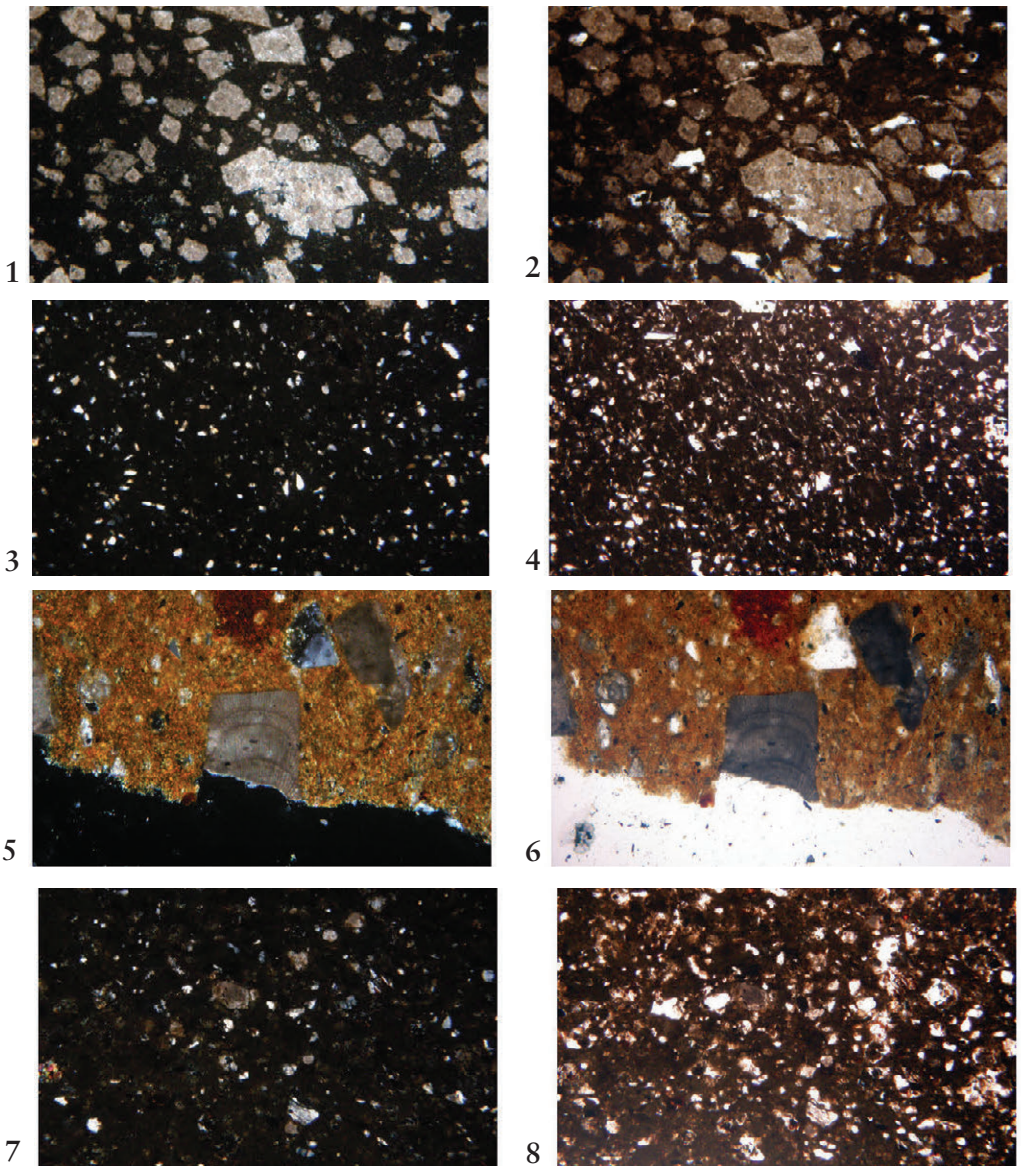

Figure 5.8 Petrographic Groups XPL/PPL (Ware I3, I4, I5, I6).

Table 5.8 Petrographic Groups XPL/PPL (Ware I3, I4, I5, I6) (Figure 5.8).

#	Reg#	Locus	Basket	Str.	Vessel	Type	PG	Ware	PL	Description
1	403	1531	13235	T2a	Juglet	JT21	PG7	I3	XPL	Moza Dolomitic Clay
2	403	1531	13235	T2a	Juglet	JT21	PG7	I3	PPL	Moza Dolomitic Clay
3	571	264	5615	S1	Juglet	JT22	PG8	I4	XPL	Cypriot Aegean
4	571	264	5615	S1	Juglet	JT22	PG8	I4	PPL	Cypriot Aegean
5	1325	1832	16373	R2b	Jar	JR16	PG9	I5	XPL	Syro-Lebanese Coast: Neogene clay with Amphiroa fossils
6	1325	1832	16373	R2b	Jar	JR16	PG9	I5	PPL	Syro-Lebanese Coast: Neogene clay with Amphiroa fossils
7	97	631	9384	M2b		Greek	PG10	I6	XPL	Greek transport amphorae
8	97	631	9384	M2b		Greek	PG10	I6	PPL	Greek transport amphorae

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formation and dolomitic sand from the 'Amminadav' Formation in Israel.

Ware: Imported
Ware I3: The specific ware associated with this PG at KEN is found among the black burnished juglets. These examples are Iron Age II imports from the vicinity of Jerusalem (see Chapter 4, this volume, for a discussion of parallels). These are very rare in the assemblage at KEN (n = 2).

Petrographic Group 8: Cypriot Aegean (Figure 5.8)

Matrix
This micaceous clay, reddish brown in XPL and yellowish tan in PPL, is highly fired, consisting of a silty angular quartz. The mica occurs frequently, and a number of examples are >.2 mm in length.

Inclusions
Rare inclusions of angular to rounded quartz are found. Otherwise, there is no other informative evidence that can be deduced from a study of the inclusions.

Geological Interpretation
This micaceous clay is typical of the Cypriot Aegean geological formations (cf. Whitbread 1995). Since all examples come from the Cypriot black-on-red juglets, it can be surmised that they originated from Cyprus.

Ware: Imported
Ware I4: These Cypriot black-on-red juglets are a very fine highly fired, with a burnished soapy-feeling fabric.

Petrographic Group 9: Syro-Lebanese Coast: Neogene Clay with Amphiroa Fossils (Figure 5.8)

Matrix
This is a clay-rich, calcareous fabric with a brownish yellow color in XPL and PPL, consisting of silty quartz (2 percent), opaque minerals, and dense carbonate crystals.

Inclusions
The main inclusions are fossiliferous marine limestone, micritic limestone, chert, angular to subangular quartz, corallinean algae *Amphiroa*, and *Mollusca*.

Geological Interpretation
Numerous studies (cf. Ballard et al. 2002; Bettles 2003a, 2003b; Goren et al. 2004:108) have associated this PG with Neogene clay derived from the Syro-Lebanese coastal areas. The occurrence of corallinean algae *Amphiroa* throughout the thin section enables a more refined interpretation of geological provenience. Bettles (2003a, 2003b) argues that the *Amphiroa*-rich Neogene clay is found around Tyre, Sidon, and Sarepta areas. This fabric is an import from this region.

Ware: Imported
Ware I5: This medium-fine ware has a shiny light red slip. Only one example was found in the complete assemblage.

Petrographic Group 10: Greek Transport Amphorae (Figure 5.8)

Matrix
This micaceous clayey matrix is light reddish brown in XPL and greenish brown PPL, fired to isotropic, with red ferruginous clay.

Inclusions
The predominant inclusions include angular quartz, plagioclase, and limestone. A few examples of mica-schist also occur.

Geological Interpretation
This ceramic is readily identified by its petrographic affinities to Aegean Greek transport amphorae. See Whitbread (1995) for a detailed discussion of the various types of clay that occur in this region.

Ware: Imported
Ware I6: This single example is a painted body sherd with white slip and black horizontal bands. It has been burnished, creating a soapy texture. See Whitbread (1995) for parallels.

Analysis and Discussion

The several statistical tables (Tables 5.9–5.11) and figures (Figures 5.9–5.11) presented here in conjunction with specific information extracted from each PG allow a number of inferences to be drawn.

The dominant proportion of the fabrics found at KEN, RHI, and L2HE sites were the results of clay acquired within a short distance and most likely produced on site. Figures 5.10 to 5.11 and Table 5.9 show that the dominant petrographic group for both the highlands and lowlands (Figure 5.10: PG1-A, 52 percent; Figure 5.11: PG1-B, 99.9 percent) are the

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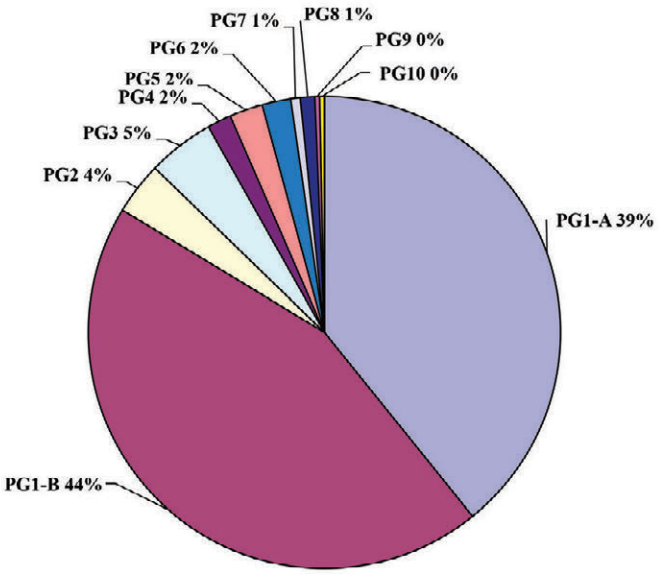

Figure 5.9 Percentage of petrographic groups represented from KEN, KAJ, RHI, KAM, KIJ, KIS, and TW (n = 306).

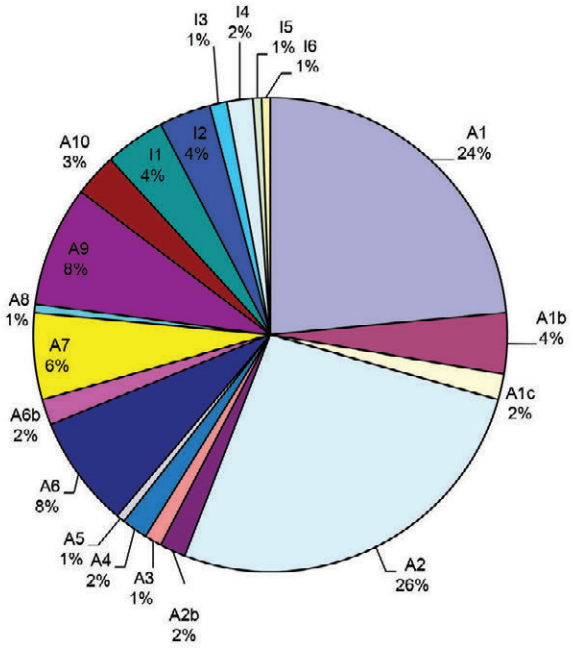

Figure 5.10 Percentage of Ware Group A and imports from KEN, KAJ, RHI, KAM, KIJ, KIS, and TW (n = 306).

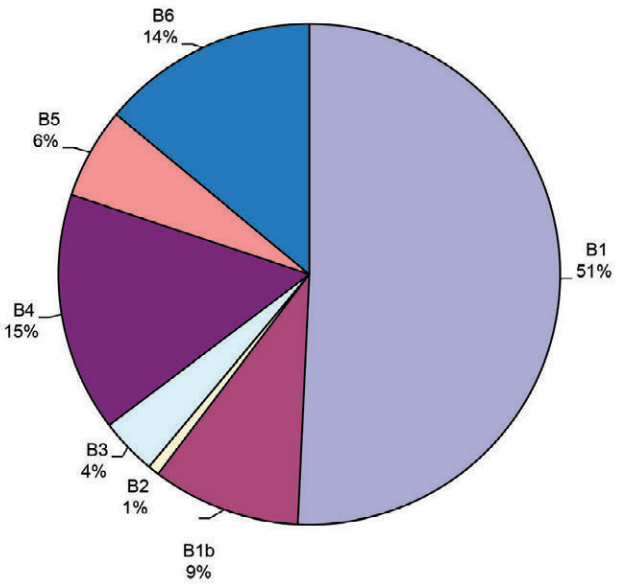

Figure 5.11 Percentage of Ware Group B from KEN, KAJ, RHI, KAM, KIJ, KIS, and TW (n = 306).

Lower Cretaceous shales originating from the local Kurnub sandstone formation outcrops.

At KEN, slag-rich Lower Cretaceous shale represents 30 percent (A2/A2b/A6b) of the sampled thin sections. This is significant, since KEN was an industrial metallurgical complex. The evidence of such a high percentage of slag-rich PG1 suggests that the pottery was produced on site by potters linked to industrial metal production activities taking place at the site during the tenth and ninth centuries BCE. The evidence of small traces of slag in the medium- to fine-ware bowls indicates that most of the clay sources were contaminated with slag. On the other hand, the visible large slag inclusions found in the A2b ware suggest either a purposeful tempering of slag or a technical decision to not sort out these granule-size particles during selection and preparation of the clay. There may have also been a perceived pyrotechnical advantage to have slag as part of the temper of the fabric. In any case, the slag inclusions are a strong indicator that the majority of the ceramic assemblage found at KEN was local to the lowland region and most likely produced on site. Since other metallurgical sites contemporary to KEN existed in the region, there is still the possibility that some of these A2 sherds may have come from these sites as well.

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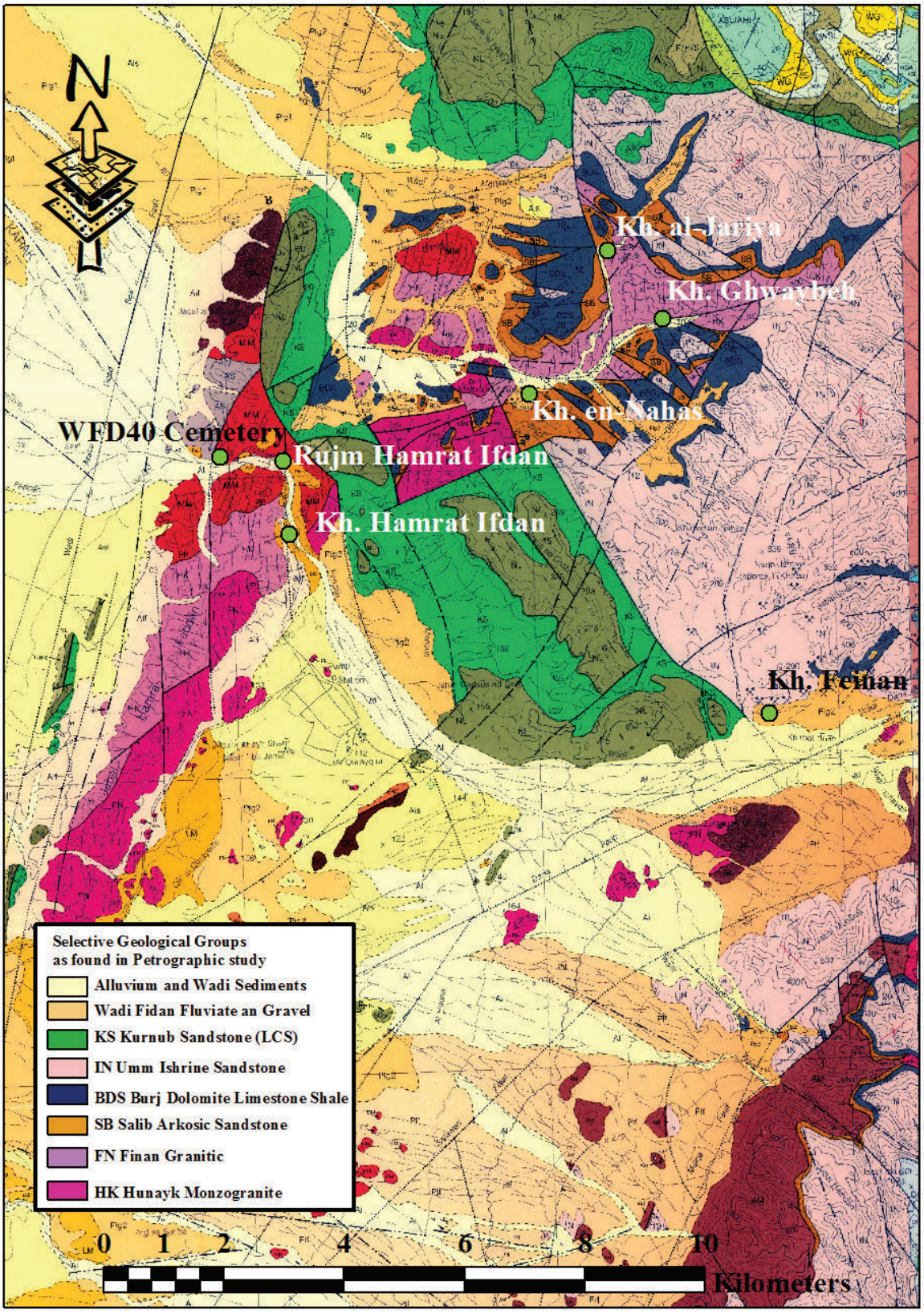

Figure 5.12 Geological map, Faynan region, Edom lowlands, Jordan. *Source: Designed in ArcGIS using National Resources Authority Geology Directorate geological map 3051 II.*

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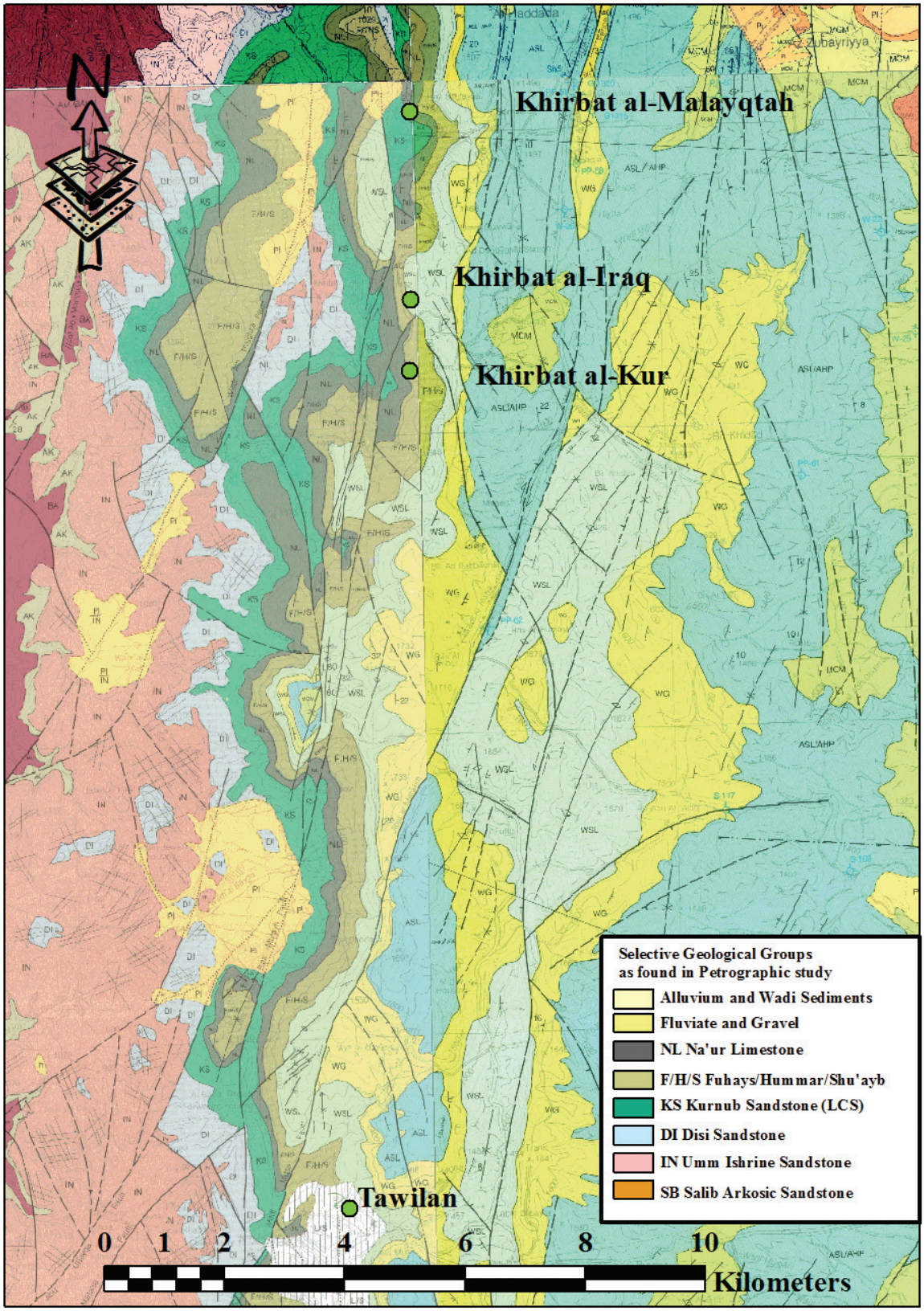

Figure 5.13 Geological map of northern Edom highlands, Jordan. *Source: Designed in ArcGIS using National Resources Authority Geology Directorate geological maps 3051 II, 3050 I, 3151 III.*

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Table 5.9 Petrographic groups and wares distinguished in the study (ratio indicates percentage of type represented out of total sample size).

P-Group	Sites	Name	Count	Ratio	Ware	Description	Count	Ratio
PG1-A	KEN, RHI Sounding A	Lower Cretaceous Shale	120	39.2%	A1	Predominant Type	40	13.1%
					A1b	Highly fired gray fabric	7	2.3%
					A1c	Fine-ware	3	1.0%
					A2	Slag Inclusions	45	14.7%
					A2b	Coarse Slag Inclusions	3	1.0%
					A3	Basalt Inclusions	2	0.7%
					A4	Calcite rich	3	1.0%
					A5	Fossiliferous Limestone	1	0.3%
					A6	Cooking Pot Fabric	13	4.2%
					A6b	Slag inclusions	3	1.0%
PG2	KEN	Lower Cretaceous Arkose	11	3.6%	A7	Medium-Fine ware	10	3.3%
					A8		1	0.3%
PG3	KEN, RHI Sounding B	Lower Cretaceous Disi Formation Sandstone	14	4.6%	A9		14	4.6%
PG1-B	KAM, KIJ, KIS, TW, RHI Sounding B	Lower Cretaceous Shale	136	44.4%	B1	Predominant Type	69	22.5%
					B1b	Coarse ware	13	4.2%
					B2	Slag Inclusions	1	0.3%
					B3	Basalt Inclusions	5	1.6%
					B4	Very Pale Brown Fabric	21	6.9%
					B5	High fired fine ware	8	2.6%
					B6	Cooking Pot Fabric	19	6.2%
PG4	KEN	Paleozoic Micaceous Clay	5	1.6%	A10		5	1.6%
PG5	KEN	Loess Soil	7	2.3%	I1		7	2.3%
PG6	KEN	Micaceous LCS-Qurayya	6	2.0%	I2		6	2.0%
PG7	KEN	Moza Dolomitic Clay	2	0.7%	I3		2	0.7%
PG8	KEN	Cypriot Aegean	3	1.0%	I4		3	1.0%
PG9	KEN	Syro-Lebanese Coast: Neogene clay with Amphorae	1	0.3%	I5		1	0.3%
PG10	KEN	Greek transport Amphorae	1	0.3%	I6		1	0.3%
Total Thin sections:			306	100.0%			306	100.0%

A small sample (n = 7) of ceramic sherds from KAJ were thin sectioned. Although the appearance of the fabric was similar to that at KEN, a number of distinctive petrographic attributes were observed: (1) none of the thin sections contained slag inclusions. This may be due to small sampling size, since during the ware analysis for the KAJ ceramic assemblage, several vessels appeared to have slag inclusions. (2) The only example of typical PG1-A was two samples (R491, CP20; R915, CP20), both cooking jugs, but they were made of a highly fired light gray cooking pot fabric. Other CP20 found at KAJ were not made of this gray fabric but appeared to contain a similar composition. All of the CP20 fabrics, including the gray fabric, were found at KEN among similar CP20s. (3) The two BL18s and JG14 were highly calicitic (~50 percent) compared with the thin sections found at KEN, where it was rare or replaced with limestone.

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Table 5.10a Identified petrographic and ware groups for thin-sectioned vessel types.

	PG1-A										PG2		PG3	PG4	PG1-B							PG5	PG6	PG7	PG8	PG9	PG10	
Type	A1	A1b	A1c	A2	A2b	A3	A4	A5	A6	A6b	A7	A8	A9	A10	B1	B1b	B2	B3	B4	B5	B6	I1	I2	I3	I4	I5	I6	T#
BL1	1														1													2
BL1f											1																	1
BL3a	7			2											2				1			1						13
BL3b	1														1													2
BL3c															3				2									5
BL3d																			1									1
BL8															1													1
BL8b															1													1
BL9	1			1																								2
BL12			2	1							1																	4
BL12c															2					6								8
BL13	2			2							1																	5
BL15				1										1								1						3
BL16			1											1								2						4
BL17		3		1																								4
BL18							2																					2
BL21	2			2									1															5
BL21a3															4				1									5
BL21b															3				1									4
BL21c																			1									1
BL21e															3													3
BL22	4														3					1								8
BL23				2											2					1								5
BL23b															2				1									3
BL24																						1						1
BL25														1								1						2
BL30	2														2				7									11
BL30b															1													1
BL30c															4													4
BL31												1																1
BL32	1																											1
BL34				1		1																						2
BL37				2																								2
BL41															3			1										4
BL56															3													3
BL57															1													1

This led to a designation of this group as A4. (4) The example with fossiliferous limestone (JR6) was the only of its kind found but otherwise appears to be local to the local geology. When all of this evidence is taken together, we can conclude that the ceramic assemblage at KAJ contains ceramics produced from different clay sources than those exploited by the potters at KEN. The location of KAJ further north up the Wadi al-Jariyeh may explain this disparity. On the other hand, KAJ was not limited to only these sources but also exploited similar clay sources as KEN and has a nearly identical fabric and morphological style as found among the cooking pots (CP20) at KEN. In Chapter 4 (this volume), the spatial distribution and association of CP20s and other parallel forms with specific stratigraphic levels at KEN are discussed in further detail.

Rujm Hamrat Ifdan has been distinguished both by radiocarbon dating and by its stylistically different ceramic assemblages (see Chapter 4, this volume) to have two significant periods of occupation. The ceramic assemblage recovered from RHI Sounding A, located at the top of the conglomerate hill, is similar to the Early Iron II material from KEN. The small sample of sherds that were thin sectioned (n = 5) from RHI Sounding A reveals that two of these sherds had slag

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Table 5.10b Identified petrographic and ware groups for thin-sectioned vessel types.

	PG1-A										PG2		PG3	PG4	PG1-B							PG5	PG6	PG7	PG8	PG9	PG10	
Type	A1	A1b	A1c	A2	A2b	A3	A4	A5	A6	A6b	A7	A8	A9	A10	B1	B1b	B2	B3	B4	B5	B6	I1	I2	I3	I4	I5	I6	T#
CP1									1	1																		2
CP2										1																		1
CP3									2																			2
CP4									1																			1
CP5									1	1																		2
CP8									1																			1
CP9									1																			1
CP15									1																			1
CP20									4		1																	5
CP30																					5							5
CP30b																					1							1
CP33																					5							5
CP36																					4							4
CP38																					1							1
CP46																					2							2
CP50																					1							1
FL2																						1						1
JG3		1											4															5
JG3d															5													5
JG3d2															1													1
JG3f															1													1
JG4		1													2													3
JG4d				1							1																	2
JG6d	2			1																								3
JG12													1															1
JG14		1					1				1																	3
JG26									1																			1
JR6				2				1																				3
JR7													1															1
JR8	1																											1
JR9	1																											1
JR10				1																								1
JR11	1																											1
JR13	1																											1
JR14				1																								1
JR15				1																								1
JR16																										1		1
JR17	1			1									1															3
JR30															1													1
JT1	1	1																										2
JT3													1	1														2
JT21															1									2				3
JT22																									3			3
JT30															2													2

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Table 5.10c Identified petrographic and ware groups for thin-sectioned vessel types.

	PG1-A										PG2		PG3	PG4	PG1-B							PG5	PG6	PG7	PG8	PG9	PG10	
Type	A1	A1b	A1c	A2	A2b	A3	A4	A5	A6	A6b	A7	A8	A9	A10	B1	B1b	B2	B3	B4	B5	B6	I1	I2	I3	I4	I5	I6	T#
KR1																			1									1
KR3	3			5																								8
KR4											1																	1
KR8													4															4
KR11	2																											2
KR12	2																											2
KR13	1			1																								2
KR15															8				2									10
KR16																			1									1
KR17															1				1									2
SJ2				1							2																	3
SJ3													1		1				1									3
SJ4				1																								1
SJ5				5	1																							6
SJ8				1	1																							2
SJ10				2																								2
SJ11				1																								1
SJ12				1																								1
SJ13						1																						1
SJ14											1																	1
SJ15																1		2										3
SJ18																5	1	1										7
SJ19				1											1			1										3
SJ20																3												3
SJ21																1												1
SJ22																1												1
SJ23																2												2
Pyxis	1																											1
Qurayya																							5					5
Painted	2			2										1													1	6
HM-Jar					1																							1
BS				1											3								1					5
Total	40	7	3	45	3	2	3	1	13	3	10	1	14	5	69	13	1	5	21	8	19	7	6	2	3	1	1	306

inclusions (R236, PT2 and R519, KR3). The ware analysis in general showed that the wheel-made pottery is identical to ware A1/2 found at KEN. Of the small thin-sectioned sample, one example, BL3a, which shares a number of morphological features and surface treatment found among parallel BL3as at KEN, had basalt inclusions. In addition, one example of painted Qurayyah ware was recovered from the area. It was not thin sectioned, due to its size, but has identical fabric as described above for PG6. These observations support the radiocarbon data, which indicate RHI Sounding A was contemporary with KEN.

In contrast, RHI Sounding B has a strong correlation with the L2HE sites designated as Ware Group B. A larger sample of this area was sampled (n = 38). With the exception of one thin section,[3] all the samples belonged to PG1. The ware analysis distinguished a subgroup B4, but the remainder could not be distinguished from B1. The identification of B2 slag-rich fabrics is significant. Although only one example was identified in thin section (R604, PT18), the ware analysis found that other PT18 also contained coarse granule-size slag inclusions. The fabric resembles the PT from KEN, but importantly, the morphological form is not witnessed at KEN. On the other hand, the latter morphological types are common among the L2HE sites (cf. Chapter 4, this volume). It was already mentioned above that the granule-size slag inclusions

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Table 5.11 Sites and areas thin sectioned.

Site/Pub	Area	Count	Ratio
KEN	A	45	14.7%
	M	25	8.2%
	R	29	9.5%
	S	35	11.4%
	T	24	7.8%
KAJ	KAJ06	7	2.3%
RHI04	Sounding A	5	1.6%
L2HE	Sounding B	38	12.4%
	KAM-A	24	7.8%
	KAM-B	7	2.3%
	KIJ	21	6.9%
	KIS	17	5.6%
	TW-J	23	7.5%
	TW-K	6	2.0%
Total		306	100.0%

found in pithoi from KEN were purposefully unsorted or used as temper. The evidence of slag in PT18 found at RHI is significant since there is no evidence found during excavations or on the surface of metallurgical activities. This would suggest that either the PT18 came from another Late Iron Age II site in the region that was conducting metallurgical activity or the slag-rich clay was purposefully collected from one of these sites and used strictly for the ceramic production of pithoi. As of yet, we have not found any evidence suggesting a late occupation at KEN, but there is still the possibility that an unexcavated area outside the center of the KEN complex was occupied during this later period. If such areas are discovered, there is a possibility that PT18 might be found there as well.

It was not possible to distinguish by petrographic or ware analysis between the ceramic assemblages recovered from the L2HE sites. All of these sites exploited the same Lower Cretaceous Kurnub sandstone formation found adjacent to these sites and below them in their respective wadi drainages (Figure 5.13). The ceramic assemblages underwent similar clay preparation, smoothing, surface treatment, and firing conditions. Therefore, the entire ceramic assemblage from each site should be considered primarily local to the Showbak-Petra region and part of a single *chaîne opératoire* (Lemonnier 1986:160, 1990, 1992). The decision to combine certain materials over others, the way an object is held while it is shaped, or the tools chosen to inscribe it are all arbitrary and often learned from one's culture. Throughout the operational sequence, the manufacturer both passively chooses to repeat manufacturing techniques of his or her culture and may also actively choose to improvise upon those techniques to solve specific problems of ideological, social, economic, or political importance. In other words, a *chaîne opératoire* is a *public artifact*—the communal practice of a series of learned cultural practices. Therefore, a number of technical choices ("technological styles") produce various unique traits to an artisan's work that become evident in the archaeological record and can be used for distinguishing one potting community from another.[4] Since these sites were all found in close proximity, it is understandable that an exchange of commodities and "cultural" models of pottery fashioning between ancient potters was common.

The circumscription of technological styles within potting communities is corroborated when the ceramic assemblages from these sites are compared to the contemporary radiocarbon-dated lowland site of RHI Sounding B (Levy et al. 2008). Across the vessel types and families, RHI has a different fabric, designated here as B4. Its consistent use suggests that a large variety of morphological forms were created by the same community of potters. The different-color fabric, however, should not be confused with its clay source; the petrographic analysis found it to be acquired from the same PG1 as found at KEN and the L2HE sites. The clearly distinguishable looking fabric is a product of the *chaîne opératoire* of the producers that made this pottery. Thus, we find a different technological style that predominates in the production of ceramics at RHI in comparison to the highland L2HE sites. The 10-hour walking distance between RHI and the L2HE sites was in the range of possible social interaction. The movement back and forth of individuals between these two areas is observed today among modern Bedouin who reside in the respective Faynan and Showbak areas. A number of possible, easily traversable routes are regularly taken by these regions' modern inhabitants. This relatively short distance suggests that these two areas could have had intense interaction. However, despite this observation, it is clear from this study that methods of pottery production were circumscribed within these different subregions of Edom. The possible

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intense interaction that could have occurred between these areas did not result in the transfer of specific technological styles between these groups. Even though on a purely functional level, the ceramic ware found at the L2HE sites can be considered superior to RHI's B4 ware, the potters at RHI did not adopt the technical procedures that resulted in this ware. Therefore, it can be inferred that some form of social boundary existed between these groups that limited the exchange of learned technological styles in ceramic production.

Furthermore, this petrographic study reveals that specifically all the ceramics so far studied for these Late Iron Age II sites lacked imports. Taken as a whole, the predominant fabrics are local or subregional in Edom at all of these sites. A possible explanation for this lack of imports is that all of these sites are small- to medium-size villages. They were not towns or important centers that would have generated the resources to acquire foreign goods or had elites who could control the exchange of those goods. If these villages did acquire foreign goods, it would most likely be through down-the-line exchange or the purchase of these goods at a nearby town (which currently has not been identified), but as of now, there is no evidence that either of these activities occurred. However, excavations at Busayra (cf. Bienkowski 2002:350), the supposed capital of Edom, had minimal evidence of imported ceramic wares as well. In the case of Busayra, where Assyrian documents attest to elite connections with foreign powers, the lack of imported pottery is puzzling.

In contrast to the sites on the plateau (KAM, KIJ, KIS, Tawilan), KEN, RHI Sounding A, and KAJ all show evidence of interaction and exchange of ceramics outside their immediate vicinity. This difference is perhaps related to the nature of these sites being industrial and perhaps an Early Iron Age II period when importation of ceramics (and social interaction) was more widely practiced in Edom. The petrographic data confirm the distinctions made between the imported pottery and the local ceramic assemblages recovered at these sites (cf. Chapter 4, Imports, this volume). At KEN and KAJ, western Negev red-slipped bowls were found. From RHI Sounding A and KEN, Qurayyah ware is found. Finally, KEN's exchange network appears to be quite extensive, since the origins of imported pottery are found in central Cisjordan (e.g., black burnished juglets), Cyprus (e.g., black-on-red juglets), Phoenica (PG9), and Greece (PG10). Each of these, however, represents a small minority (<1 percent) of the ceramics sampled (cf. Table 5.9; Figures 5.9, 5.10). These imports should be considered even more rare compared with the entire assemblage as a whole since they are just one occurrence (e.g., PG9, 10) or occur in small numbers, often as painted body sherds (see Chapter 4, Imports, this volume). Therefore, in all cases, even among the wheel-made red-slipped bowls from the western Negev and the painted Qurayyah wares, they should be considered rare, infrequent imports rather than a contingent of foreigners living at the site. On the other hand, their presence in the material record suggests that KEN was not purely just a subsidiary metallurgical complex populated by full-time craft specialists. Fine-ware goods were imported into the site by individuals who may have been in charge of metallurgical operations.

A number of important observations can also be made concerning the Qurayyah ware in relation to previous studies of its provenience. The Qurayyah ware fabric identified in this study is petrographically identical to the pottery analyzed by Rothenberg and Glass (1983) from Timna. These are thus imports from outside KEN rather than local imitations. Second, another southern import different from the Qurayyah ware, the PG4 Paleozoic micaceous painted sherds, may have originated from the Sinai and possibly from contemporary metal-producing sites during this period (e.g., Timna). However, this group shared many stylistic similarities with pottery found at KEN while the Qurayyah ware could immediately be distinguished (see Chapter 4, this volume). The "Qurayyah" ware found at KEN was not made from local clay sources and thus originated from somewhere else further southeast in the vicinity where similar clay sources have been found. The PG4 group raises the question of whether ceramic-producing groups not currently identified were exchanging their wares with the local inhabitants of Edom and possibly the Negev. The observations by Gunneweg et al. (1991) that the "Qurayyah" ware found at the Negev sites came from local clay also suggest that possibly foreign groups were living amid the local inhabitants of the Negev and Edom. Further investigation is needed to also compare the PG4 petrographic samples with the pottery identified by Gunneweg et al. (1991) to have originated from the south.

Furthermore, the petrographic analysis did not identify a single "Egyptian" (Nile ware) import. Although a lack of "current" evidence does not disqualify the possibility of Egyptian interaction in this region, it is quite clear,

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especially in comparison to the presence of Qurayyah ware at the site, that the Egyptian presence, if any, was minimal in comparison to the other neighboring polities of Edom.

Finally, at KEN, several other possible clay sources were either exploited by the local potters or reflect exchange within the southern region. The most intriguing of these is the PG3 fine white ware ceramics. This ware is specific to only a few types (KR8, JG3a, and BL14). They represent another technological style made of various specific technical choices necessary to achieve the uniformity of this ware. Specific technical choices can be seen in the selection of Disi formation clay, its preparation, shaping, finishing techniques, and firing. In addition, this ware is not an infrequent type. Within this study alone, it represents around 8 percent of the total sample thin sectioned from KEN (cf. Figure 5.11). The predominance of this subform becomes readily apparent when quantitatively compared to the ceramic assemblage of KEN as a whole since it represents the entire krater (KR8) group, jug (JG3a) group, and the majority of the bowl (BL14) group (see Chapter 4, this volume, for tables). Therefore, this ware represents several possible origins: (1) there was possibly a high degree of importation of these products into KEN, or (2) potters produced it on site but traveled to acquire the highly siliceous clay. This ware may be the same as Ware 3b: "white ware" identified by Bienkowski (2002:235). A parallel grooved jug handle (Jug D) found at Busayra and possessing identical described fabric was found at RHI Sounding B (cf. Chapter 4, JG1). The INAA study for Busayra sampled one example of this ware and found it to originate in the Wadi Arabah (Bienkowski 2002:235). As more sites are surveyed and excavated in the lowland region of Edom, we may be able to reach a more refined answer concerning the nature of these ceramics and the origin of their production. What can be concluded now is that they represent a specific class of highly specialized ceramic production with their own series of technical choices.

Conclusion

In summary, a combination of petrographic and ware analysis has enabled a fine-grained study of the various ceramic assemblages recovered from the UCSD ELRAP and L2HE stratified excavations. Based on the petrography and ware analysis of these ceramics alone, it has been possible to delineate the different regions and sites from which these ceramics originated and make a diachronic distinction between the earlier ceramic assemblages and later. In the case of the later period, where five sites could be compared, it is argued here that it is possible to distinguish different technological styles for the two subregions—the highlands and lowlands of Edom. The circumscription of these technological styles suggests that a social boundary existed even though intense interaction may have occurred between these communities. In the case of the earlier period sites, the evidence of imports suggests that these sites to a greater extent participated in the interaction sphere of their western and northern neighbors. KEN's important role in the exportation of copper was not a purely one-sided affair, but valuable "prestige goods" were also imported. In Chapter 4 (this volume), the petrographic data are combined with a morphological study to further clarify the inferences made here.

Notes

1 The wheel marks may be a direct result of a fast wheel or later purposeful smoothing.

2 It is important to note that Oakshott (1978) and later Bienkowski (2002) distinguished a similar white-colored ware coming from Busayra that they described as siliceous. Whether this is the same ware found at RHI Sounding B needs to be investigated further.

3 R303, JG3 (discussed above) probably originated from the PG3 Disi formation. It can still be distinguished from the other PG3 by its greenish white fabric and red-colored voids. The continued use of the PG3 fabric into the Late Iron Age II is significant.

4 See Chapter 4 (this volume) for an extended discussion of how social boundaries and technological style are related. For several ethnoarchaeological examples of this principle occurring, see Deal (2007), Dietler and Herbich (1998), van der Leeuw (1993), Stark (1998), and Stark et al. (1998).

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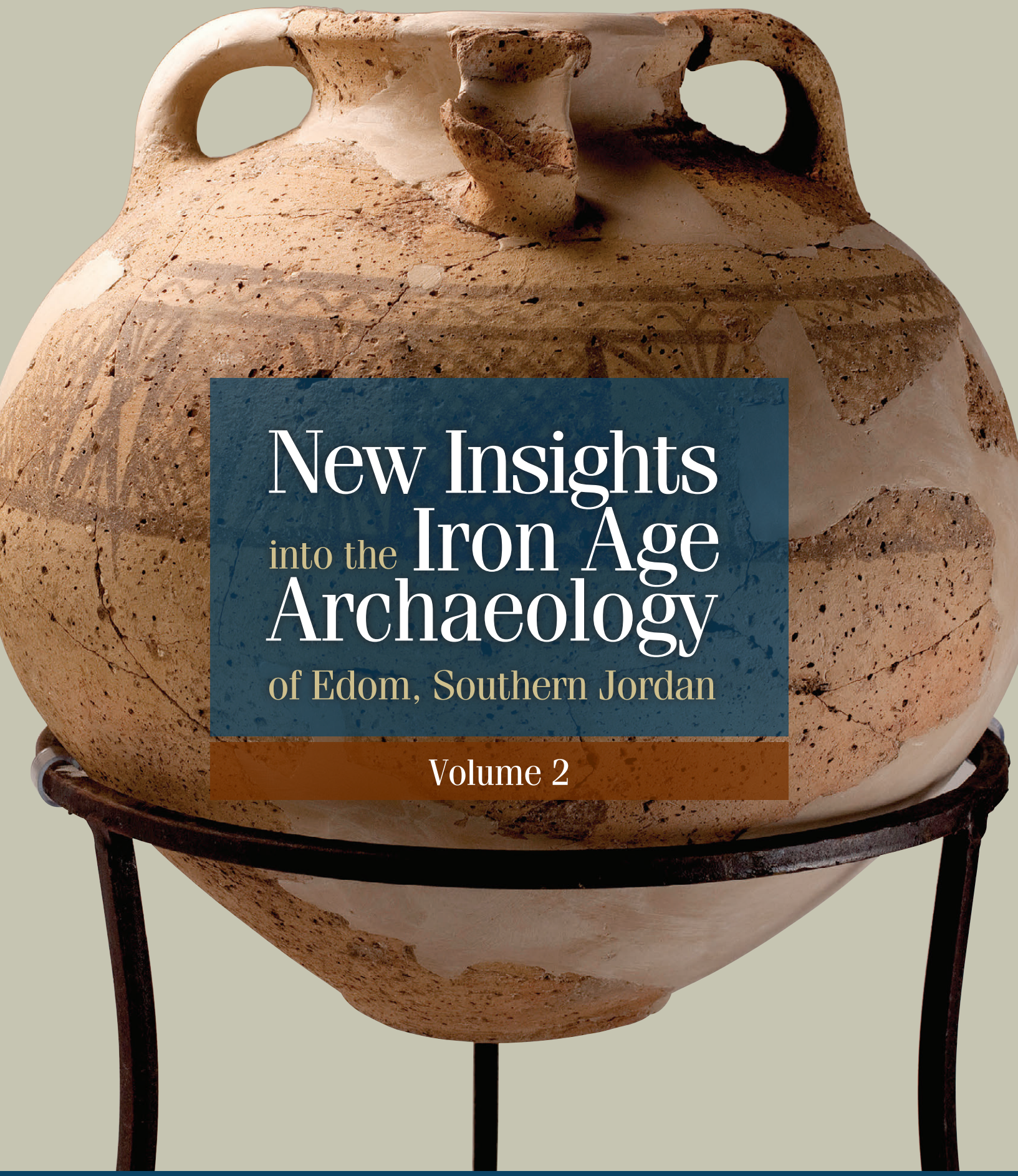

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Volume 2

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6 Local Iron Age Trade Routes in Northern Edom

From the Faynan Copper Ore District to the Highlands

Erez Ben-Yosef, Mohammad Najjar, and Thomas E. Levy

This chapter presents results of a regional archaeological road survey conducted in the summer of 2007 in the mountainous area between the copper ore district of Faynan and the Iron Age administrative center of Busayra (biblical Bozrah). We recorded three major ancient ascents, Naqb al-Ghuwayba, Naqb al-Jariya, and Naqb ad-Dahal. These ascents take advantage of the local geological setting to overcome an elevation difference of more than 1,000 m in the rugged terrain between the lowlands of the Arabah Valley and the Edomite plateau. Especially significant is the discovery of portions of these ascents that were not disturbed by activities of later periods, possibly representing Iron Age road construction. We discuss these finds in light of descriptions of early travelers, the physical setting of the landscape, the geographical history of the region, and the general picture of Iron Age trade routes in the southern Levant. In addition to dealing with the local road system, this chapter helps fill in a knowledge gap concerning the archaeological landscape of southern Jordan by introducing some major new sites, natural resources, and other human-related features in a previously unsurveyed area.

> Every landscape is a code, and its study may be undertaken as a deciphering of meaning, of the cultural and social significance of ordinary but diagnostic features. … Any landscape is so dense with evidence and so complex and cryptic that we can never be assured that we have read it all or read it aright. The landscape lies all around us, ever accessible and inexhaustible [Meinig 1979:6].
>
> Landscape constitutes a discourse through which identifiable social groups historically have framed themselves and their relations with both the land and other human groups [Cosgrove 1998:xiv].

Opposite: Survey team using differential GPS unit to map an ancient road identified in the survey from Faynan to the Iron Age administrative center of Busayra (biblical Bozrah). *Photo: Erez Ben-Yosef.*

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Introduction

The red sandstone-dominated landscape of southern Jordan has been called "Edom" since biblical times (Avishur 2007). With its copper ore–rich lowland, cliffs, and precipitous mountain slopes embedded with "islands" of Mediterranean terrain in the highlands, the landscape of Edom had a distinct impact on the emerging local Iron Age (ca. 1200–586 BCE) polity bearing the same name.[1] This landscape no doubt inspired the spiritual life of the Edomites and their perception by others such as the neighboring Israelite polity (see, e.g., Jer. 49.16, Obad. 1.3). Even more so, this multifaceted landscape affected the settlement pattern, defense system, economics, and "landscape of movement" (Snead et al. 2009b) of this remote polity. This chapter focuses specifically on the Iron Age routes in the vicinity of lowland Faynan and their ascent to highland Busayra, two important economic and administrative centers in the heart of ancient Edom. These routes were influenced and constrained by the dominant landscape, and their reconstruction depends on detailed analysis of the local terrain associated with the Iron Age material culture. The core of this chapter contains data from our regional Faynan Busayra Regional Survey (FBRS) conducted during the summer of 2007. The survey was designed to track ancient routes connecting the lowlands and highlands of Edom. Together with an investigation of geographical features in the region, the survey data comprise the basis for a tentative reconstruction of an Iron Age road network and a discussion of road construction quality for this period in the southern Levant. The regional survey has also resulted in a substantial addition of archaeological sites from a region hitherto unsurveyed.

In recent years, the Iron Age archaeological record of the Faynan copper ore district, situated on the eastern side of the Wadi Arabah Valley (inset to Figure 6.1), has been at the center of a systematic research carried out by the University of California at San Diego (UCSD) and the Department of Antiquities of Jordan (DOAJ). In an attempt to enhance our understanding of the local society and related historical processes, multiple excavations and full-coverage surveys took place under the Jabal Hamrat Fidan (JHF) project (e.g., Levy, Adams, and Najjar 2001) and the consecutive Edom Lowlands Regional Archaeology Project (ELRAP, e.g., Levy and Najjar 2007 and chapters in this volume), in the northern and western portions of Faynan (Figure 6.1). The FBRS project was conducted as part of ELRAP to further contextualize the ever-growing pool of information concerning the Edomite lowlands by examining the connections between the Faynan resource zone and the highlands of Edom (in particular with the site of Busayra).

FBRS covered an area of approximately 250 km^2, from the basin of Wadi al-Ghuwayba in the south to the basin of Wadi al-Khanzira in the north (Figures 6.1 and 6.2).[2] To the east, we chose as a boundary the prominent ridge of Jabal al-Rummana and the King's Highway on the edge of the Edomite plateau, and to the west the "old road" (MacDonald 1992a, appears on most Jordanian maps prior to 1989)—the principal north–south dirt road to the east of the current highway of Wadi Arabah. We surveyed this vast area by focusing on the main dirt roads, easily accessible paths, and optional ancient routes, identified by aerial photography as well as topographic and geological maps. The survey was designed to answer specific research questions (see below); thus, it did not provide "full-coverage" data or a "random sample" statistic (e.g., Banning 2002; Judge et al. 1975).

The main goal of the FBRS was to identify and record potential Iron Age routes between the lowlands and highlands of Edom north and northeast of Faynan. In addition, other secondary objectives were (1) to connect the intensely surveyed area of Faynan to the areas surveyed by Burton Macdonald's projects to the north and northeast (MacDonald 1992a; MacDonald et al. 2004) by identifying and recording major archaeological sites in the intermediate unexplored region; (2) to assess the natural environment of the survey area and identify natural resources (potential mining areas, water sources); (3) to locate areas of interest for full-coverage surveys in the future; (4) to record major archaeological features in the 'Ain al-Ghuwayba archaeological complex (Ben-Yosef et al. 2009a), the northeastern gateway to the Faynan region in the Iron Age (and the destination of the principal route from Busayra; see below); and (5) to identify and record trails and unmapped dirt roads for further development of the area as an ecotourism park and research center (Levy and Najjar 2007).

In the following sections, we present (1) the physical background for the local road network in the region of Faynan, (2) an overview of earlier fieldwork in the region, (3) a summary of the results of the FBRS, (4) a discussion concerning the nature of Iron Age road construction in Edom, and (5) a tentative reconstruction

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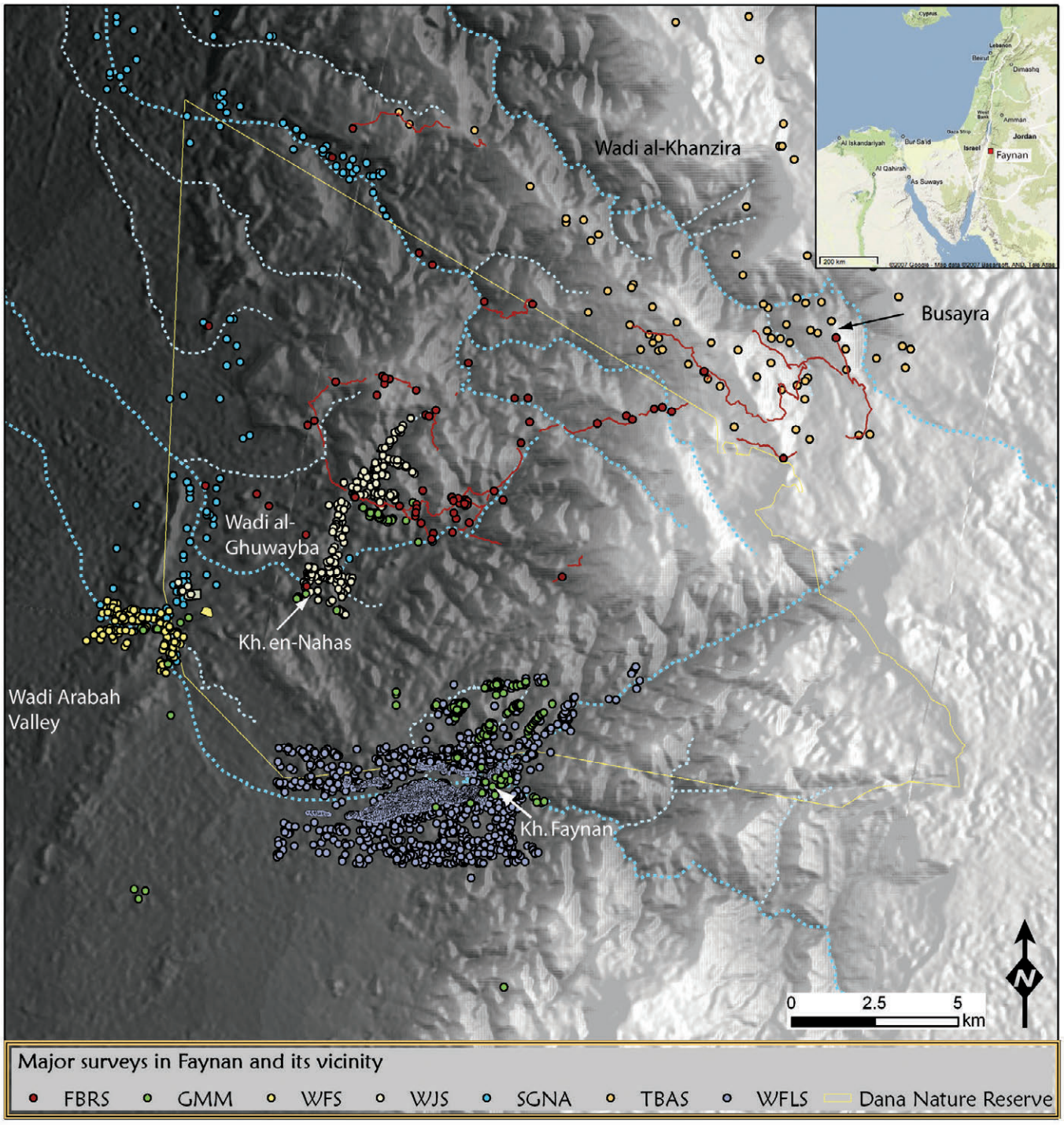

Figure 6.1 Shaded-relief map of Faynan copper ore district (Jordan) and its vicinity. Archaeological sites (all periods) recorded by major surveys in the region are plotted, as well as the boundary of Dana Nature Reserve. Kh. = Khirbat ("the ruins of" in Arabic); FBRS = Faynan-Busayra Regional Survey, red lines are recorded road segments (conducted in 2007, this chapter); GMM = German Mining Museum archaeometallurgical survey (1983–1992, described partially in Hauptmann 2007 and references therein); WFS = Wadi Fidan Survey (field season of 1998 in Levy, Adams, Witten, et al. 2001, field season of 2004, contiguous portion higher along the wadi, Chapter 7 in this volume); WJS = Wadi al-Jariya Survey (season of 2002 in Levy et al. 2003 and season of 2007, Chapter 7, this volume); SGNA = Southern Ghor and Northern Arabah Survey (1985–1986, MacDonald 1992a); TBAS = Tafila–Busayra Archaeological Survey (1999–2001, MacDonald et al. 2004); WFLS = Wadi Faynan Landscape Survey (1996–2000, mostly in Barker, Gilbertson, et al. 2007 and references therein).

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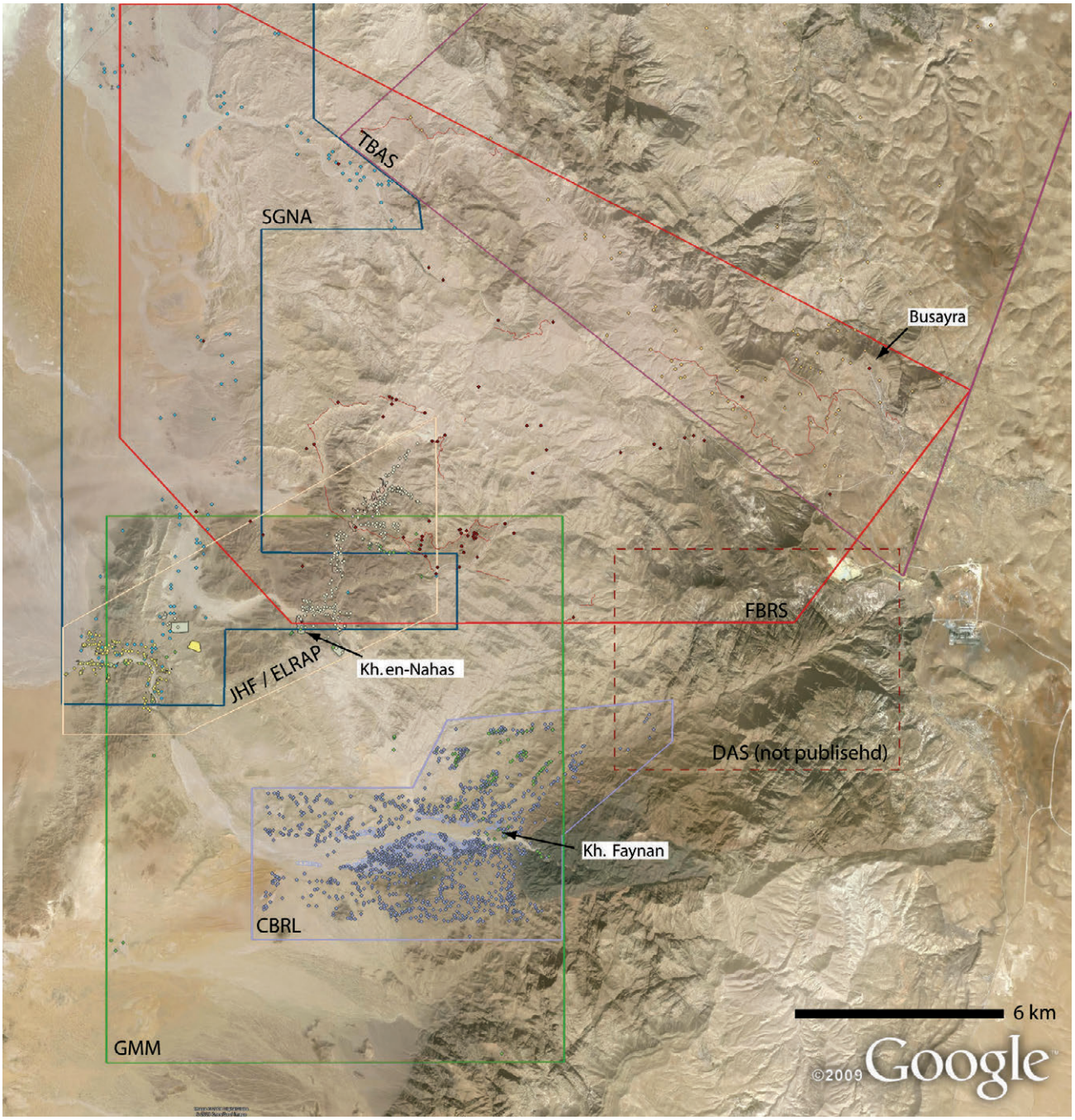

Figure 6.2 Satellite image (Google Earth) of the Faynan copper ore district (Jordan) with the main archaeological project areas indicated. Archaeological sites recorded by major surveys in the region are plotted (cf. Figure 6.1 for key), as well as schematic delineation of main research areas. CBRL = Center of British Research in the Levant (formerly BIAAH, British Institute at Amman for Archaeology and History; see in particular Barker, Gilbertson, et al. 2007 [Wadi Faynan Landscape Survey], Finlayson and Mithen 2007 [The Dana-Faynan-Ghuwayr Early Prehistory Project], McQuitty 1998 [The Wadi Faynan Project], and Wright et al. 1998 [The Wadi Faynan Fourth and Third Millennia Project]); DAS = Dana Archaeological Survey (an extensive, unpublished survey in the Dana Nature Reserve conducted by George Findlater [also affiliated with CBRL]; exact extent is unknown); GMM = German Mining Museum (Deutsches Bergbau-Museum, Bochum; Hauptmann 2007 and references therein); JHF = Jabal Hamrat Fidan Project (University of California at San Diego and the Department of Antiquity of Jordan, Amman; see Levy et al. 2004; Levy, Adams, and Najjar 2001); ELRAP = Edom Lowlands Regional Archaeology Project (University of California at San Diego; see Levy et al. 2008 and chapters in this volume); SGNA and TBAS are regional surveys by MacDonald (see Figure 6.1 for details); BLSP = The Barqa Landscape Survey Project (Russell B. Adams, McMaster University, ongoing).

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of the local routes as part of the "global" road system in the southern Levant during the Iron Age. In the appendix, we provide a description of a recently identified desert kite from the region of Faynan, to date, the only such installation known from the eastern side of the Arabah Valley.

Geographical Setting

The copper ore district of Faynan lies within the Saharo-Arabian desert zone of the northeastern Arabah valley, around 40 km south of the Dead Sea and on the foothills of the Jordanian plateau. The district is named after the major archaeological site of Khirbat Faynan (not to be confused with the small, mainly Pottery Neolithic site of Tell Wadi Faynan found in the 1980s; Najjar et al. 1990), located at the confluence of Wadi Dana and Wadi Ghuweir (Figures 6.1 and 6.2) and identified as biblical Punon (Num. 33:42f., 1 Chron. 1:52 and see also "Pinon" in Genesis 36:40–43) (first by Seetsen in 1854; see Edelman 1995).[3] Because of its economic importance, the region of Faynan constituted the core of the biblical kingdom of Edom, at least in its incipient stage and probably as long as intensive copper exploitation was practiced there (Ben-Yosef et al. 2010; Hauptmann et al. 1985; Knauf 1995). The extent of the biblical/Iron Age kingdom of Edom fluctuated throughout the centuries and is poorly delineated in biblical and other historical accounts. It is generally accepted that the mountain highlands of southern Jordan were the heart of this polity (Bartlett 1989; Edelman 1995), with Bozrah (Gen. 36:22; Isa. 34:6; 63:1; Jer. 49:13,22; Amos 1:12), one of its few securely identifiable settlements (modern Busayra), as its administrative center at least during the late Iron Age (Bienkowski 1995, 2002; Crowell 2004; Whiting 2007). It is also widely accepted that the term *Edom* referred initially to a distinct geographic region (e.g., 2 Sam. 8:14) and only later came to designate a polity or people. This is exemplified by the earliest known reference to Edom in the Egyptian source of Papyrus Anastasi VI[4] (referring to an event in the late thirteenth century BCE) (Bartlett 1989:37–38) and, maybe by the descriptive nature of the term *Edom*, meaning "red" in Hebrew and probably referring to the prominent red sandstone cliffs of the mountain slopes of southern Jordan (Edelman 1995). A few other geographic terms in the Bible are associated with Edom, including Se'ir, Gebal, and Teman. Se'ir has been identified as the wooded land of southern Jordan following the Hebrew meaning "hairy" for "Se'ir," as the area south of Showbak following the resemblance of "Sei'r" to the modern Arabic district name of "es-Shera," or as some areas in the Negev, following the interpretation of Egyptian texts (see in particular Bartlett 1989:42–44; Edelman 1995; Zucconi 2007). Gebal has been identified as the area north of Showbak following the modern Arabic district name el-Jibal, with Eusebius reference to Gebalene and Josephus reference to Gobolitis (see Bartlett 1989:39). Teman has been identified as a territory in southern Edom and earlier as a specific settlement (see Bartlett 1989:40; de Vaux 1969:379–385).

The geography, geology, and ecology of Faynan have played a significant role in the development and function of societies in this region (see details in Bruins 2006; Hauptmann 2007:39–53; MacDonald 1992b; Moumani 2004; Palmer et al. 2007:25–38). Some of the aspects of the natural environment also have implications for understanding and reconstructing the local and regional road networks—most important, the geology, topography, and the location of major water sources. As noted above, the Faynan region is located on the eastern margins of the Dead Sea–Wadi Arabah rift system, a major geological feature that is responsible for the dramatic morphology of the landscape and the distribution of different rock formations and ore outcrops. The rifting process resulted in the creation of the deep Gulf of Aqaba, the elongated Arabah Valley, the depression of the Dead Sea (as is well known, the lowest place on earth), and an uneven lifting of both sides of the rift valley. While the Negev hills to the west rise gradually above the Arabah up to an elevation of a few hundred meters above sea level, the Edomite mountains to the east rise abruptly up to an elevation of almost 2,000 m above sea level and create a substantial topographic obstacle (Figure 6.3). Approximately 1,000 m in elevation separate Faynan and Busayra over a distance of less than 15 km as the crow flies, and any route connecting the two centers must cope with the radical altitude challenge.

In addition, the considerably greater uplifting of the eastern side of the Arabah Valley resulted in the exposure of deep rock formations that characterize the slopes of the Edomite mountains and generally are not exposed on the western side (the Negev). Among these formations is the Umm Ishrin, whose red sandstone characterizes the Edomite landscape and forms the background of important sites such as

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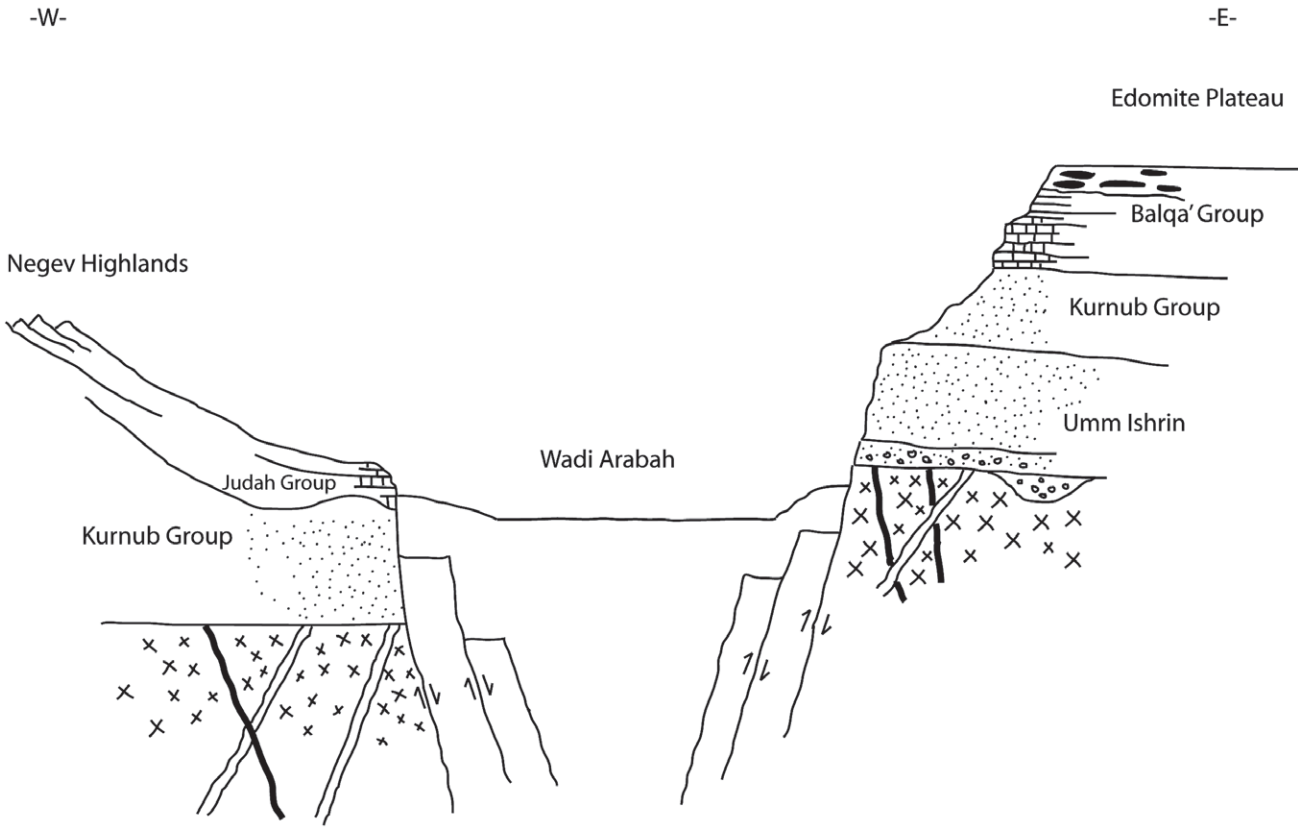

Figure 6.3 Schematic cross section of the Dead Sea Rift showing the main geological units. The topographic and geological obstacles are more prominent on the eastern side of the rift, and the construction of ancient (and modern) roads was more challenging (adjusted after Ravek and Shmida 2000).

Umm al-Byara and Sel'a. Because of the differences in rock mechanics and erosional characteristics, each rock formation presents different levels of difficulty for passage. For example, the marine sediments of the younger formations (such as Amman, Wadi as-Sir, and Shuayb; Tarawneh 1987) create ridges and slopes that are gradual and relatively easily accessible. Naqb ad-Dahal, the main route from Busayra directly west to the Arabah Valley, takes advantage of an extensive exposure of such formations and a "break" in the continuity of slopes usually made of the less passable formations (see below). The massive red sandstone of the Umm Ishrin formation usually creates sharp cliffs and constitutes the major obstacle for routes connecting the highlands and lowlands of Edom. To overcome this obstacle where there was no massive interruption in the exposure of this formation, routes took advantage of local fault systems that resulted in a more moderate and passable landscape, backed up with road constructions where necessary (examples are Naqb Dana and the Dana fault and Naqb Ghuwayba and the Ghuwayba fault system; see details below). Figure 6.4 summarizes the major formations exposed along the slopes of the Edomite mountains and their morphological characteristics. It also shows the stratigraphic location of the Burj formation, the main copper ore deposit in Faynan, whose local exposure determined the location of many sites in the region.

The area covered by FBRS includes three major wadi basins (separate water catchments zones); all are part of the Wadi Arabah and the Dead Sea drainage system (Figure 6.1). The wadi basins from north to south are Wadi al-Khanzira (Arabic for "wild sow") and its tributary, Wadi ad-Dahal and its tributaries (notably the southern branch of Wadi Jleila), and Wadi al-Ghuwayba (Arabic for "little grove," named after the grove at the small oasis of 'Ain al-Ghuwayba) and its tributaries. The next wadi basin to the south (Figure 6.1) is Wadi Faynan/Fidan and its pronounced tributaries of Wadi Dana and Wadi Ghuweir, along which many

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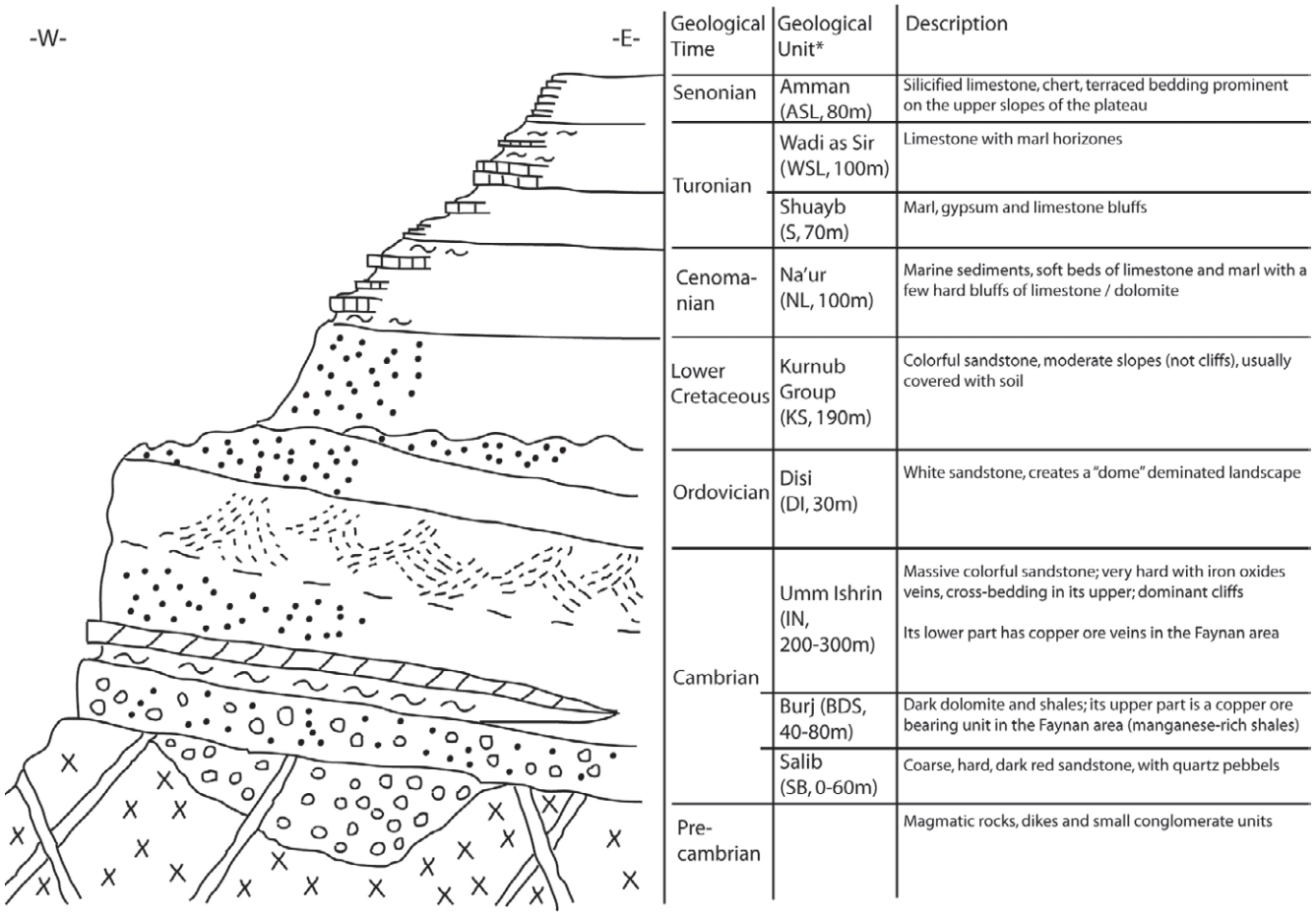
of Faynan's important sites are located, including Khirbat Faynan and Khirbat Hamra Ifdan. The wadis are primarily dry valleys or canyons, carrying water on rare occasions of strong local rains during the winter or the transformation seasons, usually in the form of flash floods. However, in each of the major wadi basins, permanent springs support small oases and are reliable water sources in the desert region of southern Jordan and the eastern Arabah ('Ain ad-Dahal, 'Ain al-Ghuwayba and 'Ain Fidan, respectively; 'Ain—Arabic for "spring"). In addition to the well-known oases, we recorded other water sources in the FBRS area that mostly include *thamail* (Arabic—pl. of *thamila*), dug depressions into high water tables in wadi beds (e.g., Evenari et al. 1982:152), representing additional water sources possibly available in antiquity as well (see below). A traveler or a caravan passing through the landscape of southern Jordan, particularly its lowlands, is entirely dependent on such water sources. The yearly average rainfall, approximately 60 mm in the Arabah (Bruins 2006; MacDonald 1992b:15) and above 200 mm in the highlands (up to 500 mm in a rainy year; Amiran et al. 1970) in the highlands, restricts agriculture to the higher slopes only, although some of the oases supported extensive fields on the wadi terraces below them (most notably the field system recorded by the Wadi Faynan Landscape Survey [WFLS] near Khirbat Faynan and dated to the Early Bronze and Iron Ages [see Figure 6.1 and reference in caption]; 'Ain al-Ghuwaibe supports modern olive orchards cultivated by Bedouin from the Man'aja section of the Huwaytat tribe).



Geological Time	Geological Unit*	Description
Senonian	Amman (ASL, 80m)	Silicified limestone, chert, terraced bedding prominent on the upper slopes of the plateau
Turonian	Wadi as Sir (WSL, 100m)	Limestone with marl horizones
	Shuayb (S, 70m)	Marl, gypsum and limestone bluffs
Cenoma-nian	Na'ur (NL, 100m)	Marine sediments, soft beds of limestone and marl with a few hard bluffs of limestone / dolomite
Lower Cretaceous	Kurnub Group (KS, 190m)	Colorful sandstone, moderate slopes (not cliffs), usually covered with soil
Ordovician	Disi (DI, 30m)	White sandstone, creates a "dome" deminated landscape
Cambrian	Umm Ishrin (IN, 200-300m)	Massive colorful sandstone; very hard with iron oxides veins, cross-bedding in its upper; dominant cliffs Its lower part has copper ore veins in the Faynan area
	Burj (BDS, 40-80m)	Dark dolomite and shales; its upper part is a copper ore bearing unit in the Faynan area (manganese-rich shales)
	Salib (SB, 0-60m)	Coarse, hard, dark red sandstone, with quartz pebbels
Pre-cambrian		Magmatic rocks, dikes and small conglomerate units

Figure 6.4 Schematic geological cross section of the Edomite mountains, representing major units and their appearance on the mountain slopes. The main obstacle for roads ascending from the Arabah Valley is the Umm Ishrin formation that appears as sheer cliffs of hundreds of meters. The Faynan copper ore district is based mostly on minerals of the Burj formation (and lower Umm Ishrin); Busayra is located on the Na'ur limestone (cf. Figure 6.18). In the area covered by FBRS, the terraced landscape of the upper geological units was extensively used for agriculture (characteristic of the edge of the Edomite and Moabite plateaus) (drawing after Rabba' 1991, 1994; Ravek and Shmida 2000).

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The morphology of the wadi basins is dictated by the underlying geology, and in places where the easily eroded rock formations are exposed and/or a substantial fault or cracking occurs (a break in the continuity of rock units, usually manifested as a weak zone along linear segments), they may be shaped as relatively wide valleys with gradual slopes, thus constituting a preferable course for ancient routes (e.g., Wadi ad-Dahal). However, in most cases along the eastern side of the Arabah rift valley, the wadis are shaped as deep canyons with segments of narrow gorges, impassable without special rappelling gear and presenting a significant obstacle for ancient routes (e.g., Wadi al-Khanzira, Wadi Ghuweir, and Wadi Feid; see below and Ben-David 2007).[5]

The general direction of the wadis in northern Edom and the area of Faynan is from east to west or from southeast to northwest (Figure 6.1), and thus roads that connect places along trajectories other than those will usually need to overcome the difficulty of crossing a number of different wadi systems. This is the case with the main road from Faynan to Busayra, whose general direction is from southwest to northeast (see below).

The Faynan-Busayra Regional Survey (FBRS) in Context of Earlier Research

The Faynan copper ore district attracted the attention of travelers and scholars for centuries and was subjected to an intensive archaeological and archaeometallurgical research during the past few decades, including various surveys of different extent and scales of resolution. The importance of the region as an ancient copper production center was recognized early on, as demonstrated by a map from 1732 by Bourguignon d'Anville (1897), where Khirbat Faynan (there as *Phenon*) appeared together with a specific notation for copper slag (*Aeris Fodinae*). According to Weisgerber (2006:2–3) this notation is the first-ever mapping of slag anywhere and probably refers to the massive slag mounds around the Roman/Byzantine ruins on and around the ancient mound (for the map segment depicting Faynan and the southern part of the Dead Sea, see Weisgerber 2006:Figure 1).

In contrast to early references to the prominent and centrally located ruins of Khirbat Faynan, the ruins of Khirbat en-Nahas (Arabic for "ruins of copper") and two other nearby Iron Age copper production sites were first reported only in the early twentieth century. Khirbat en-Nahas, the largest Iron Age copper production center in the southern Levant, was first reported by the Austrian-Czech orientalist Alois Musil, who first visited the area in 1898 (Musil 1907–1908). Musil also reported the site of Khirbat al-Ghuwayba, located around 3 km northeast of Khirbat en-Nahas in the upper part of the same wadi basin. The first to correctly date these sites to the Iron Age and to identify Khirbat en-Nahas with biblical 'Ir-Nahas ("City of Copper"; Glueck 1940a:83) was the American archaeologist Nelson Glueck, who visited the area in March 1934 (Glueck 1935; for an overview of his research in Transjordan, see Dever 2000). Glueck also reported the site of Khirbat al-Jariya ("ruins of the handmaiden") located in a hidden valley around 2.8 km northeast of Khirbat en-Nahas. Although Glueck claimed to be the first to discover the secluded site (Glueck 1935:23), while collecting background material for the FBRS, we found out that the 1883 British expedition of Major Kitchener reported an unnamed copper production site that is certainly Khirbat al-Jariya (Kitchener 1884 and see below). Another early twentieth-century researcher who provided significant descriptions of sites around Faynan was the German scholar Fritz Frank (1934). Frank visited the area in 1932–1933, and his descriptions include sites in Wadi Fidan (there referred to as Wadi Ifdan).

The itineraries of early travelers are important not only for locating archaeological sites but also for tracking ancient roads. As these explorers traveled by foot or by camel and relied on the guidance of local Bedouins, the paths chosen were probably the most accessible and may indicate preferred routes used also in antiquity. Moreover, their detailed descriptions point out major water sources and portray the experience of traveling through the harsh landscape under conditions more similar to antiquity than those of modern time. One can learn about the average distance a camel can travel for a typical journey day, the maintenance needs for establishing campsites, and the negotiations involved in crossing a land controlled by nomadic tribes (e.g., van der Steen 2006). In a few cases, these early explorations resulted in maps (some were designed as proper mapping expeditions) and thus provide additional sources for the study of ancient routes (Tishby 2001; and see a comprehensive overview of maps of southern Palestine 1799–1948 in Levin et al. 2010). In the region covered by FBRS,

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the descriptions of Kitchener (1884) and Musil (1908) provide valuable information regarding ancient roads, the latter specifically regarding the question of the main road connecting Faynan and Busayra. It is informative to review several of these early reflections on travel in the research region.

Major Horatio H. Kitchener of the Palestine Exploration Fund (PEF) led an expedition through the Arabah Valley in 1883. Leaving ʻAqaba on December 3, they progressed north along the *eastern* margin of the valley, reaching the Faynan region after several days. Their first campsite was at ʻAin al-Buweirdeh, a small oasis nestled in the sand dunes of the southwestern part of the region. They report rich archaeological remains near the springs, including "terraces of an old town of considerable extent," "numerous little mounds of artificial appearance," and "portions of an aqueduct" (Kitchener 1884:213). This area has yet to be properly surveyed, as it has not been included in the area of any of the modern research teams. The al-Buweirdeh springs area has great potential for archaeological discoveries because of its permanent water sources.[6] The next day, the expedition continued north, missing Khirbat Faynan (which is further to the east than their course of travel) and pitched a campsite near the mouth of Wadi al-Ghuwayba. While Kitchener himself explored the western side of the Arabah (although without reaching ʻAin Huseib "owing to the want of knowledge of the locality by [his] guide"), G. Armstrong (Royal Engineer) explored the landscape to the east:

> Camp was pitched near the mouth of Wady Guweibeh, and I was extremely glad to find that a day's halt was to be made in this locality. … Armstrong explored the country towards the east, and found, six miles north-east of Feidan, the ruins of a small town in a valley, surrounded by bold and precipitous cliffs; the ruined walls are from a foot to 3 feet high, the stones roughly squared, and of no great size; some black heaps resembling slag heaps point out that very probably ancient mines may be found in the neighbourhood [Kitchener 1884:213–214].

A study of the PEF map of this expedition (Figure 6.5a,b) shows clearly that the small town is Khirbat al-Jariya, making this report to be the first to mention the site and to recognize this part of Faynan as an ancient mining district (Ben-Yosef and Levy in press). The next passage is also interesting:

> A path leads from Wady ʻArabah to this valley [of Khirbat al-Jariya], crossing the watershed into Wady Ghuweir, where it joins, leading up the valley in a south-easterly direction, a beaten and well-worn track: this was probably the pilgrimage road from Gaza to Mecca. Lower down in the Wady (Wady Ghuwir) are numerous springs of sweet water trickling out of the bed of the wady; and in a narrow gorge the rocks are literally covered with Bedouin tribe marks, Arabic inscriptions, &c., the work of pilgrims on their way to Meca [Kitchener 1884:214].

This unique description actually follows Naqb al-Jariya to Wadi ad-Dahal (here named Wady Ghuweir) and clearly expresses the importance of Naqb ad-Dahal as a central route connecting Wadi Arabah to the highlands for centuries and millennia. The map (Figure 6.5b) indicates the location of several sites recorded also by FBRS, including "graves" (FBRS Site 8) and "springs" (immediately to the north of the graves, FBRS Site 53). The inscriptions described in the passage above and indicated on the map near the springs of ʻAin ad-Dahal were recorded by us as FBRS Site 50 (see below).

The importance of Naqb ad-Dahal as a regional road is demonstrated also by the descriptions of T.E. Lawrence ("of Arabia") who traveled through this route in the winter of 1918 on his way from at-Tafila to Beersheba:

> At Buseira, the little village on a hull of rock over the abyss, they insisted that we halt to eat. I was willing, because if we fed our camels here with a little barley we might ride all night and reach Beersheba on the morrow: but to avoid delay I refused to enter their houses, and instead ate in the little cemetery. … Afterwards we went down the zigzags of the great pass into the hot bottom of Wadi Dhahal, over which the cliffs and the hills so drew together that hardly did the stars shine into its pitchy blackness. We halted a moment while our camels stilled the nervous trembling of their forelegs after the strain of the terrible descent. Then we splashed, fetlock deep, down the swift stream, under a long arch of rustling bamboos, which met so nearly over our heads that their fans brushed our faces. The strange echoes of the vaulted passage frightened our camels into a trot.

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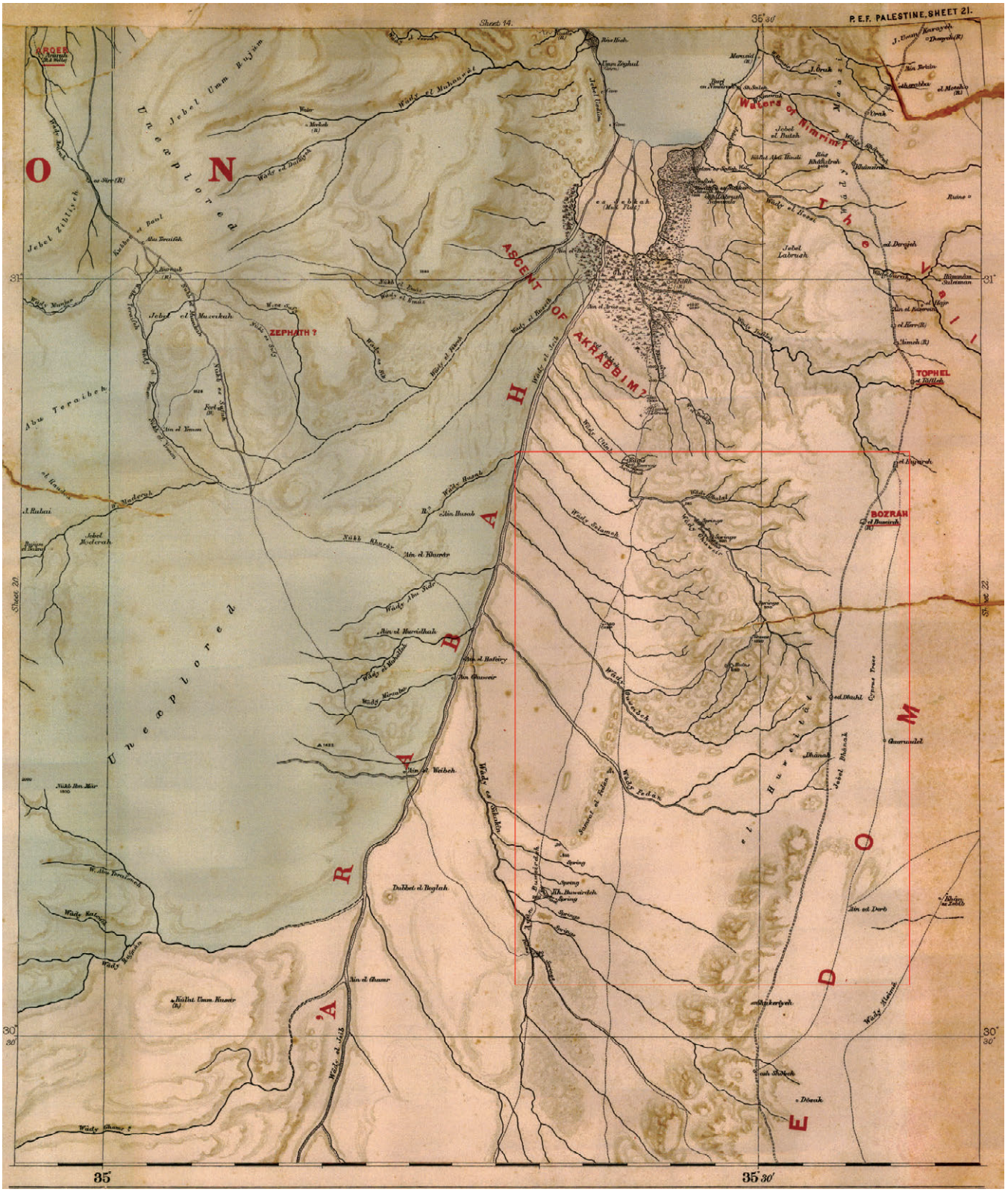

Figure 6.5 (*a*) Sheet 21 of the small-scale Palestine Exploration Fund map series showing the northeastern side of the Arabah Valley. The map was published in the 1883 by Major H. H. Kitchener, R.E. (Royal Engineer) and is based on the survey of the 1883 expedition to the region (see text for details). For details of the Faynan-Busayra region, see Figure 6.5b. (Map courtesy of the Survey of Israel Historical Archives).

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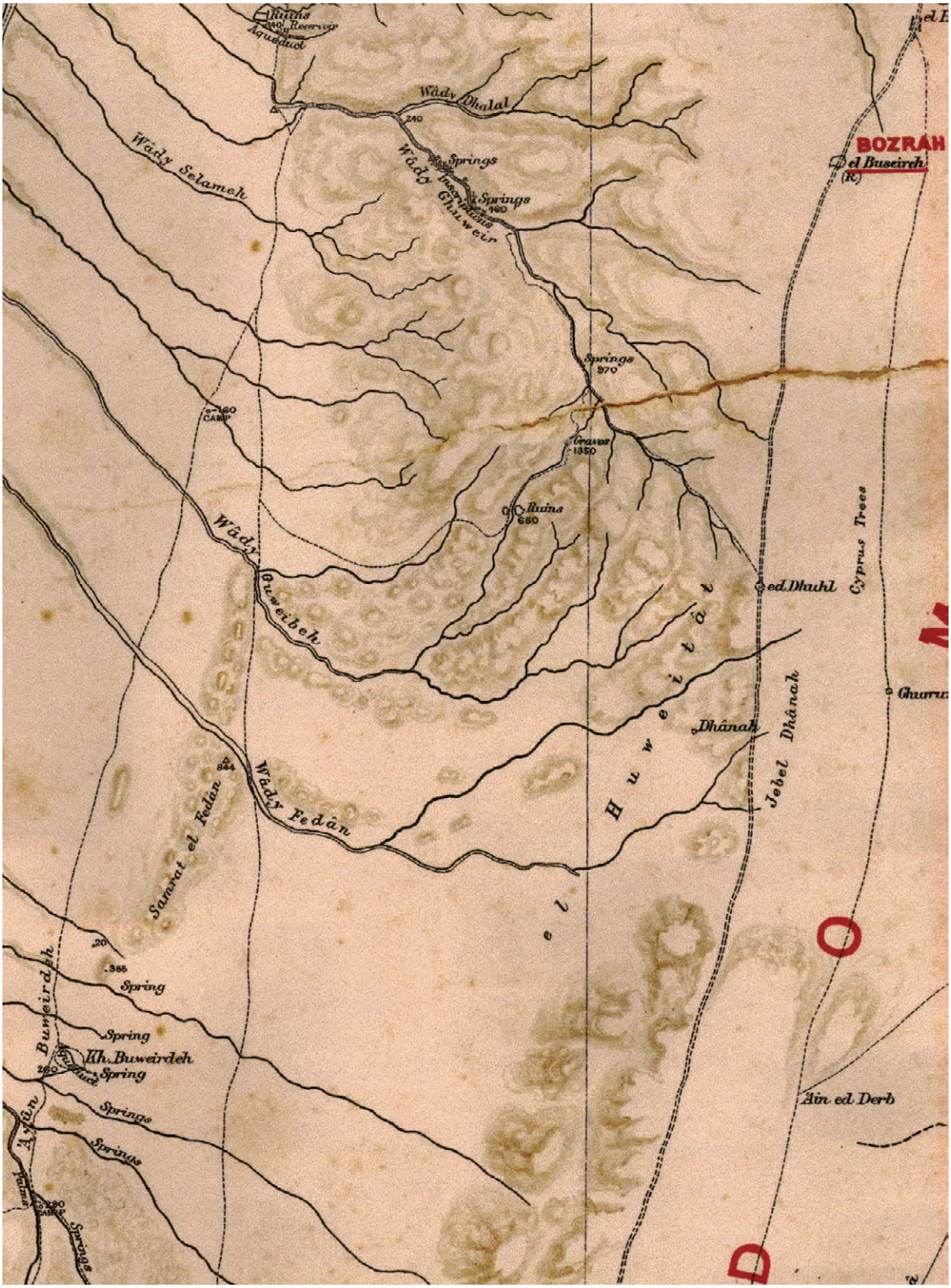

Figure 6.5 (*b*) The Faynan-Busayra region in the 1883 Palestine Exploration map of Major H. H. Kitchener, R.E. (see Figure 6.5a). The map depicts for the first time the ruins of Khirbat al-Jariya and the inscriptions of Wadi ad-Dahal (FBRS Site 50; on this map, the wadi is called "Ghuweir"); also note that the expedition's journey from Wadi al-Ghuwayba to Wadi ad-Dahal follows Naqb al-Jariya and passed through the cemetery of FBRS Site 8 ("Graves"); see text for details. (Map courtesy of the Survey of Israel Historical Archives)

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> Soon we were out of it, and out of the horns of the valley, scouring across the open Araba. We reached the central bed, and found that we were off the track—not wonderful, for we were steering only on my three-year-old memories of Newcombe's map. A half-hour was wasted in finding a ramp for the camels, up the earth cliff [Lawrence 1936:500–501].

After crossing the Arabah, they reached Husb ('Ain Husub) and continued easily to Beersheba. Lawrence based his navigation on "three-year-old memories" of Captain S. F. Newcombe's map (Levin et al. 2010:7) that was published in 1915 and clearly delineates two major roads crossing the Arabah toward 'Ain Husub: one from Wadi ad-Dahal and the other from Wadi Fidan (Figure 6.6). For further discussion regarding Naqb ad-Dahal, see below.

After visiting the area of Faynan in 1898, Musil's expedition headed to Busayra. Musil's itinerary, accompanied by his map (Figure 6.7) and the 1916 Turkish-German map (clearly based on Musil's descriptions, Figure 6.8a,b), still presents some difficulties when attempting to track his exact route. Deciphering Musil's itinerary and identifying the sites along the ascent(s) described may help reconstruct aspects of the ancient road network in this region and locate important road stations. Therefore, we provide a translation of the relevant passage.[7]

> At 7:29am, as we wanted to ride from the Ratijje-hills down into the plain, we saw a large group of men on horseback that came out of the 'Araba (from the west) and that appeared to offer water to their horses at the junction of the sejl Dana with the sejl ed-Datne. Our guide immediately fled and we had to follow him. He believed that the riders were robbers, and he feared to meet their scouts in the sejl Dana. Therefore, he steered toward the east to climb up the steep slope of Hamra Haled. It was a very arduous ride, one of the most demanding that I have undertaken throughout my travels. We had to guide our horses on foot, crawl upwards from one block to the next, and stop in front of steep cliffs to look for a usable path. On several occasions we believed that our horses would slip and fall off the slippery rock, and we often had to stop to let them rest. The slave's mare fell and damaged its left front hoof, which delayed our ascent so much that we only finally reached the nkejb Asemer at 11:42am and the high plateau at noon. We did, after all arrive at the top, but were completely exhausted.
>
> After several minutes we came upon a good old path/road, which leads at the southern slopes of the g. aba-l-Hazuk from the ridge of the g. el-Hesen to the nkejb Asemer and nakb el-Rwetbe. Through the nkejb Asemer one reaches directly the copper shafts in the Ratijje-hills.
>
> At 12:20pm we stopped at the h. Makta. It is a strong fortress on the left bank of the w. el-Ebr that forms the beginning of the w. es-Salamani. North of it lies the ancient fortress el-Ebr which controlled the mountain passes nakb el-Garijje, nakb el-Murabba and nakb ed-Dahal. The whole region between the sejl Hanejzir and sejl Dana is on the high plateau covered with ancient dense oak forest, whereas on the slopes grow dark green 'Ar'ar- or Lizab trees. We rode eastwards through this dense oak forest at 1:32pm, along the left bank of the w. el-'Ebr, until we left the forest at 3:05pm and took leave of our guide at the h. and 'ajn Sarab.
>
> From the h. Sarab, which is built of black partially worked stones and located along the western border of the built-on high plateau, we continued our ride north-eastward. At 3:30pm we crossed the nakb ad-Dahal road that was coming from the southeast and we stopped near it at the moje Goza, a powerful spring. From there we had a beautiful view towards northwest of the area of Busejra [Musil 1908:298–299].

From Musil's description and the maps (Figures 6.7 and 6.8b), we learn the following: (1) there is no easy way to climb directly from the Ratijje-hills (the mining area of Wadi Qalb Ratiye; Hauptmann 2007:112) to the ridges of Jabal Rumana and Busayra; (2) the important mountain roads in this area were nkejb Asemer, nakb el-Rwetbe, nakb el-Garijje, nakb el-Murabba, and nakb ed-Dahal; (3) important fortresses/road stations in the area are h. Makta and el-Ebr; and (4) it is possible to get from Faynan to Busayra in one long day of traveling, even if one takes a difficult path. We were able to securely identify nakb el-Rwetba (Naqb al-Ghuwayba), nakb el-Garijje (Naqb al-Jariya), and nakb ed-Dahal (Naqb ad-Dahal) and to suggest identification to the location of nkejb Asemer (Naqb as-Samar) and nakb el-Murabba (Naqb al-Murab'a). The different roads are described

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Figure 6.6 Faynan region on a British map of 1915 ("Prepared at the Ordnance Survey Office, Southampton, 1914, and printed at the War Office, 1915"). The mapping was carried out under the direction of Captain S. F. Newcombe, R.E.; the eastern part of the map (hills in broken lines) "[has] been adjusted from a map by Major H.H. Kitchener, R.E. dated to 1883" (see Figure 6.5a) and is considered "unreliable"; note the two main roads crossing the Arabah toward 'Ain Hasib from Wadi Fidan and Wadi ad-Dahal. (Sheet North H-36 L-I and parts of II, Africa 1:125,000 maps, contours approximately 100 feet; courtesy of the Survey of Israel Historical Archives)

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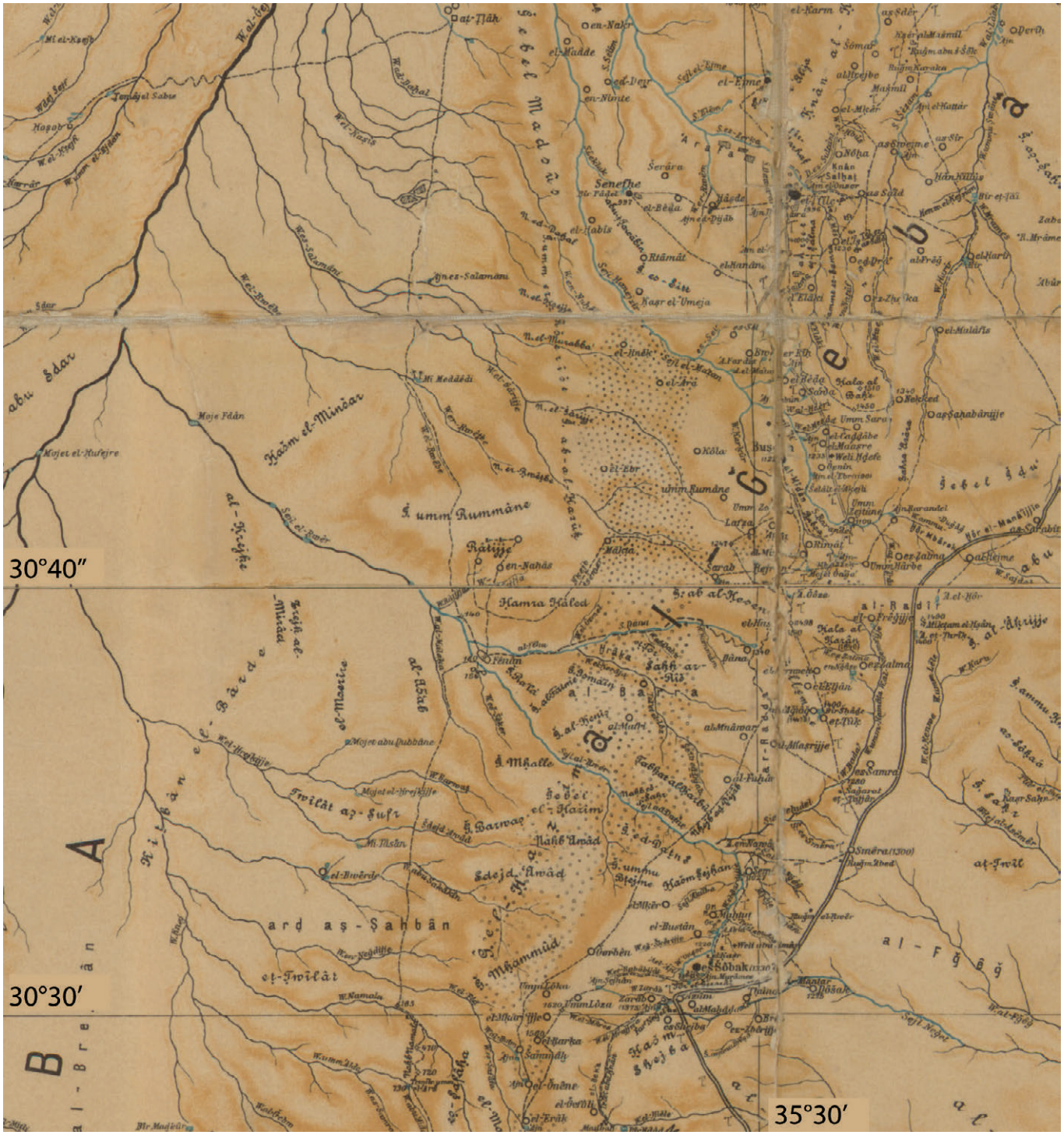
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in the sections below. The site of h. Makta (Khirbat Maqta) appears on modern topographic maps and is well known (Glueck 1935:98, there as "Kh. Maqtah") while the location of the other fortress (el Ebr) is still a riddle to us. The description of el Ebr suggests that it was an important control point on the main road from northeastern Faynan area to Busayra, probably somewhere along the route described by our team. If we consider the original map of Musil (Figure 6.7) to be more accurate than the Turkish-German map (Figure 6.8a), the centrality of the place ("controlled the mountain passes nakb el-Garijje, nakb el-Murabba and nakb ed-Dahal"), and the fact that Musil was able to observe the ruins from a long distance, we suggest that FBRS Site 20 ("The Outcrop Fortress") may be the elusive el-Ebr (see details below).

Musil's descriptions emphasize the importance of tracking toponyms while conducting regional surveys. Not only do toponyms bear the potential of retaining ancient location names, but they are also a key to deciphering early travelers' accounts and thus provide access to invaluable sources of information. This is not always easy, as exemplified by Major Kitchener's account:

> It was impossible to find out the exact name, as the Arabs themselves were divided on the subject. I am inclined to think Buweirdeh is the correct name. It is almost impossible to collect the correct nomenclature when travelling so rapidly through a country, with Arabs from a different district, and though I took every means in my power to determine the names definitely, I am not at all confident that in all cases I have obtained the correct names, or nearly as many as might be collected by a more prolonged visit to the neighbourhood [Kitchener 1884:213].

Another insightful example for the importance of accurate recording of toponyms and the great confusion that may result from mistakes is Glueck's description of Khirbat Hamra Ifdan (Adams 1992). The site described by Glueck is not the one currently identified by this name (Levy et al. 2002) but the one published recently as Rujm Hamra Ifdan (Levy et al. 2008 and see Chapter 9, this volume). The latter should not be confused with Glueck's Rujm Hamra Ifdan, a different site that is not securely identified and may or may not be the same as Frank's (1934) Rujm Hamra Ifdan. Recording toponyms in the area covered by FBRS was an extremely difficult task, as this region is part of the Dana Nature Reserve that in the 1990s forbade most of its original Bedouin population from sojourning in the area (see below, under the methodology section, and Table 6.1).

Glueck's visit to the region in 1934 yielded some interesting descriptions of the upper reaches of Wadi al-Ghuwayba and Wadi ad-Dahal basins, including reference to the Iron Age roads and some related outpost (for the identification of sites mentioned in the following, see Table 6.1):

> Busayra-Bozrah guarded the Edomite track leading along the western edge of the Jebel esh-Shera, and controlled the approaches from the east to the copper mines in the 'Arabah centering about Kh. en-Nahas. It was evidently the strongest Edomite city in northern Edom, its natural position making it practically impregnable. … Proceeding to the west-northwest we came to Kh. Maqtah ([Site] 188), on the western edge of the plateau, below which in the 'Arabah the regions of Kh. en-Nahas and Kh. Gheweibeh are visible. It is a small, indistinguishable ruin. No determinable sherds were found. Two and a half kilometres to the north we came to a small, completely destroyed site called Kh. Jeleil ([Site] 189), overlooking the Neqb Jariyeh and the Neqb Gheweibeh. There were no sherds, but a few scraps of copper were found. Kh. Jeleil may have been an Edomite post along the tracks leading from the copper mines in the 'Arabah, below the Neqb Jariyeh and the Neqb Gheweibeh, to Bozrah. Kh. Maqtah may originally have been a similar post. It is also possible that from these sites in a wooded area charcoal was supplied to the mines for the smelting operations. Two kilometers farther north we came to a small, ruined Arabic structure, measuring about 15 by 7 metres and oriented north-northeast by south-southwest. It is made of rudely cut limestone blocks, with small stones between the rows. No sherds were found. It is known as el-Qasr, or Kh. el-Qasr ([Site] 190). Three and a half kilometres to the east we came to Kh. el-Kulah ([Site] 191), situated on the top of a high, steep hill and commanding a view over the 'Arabah to the west. Busayra is below it to the east. There was a group of abandoned Arabic houses on top of the hill. No sherds were found [Glueck 1935:97–98].

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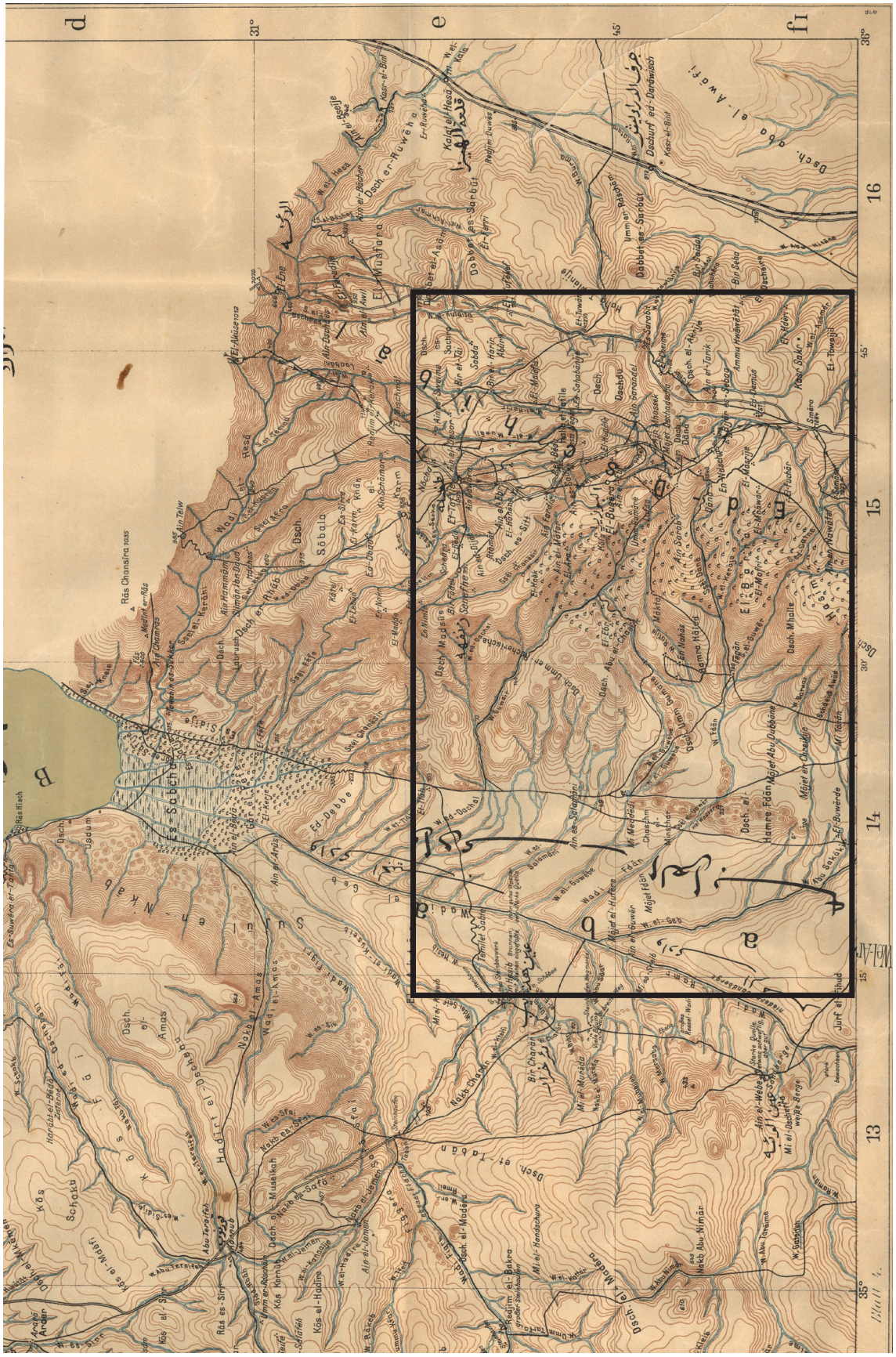

Figure 6.8 (*a*) Faynan region in a German-Turkish map of 1916 based on Musil's descriptions with added details (cf. Figure 6.7; note the incorrect location of En Nahas on both maps and similarities of routes). The topography is distorted but maintains the general distribution of wadi basins: Wadi ad-Dahal with the main road leading to the Arabah and further to 'Ain Hesib, Wadi al-Ghuwayba with the main road leading to Busayra, and Wadi Dana-Fidan with the main roads to Khirbat Faynan; "Dsch." stands for "Jabal," meaning "mountain" in Arabic; the name of the highland region, al-Jabal, is also indicated (here as Ed-Dschibâl). See text for further discussion. (Sheet 2 of the Turkish-Egyptian boundary areas 1:250,000 map series [Karte des türkisch-ägyptischen Grenzgebietes, Vorläufige Ausgabe, nur für den Dienstgebrauch, "temporary sheet, for official use only"]; courtesy of the Survey of Israel Historical Archives).

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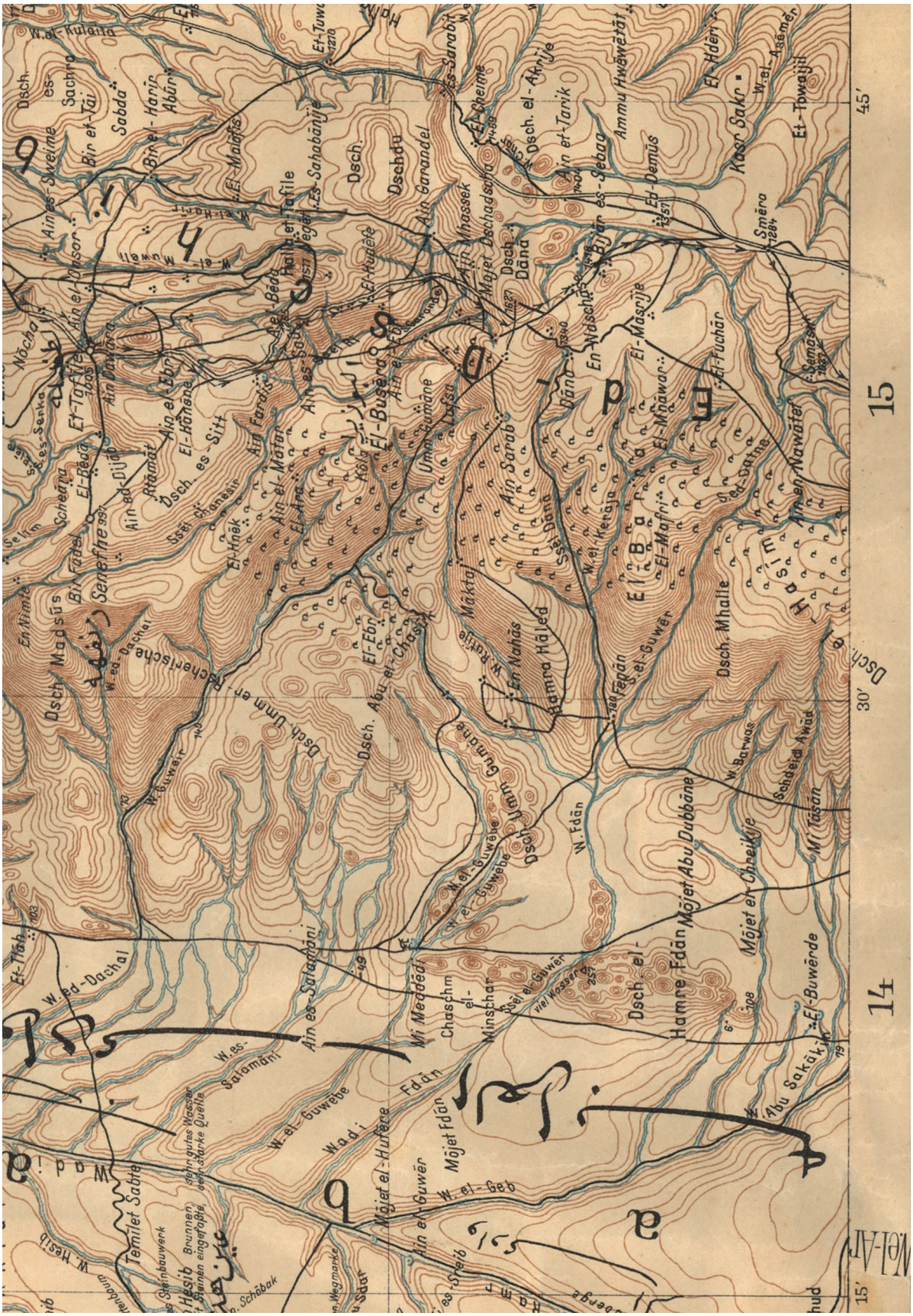
Dschebel Mhalie
Hamra Fdān
Mōjet Abu Dubbāne
Mōjet el-Cheikije
Mōjet Fdān
Ain es-Sarabīt
Ain Sarab
Ain Garandel
Dschadu
Dschebel Dāna
Ain Mnassek
Mōjet Dschadsaha
Dsch. el-Akrije
Ain et-Tarik
Ammu Hwawēzāt
Ed-Demūs
Kasr Sakr
Et-Tpwajjih
El-Maschāra
El-Mafrir
El-Muawwar
El-Fuchār
Ain en-Nawāter
Ain el-Ebr
Ain el-Mōtar
Ain el-Fōka
Ain el-Hōhane
Ain ed-Djidb
Ain es-Sweime
Ain el-Qasr
Ain es-Sahabānije
Ain es-Salamāni
Ain el-Guwēr
Ain el-Hufēre
Ain el-Ghuwēbe
Ain el-Buwēde
Ain el-Sakākir
Ain Abu Sakākir
Ain el-Ghuwēbe
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Ain el-Ghuwēbe

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With the exception of the small-scale (a single fieldworker) surveys of H. Kind (1965, including a survey of the copper ore district of Abu Khusheiba) and T. Raikes (1980, 1967-1969, and the mid-1970s), systematic surveys and research in Faynan started in the early 1980s. The major archaeological (and archaeometallurgical) surveys are summarized in Figure 6.1 and the major archaeological projects in Figure 6.2, including activity years and main references in the captions. The 1980s are marked by the intense archaeometallurgical investigations of the Deutsches Bergbau-Museum (Hauptmann 2007) in addition to more limited publications of archaeological work by King et al. (1989) on the Byzantine churches of Khirbat Faynan. In the 1990s, foci of research developed around two areas, one near Khirbat Faynan (CBRL) and the other around Wadi Fidan and Wadi al-Ghuwayba (UCSD–DOAJ).

The research around Khirbat Faynan was declared as the flagship of the British Institute at Amman for Archaeology and History (BIAAH, later the Center of British Research in the Levant, CBRL; see McQuitty 1998) and included numerous surveys and supported excavations, some directly related to the Wadi Faynan Project initiated in 1993 by William Lancaster in association with the establishment of the Dana Nature Reserve that same year (e.g., Barnes et al. 1995; Findlater 1999; Findlater et al. 1998; Ruben et al. 1997), and others were associated in some way with the CBRL, starting in 1996 (Barker, Gilbertson, et al. 2007; Finlayson and Mithen 2007; Freeman and McEwan 1998; Grattan et al. 2007; Wright et al. 1998). A major survey of Wadi Dana and its vicinity was conducted by George Findlater of the CBRL, overlapping some of the area covered by FBRS. This survey was done as part of the resource management of the Dana Nature Reserve of the Royal Society for the Conservation of Nature in Jordan (RSCN) and has yet to be published. In the same general area surrounding Khirbat Faynan, Najjar and colleagues conducted excavations in the Neolithic sites of Tell Wadi Faynan and Ghuweir 1 (Najjar et al. 1990; Simmons and Najjar 2006, respectively); research on the latter is still ongoing. In the area of Wadi Fidan and Wadi al-Ghuwayba, small-scale excavations started with the Wadi Fidan Project (Adams 1991) that was part of the larger Deutsches Bergbau-Museum work in the area. In 1997, a social archaeological investigation of ancient mining and metallurgy was initiated as the Jabal Hamrat Fidan Project (Levy, Adams, and Najjar 2001; Levy et al. 1999; Levy, Adams, Witten, et al. 2001), affiliated with UCSD and DOAJ. Since 2006, the research in this region has been carried out under the Edom Lowlands Regional Archaeology Project (ELRAP) affiliated with UCSD (of which the current survey is part; see above) and co-directed by T. E. Levy (principal investigator) and M. Najjar. Under those projects, in addition to substantial excavations in various sites, extensive, full-coverage surveys were conducted. In 1998 and 2004, archaeological sites in Wadi Fidan were recorded (Levy, Adams, Witten, et al. 2001; for results of the 2004 survey, see Chapter 7, this volume), and in 2003 and 2007, surveys of Wadi al-Jariya and parts of Wadi al-Ghuwayba revealed "an Iron Age landscape"—a condensed scatter of Iron Age sites in this region of Faynan (Levy et al. 2003; Chapter 7, this volume, and see below). To test Iron Age relationships between the Saharo-Arabian desert, steppe, and Mediterranean zones in Edom, Neil Smith (with Levy and Najjar) initiated the Lowland to Highlands of Edom Project (L2HE) survey and excavation project (see Chapter 3, this volume).

Recently two new regional projects were started in the Faynan area and its periphery, the Barqa Landscape Survey (BLS), led by John Grattan and Russell Adams in the sand dunes around the site of Barqa al-Hatiye, and the Wadi Feid Survey (WFS), led by Kyle Knabb (with Levy and Najjar in the vast area of this wadi basin, on the southern and southeastern periphery of the Faynan region. The WFS project is also aimed at clarifying processes of settlement and interaction between the lowlands and highlands of northern Edom.

The surveys by Burton MacDonald and his colleagues covered an extensive landscape, including parts of eastern Faynan region, the northeastern Arabah Valley, the lower part of Wadi ad-Dahal, and the terrain around Busayra (MacDonald 2007) (Figures 6.1 and 6.2). These surveys provide invaluable archaeological data for the areas surrounding Faynan to the east and north, although the methodology was not consistent and the surveys were not comprehensive. The Southern Ghors and Northeast 'Arabah Archaeological Survey (SGNA, carried out in 1985–1986; MacDonald 1992a) focused on sites along relatively easily accessible routes (mostly dirt roads) and thus was likely to miss important sites that can be reached only by foot (see, e.g., FBRS Site 57). The Tafila-Busayra Archaeological Survey (TBAS, carried out in 1999–2001; MacDonald et al. 2004) was based on a random square sampling method adjusted to fit three different topographical zones in addition

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to intensive survey of the hinterlands of Busayra (3-km radius from the citadel). Both SGNA and TBAS did not cover the upper portions of Wadi ad-Dahal and the important road that connects Busayra to the Arabah (Figure 6.1); however, MacDonald was fully aware of this (MacDonald 2006:86). These gaps, in addition to the gap in the surveyed landscape between SGNA, TBAS, and the intensive surveys of the Faynan district (Figures 6.1 and 6.2), were one of the incentives for conducting the FBRS reported on here.

The Road Survey Methodology

Dating ancient roads based on archaeological remains is a difficult and often impossible task as most of the routes, which inevitably pass through the most convenient terrains, were used for centuries and millennia and travelers usually left little behind. It is only when the road is closely associated with sites from specific periods (e.g., the Mamluk mail roads and associated caravanserais [e.g., Lee et al. 1992]) or when the road construction techniques are well fixed within a specific cultural framework with a strong material culture signature (e.g., the Roman imperial roads [e.g., Roll 1999]) that a date is obtainable. However, the date is still usually limited to one "proven" period out of many in which traffic along the same route was possible. Dating roads in the Levant to periods earlier than the Roman, including the Iron Age, is even more difficult, as the massive and condensed road network built by Roman engineers and legions obscured many remains of earlier road constructions (see map in Roll 1999:Figure 1). In some cases, historical sources may shed light on the date of a road, as in the case of the Darb al-Hajj in northern Sinai (the Muslim pilgrimage route to Mecca [e.g., Tamari 1982]). The Hebrew Bible has been a source for many reconstructions of Iron Age routes (e.g., Aharoni 1979; Aharoni and Rothenberg 1960; Dorsey 1991; Kirk 1938; Rothenberg 1967:160–171). However, the biblical accounts present intricate difficulties and challenges of dating and interpretation, especially in regard to the stories of the Israelites' travels through the wilderness (in which Punon is mentioned as a road station; see above). The basic biblical road maps (e.g., Aharoni et al. 2002:maps 9 and 10) are based mostly on speculative arguments and are not part of a scholarly consensus, although some of the road identifications are supported by strong arguments and archaeological evidence (e.g., "Way to Edom," Aharoni and Rothenberg 1960, and see below).

Dating ancient roads in the area covered by FBRS is based primarily on the dating of associated sites and occasional finds on the paths themselves. However, the original design of the survey took into account the unique situation in the research area in which the destination of the routes at the Faynan end point is "An Iron Age Landscape" (Levy et al. 2003), densely covered with Iron Age sites with markedly fewer remains from other periods (see also Ben-Yosef et al. 2010:Figure 1 for a map of an Iron Age site distribution in Faynan). This situation increases the probability that roads (and associated constructions) ending in this specific area of northern Faynan can be dated to the Iron Age. The Iron Age II fortresses, mines, and structures of Ras al-Miyah (Ben-Yosef et al. 2009a and more finds reported below), located on the most direct road connecting Faynan and Busayra, further support this supposition.

Identifying ancient routes in the field may also present challenges, especially in relatively flat terrain. In wide valleys (e.g., along the Arabah Valley), where no constructions were needed to support the path and travelers were not confined to follow a specific course, remains are usually scarce and can evolve into "multitrack" dendritic patterns across wide areas (the paved roads of the Roman period are an exception). Tsoar and Yekutieli (1992) suggest a method to identify ancient roads based on the geomorphological impact of movement on loess soils in the northern Negev, but reconstruction of roads in such areas is usually based on extrapolation of identified road segments and other relevant data (location of watchtowers, caravanserais, other associated sites). The rugged terrain and relatively steep slopes in the FBRS area required substantial constructions (visible in the archaeological record), especially if the road was prepared for the traffic of camels, as is the presumed case for the Iron Age.

For identifying ancient roads in the vast area covered by FBRS, we relied on a variety of maps and satellite imagery to locate all passable terrains prior to the fieldwork. We used topographic maps of various scales and publications, geological maps of the region (following the principles described in the geographical setting section above), and satellite imagery from Google Earth (available in high resolution for this area) and Ikonos (courtesy of Geoeye). The maps and satellite imagery were also used to locate major sites by careful examination of the survey area. Many of the sites recorded by FBRS, including the fortresses of Ras al-Miyah (Ben-Yosef et al. 2009a), are clearly visible

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in Google Earth, and some of the topographic maps display ancient walls, as is the case for FBRS Site 37 (leading to its discovery).

In preparation for the fieldwork, we attempted to glean information about ancient (and modern) paths, sites, and regional toponyms from the local Bedouin of different tribes now settled in the village of Quraiqira near the Wadi Faynan. As mentioned above, the construction of the Dana Nature Reserve in the early 1990s resulted in moving the nomadic inhabitants of the area outside of the reserve boundaries, making it difficult to find knowledgeable informants to track down this valuable information (see above). Nevertheless, with the help of Jum'a 'Id al-Azazmeh and 'Aweid Sayadin, we were able to collect some information about mountain paths and location names. Table 6.1 summarizes all the toponyms we were able to locate for the area covered by the FBRS, including geographic names from early travelers and modern cartography. A few wadis with no trackable toponyms were important references in our survey notes and were assigned invented labels; they also appear in Table 6.1. The transliteration of the Arabic names is extremely inconsistent in different publications. For example, the Wadi and district name Faynan (فينان) appears frequently as Fenan or Feinan, and the geographic designation "Ghor(s)" (غور) appears sometimes as Ghawr(s) in publications by the same author (e.g., MacDonald 1992a and 2007, respectively). The confusion stems from the different conventions of transliteration that in turn are associated with inherent differences between the spoken and written Arabic (spoken vowels sometimes do not have corresponding written forms). For future reference, we added the written Arabic format for the toponyms recorded in Table 6.1.

FBRS Recording System

Accessible terrain was surveyed by a team of four, with a four-wheel-drive pickup truck accompanied by on-the-ground pedestrian survey. Occasionally, our team backpacked and camped in less accessible areas to explore remote destinations. Locations of FBRS sites and road segments were recorded by a differential GPS system (Figure 6.9), with the base station located on a roof of a rented house in the village of Qureiqira.[8] The survey recording system was integrated into the more general ELRAP digital archaeology recording system (Levy and Smith 2007). Each GPS reading was assigned a unique number in a running order (1 to 12,501). The precision of the location records after correction is subcentimeter both for the X-Y coordinates and elevation (Z), although technical problems during the fieldwork sometimes resulted in precision of up to a submeter resolution. For any practical and interpretational purposes, a submeter resolution is adequate and is better than the resolution usually published for archaeological surveys (until the 1990s, location coordinates were obtained only from topographic maps that were 1:50,000 scale at best). For checking the system, we established control points that were measured repeatedly and on different days (they were also used as a reference for the daily initiation of the GPS unit). The greatest benefit of a differential GPS system is that it enables recording architectural features relatively fast and on the fly, resulting in accurate architectural plans (e.g., FBRS Sites 12 and 37; see below).

We recorded only major sites in the survey area and most of the sites that are located along main routes (excluding remains of recent Bedouin activities). Road constructions (such as retaining walls and marginal markers) were recorded as part of "road segments" unless they were exceptionally substantial and defined as a site (e.g., Site 14). For each site, the center point was recorded with the GPS system, along with a polygon of its area and any architectural features. If present, pottery sherds and other diagnostic artifacts were collected. Detailed digital photographs (approximately 1,700) were taken (see digital appendix to this volume). In addition to these data, detailed descriptions of each site were prepared in the field and in the lab during the expedition (Figure 6.9a,b).

Road segments were recorded by walking with the GPS antenna (Figure 6.9c) or in a few cases by holding it in the back of the truck while traveling on modern road segments. Sometimes only representative segments of a road were recorded (start/end, switchbacks, etc.). However, this provided sufficient data that could be melded with other map and aerial photography sources to fill out the complete route. The roads were divided into six categories (Table 6.2): (1) current dirt roads, (2) old dirt roads, (3) goat tracks, (4) donkey trails, (5) camel trails, and (6) other. Identifiable paths were assessed for their "accessibility level," which in a given terrain is a measure of the level of investment in road construction. The "camel" category, representing the most accessible paths excluding modern constructions, is also the most relevant for reconstructing the Iron

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Figure 6.9 Recording methods of the Faynan-Busayra Regional Survey include differential GPS measurements of site centers, site perimeters, architectural features and road segments, collection of pottery sherds, and detailed description of the sites and roads. (*a*) Collecting pottery sherds and recording a small Iron Age (?) watchtower at the Ras al-Miyah Archaeological Complex (FBRS Site 21), (*b*) recording an artesian well in the Arabah Valley (Site 49C), and (*c*) recording a segment of the main road from Faynan to Busayra (FBRS Road Segment 6). *(All photographs in this chapter are by E. Ben-Yosef, unless otherwise noted).*

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Age road network in the region, as the camel was the common draft animal in the Iron Age II (and probably in the Iron Age I as well; see Jasmin 2006), especially in this arid regions of the Levant (cf. camel figurines from Busayra; Sedman 2002). Camels have much more difficulty in passing through steep slopes and narrow paths than donkeys or mules, and thus the roads should have been adjusted accordingly with switchbacks and shallow steps. Moreover, roads for the traffic of loaded camels should be wide enough for the passage of two caravans heading in different directions. This entails more construction efforts. For example, retaining walls are needed to maintain a wide road where the path crosses gullies or where it is perpendicular to a steep slope. Roads that were prepared for camel traffic in difficult terrain are called a *naqb* by the local Bedouins (usually it is also an ascent that overcomes significant elevation differences). For archaeologists, identifying *naqbat* (pl.) is key for tracking ancient routes (Table 6.1).

In the area of Faynan, the category of "old dirt road" (Table 6.2) presents a challenge. During the 1970s, the Natural Resources Authority (NRA) of Jordan conducted prospecting surveys all over the copper ore–rich zones and blazed many dirt roads that were deserted immediately after. Today, these severely eroded roads may appear as an ancient path (in some places, the NRA used small blazing machines, resulting in relatively narrow and atypical dirt roads that today are even more confusing [e.g., FBRS Road Segment 40]). In some places, it is evident that these NRA roads completely obscure ancient tracks (e.g., FBRS Road Segments 3, 4, and 5). "Current dirt road" (Table 6.2) may also cover an ancient road, and indeed this is the situation in the agricultural hinterland of Busayra. Rapid development in recent years has resulted in many new dirt roads leading to agricultural fields, some destroying undocumented remains of ancient paths (e.g., FBRS Road Segments 18, 19, and 57 and see Ben-David 2009 for recent destruction of parts of Naqb ad-Dahal).[9]

To facilitate analyzing the FBRS data, we incorporated them into a Geographic Information System (GIS) and Microsoft Access database. The post–field analyses as well as the maps presented in this chapter were done using this system (ArcView). The basic method of collecting field notes, including descriptions of many archaeological features not recorded as a site or a road segment, was by writing a daily topographic journal. This journal contained field observations noted on a printed large-scale UTM map. A few of the archaeological features were defined as an archaeological site only after the fieldwork based on these notes (e.g., FBRS Sites 54 and 55; the location of such sites is based on the topographic maps). A copy of the daily topographic journal is available in the supplementary digital material of this chapter.

Survey Results

The location of the FBRS sites and road segments is indicated in Figures 6.10 and 6.11, and their description is summarized in Tables 6.3 and 6.4, respectively. A total of 60 sites were recorded, most of which (n = 33) did not yield any identifiable pottery and could not be dated. A large number (n = 20) were dated to the Iron Age (mostly Iron Age II) and are primarily concentrated in the Ras al-Miyah Archaeology Complex near 'Ain al-Ghuwayba (Figure 6.11 and see below). The most common recorded site category is "defensive," and many of the sites in this category were directly related to the local roads. A total of 59 road segments were recorded forming a combined length of ca. 56 km. The most frequently recorded road segment category is "donkey" (n = 19) and "camel" (n = 15), but the length of each segment is different and sometimes arbitrary. In the following, we elaborate on the major finds, especially in regard to the road system in this region. The entire digital photography archive from the FBRS, including sites not detailed below and landscape views, is available in the supplementary digital material of this chapter. In addition, all data will be available online as part of the *Digital Archaeology Atlas of the Holy Land*, at http://daahl.ucsd.edu/daahl/.

The Ras al-Miyah Archaeology Complex

Ras al-Miyah (Arabic for "The Water's Head"), the area around 'Ain al-Ghuwayba oasis, is abundant with archaeological sites, mostly dated to the Iron Age II (Figure 6.11, Table 6.3). The largest site is Khirbat al-Ghuwayba (FBRS Site 1; Glueck 1935:22–23, 164 Plate 2; Hauptmann 2007:132–133; MacDonald 1992b:76 [SGNA Site 161]), a light, around 7-ha scatter of Iron Age slag located on both sides of Wadi al-Ghuwayba near the spring (Figure 6.12). Some substantial architectural remains are located mostly on the northern bank of the wadi and represent later occupations, probably Roman-Nabataean dwellings near the permanent water source. Surface finds include ceramics that span multiple periods with strong evidence for an Iron Age occupation.

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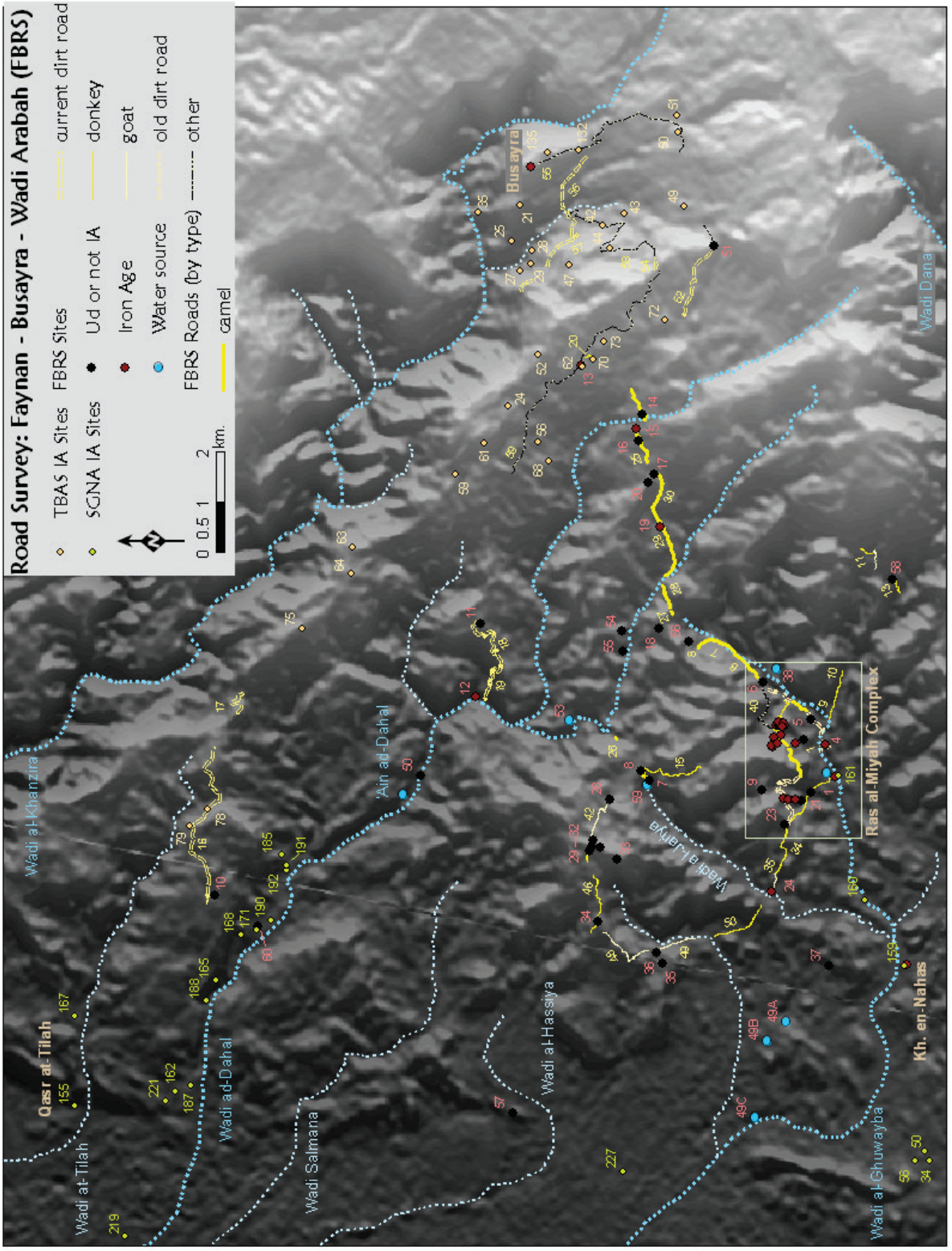

Figure 6.10 Sites and road segments recorded by the FBRS and Iron Age sites of MacDonald's projects (only south of Wadi al-Khanzira; for SGNA, see MacDonald 1992a; for TBAS, see MacDonald et al. 2004) (GIS shaded relief map based on ASTER satellite data). The FBRS area includes the three major basins of Wadi al-Ghuwayba, Wadi ad-Dahal, and Wadi al-Khanzira.

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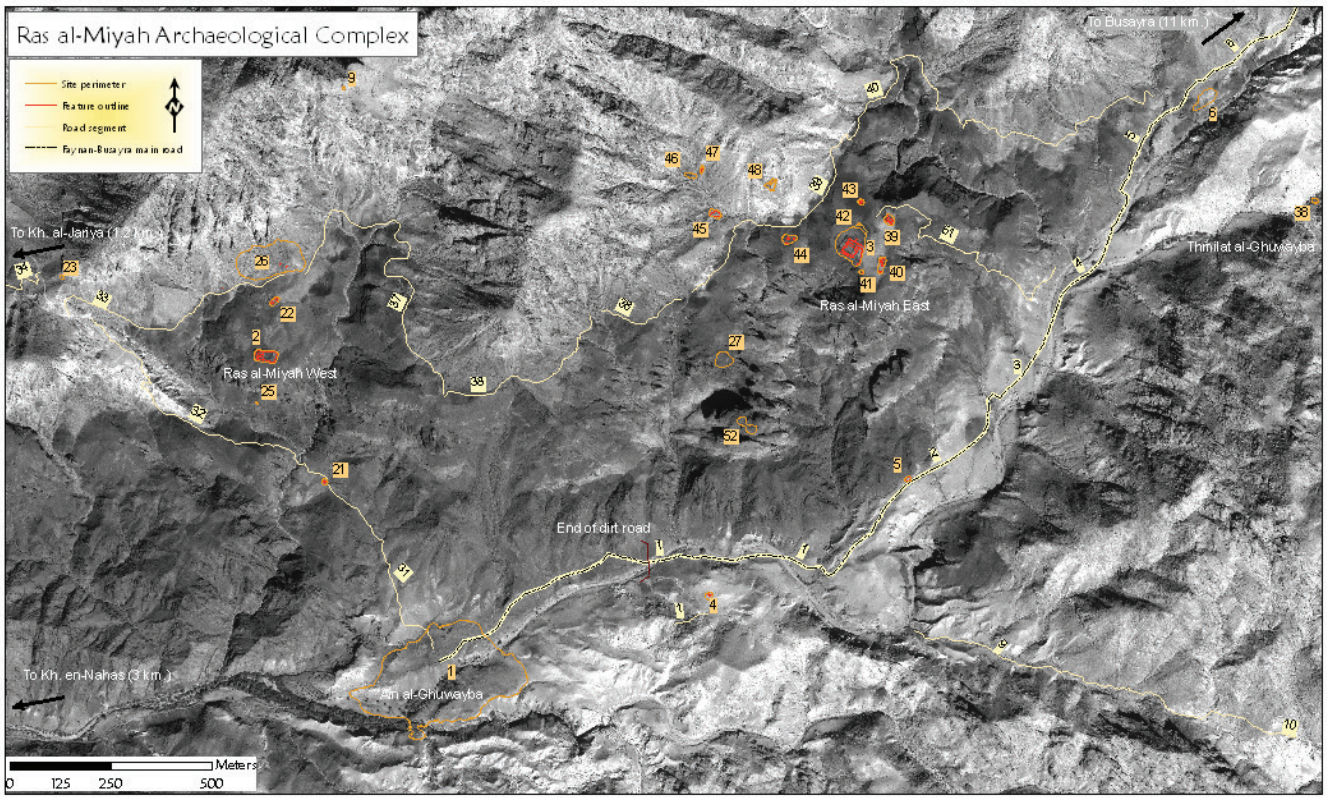

Figure 6.11 Sites and road segments recorded by the FBRS at the Ras al-Miyah Archaeological Complex (high-resolution satellite image, Ikonos, Geoeye). This area is the head of the principal road between Faynan and Busayra. The road climbs along the bank of Wadi al-Ghuwayba (Road Segments 1-6).

Recent probing conducted in 2009 near the center of the north bank portion of the site confirmed that Khirbat al-Ghuwayba was occupied in both of these major periods (Ben-Yosef et al. 2013).[10] The smelting activities were dated by MacDonald to the Iron Age I (based on pottery sherds) and by the recent probing to the Iron Age I to IIA (based on ceramic and technological parallels to Khirbat al-Jariya, as well as two ^{14}C dates). Based on this dating, the copper smelting at Khirbat al-Ghuwayba is not synchronous with the nearby extensive Iron Age IIB–C mining complexes (FBRS Sites 26, 46, and 47; Figure 6.13f) and the massive fortresses associated with them (FBRS Sites 2 and 3, "Ras al-Miyah West" and "Ras al-Miyah East," respectively; see Ben-Yosef et al. 2009a and Figure 6.13). This situation presents a certain difficulty as currently there is not a single smelting site that dates to the late Iron Age in the Wadi al-Ghuwayba basin (Ben-Yosef et al. 2010), and the destination of the ore from Ras al-Miyah mines remains unknown to us[11] (see discussion in Ben-Yosef 2010, especially Chapter 9).

Located on the main road between the highlands of Edom and Faynan (see below), Ras al-Miyah is the closest Iron Age mining area to ancient Bosra (Busayra). In the Iron Age IIB–C, the heyday of Busayra as a regional administrative center (Bienkowski 2002), Ras al-Miyah was a center of various activities primarily related to the mining operation in the cliffs above the 'Ain al-Ghuwayba oasis. In this area, blocked mining shafts and tailings are visible on the lower slopes of the Umm Ishrin formation, and numerous small structures are located nearby (Figure 6.13e). The most prominent architectural features are the fortresses, also located immediately in front of the mining complexes. The two fortresses are made of different building materials (Figure 6.13c,d) and have entirely different architectural plans (Figure 6.13a,b). The eastern fortress (FBRS Site 3) is accompanied by a massive watchtower hanging on a narrow shelf in the sandstone cliffs nearby (FBRS Site 48); as shown in our earlier research (Ben-Yosef et al. 2009b), intriguingly, this fortress was never completed and shows evidence of abrupt stoppage in the middle of its construction process. Many of the auxiliary sites in

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Figure 6.12 An overview of Khirbat al-Ghuwayba (FBRS Site 1) and ʻAin al-Ghuwayba (Arabic for "Spring of the Grove") from the fortresses area (the cliffs above the wadi). This is the head of the principal road to Busayra and a large Iron Age copper production site.

the vicinity of Ras al-Miyah and their interpretation are discussed in Ben-Yosef et al. (2009a), including details about the unfinished fortress and results of its sounding carried out during the ELRAP 2006 field season. The area has abundant pottery sherds, represented in places by a dense surface scatter. They are of typical Edomite forms and clearly distinct from the common ceramic finds at Khirbat al-Ghuwayba, Khirbat al-Jariya, and Khirbat en-Nahas. A few were published in the ceramic plate of Ben-Yosef et al. (2009a:Figure 19), including a broken oil lamp from the mine of FBRS Site 26. Figure 6.14a,b presents additional pottery from sites of the Ras al-Miyah Archaeology Complex.

An enigmatic pottery scatter (FBRS Site 27) was recorded by us in the cliffs to the northwest of the fortress of Ras al-Miyah East[12] (Figure 6.11). The site is located on a flat topographic shelf of the Salib dark red sandstone unit overlooking Wadi al-Ghuwayba and a prominent topographic dome of the same rock formation (Figure 6.15). It is not directly associated with any route, and even the constructed path that connects the two fortresses of Ras al-Miyah passes on a higher topographic shelf more than 100 m away (FBRS Road Segments 37–39, Figure 6.11, and description in Ben-Yosef et al. 2009a). The dense pottery scatter spreads over an area of ca. 0.3 acres; in addition, abundant fragments were found below the sheer cliffs and in rock crevices surrounding the site. The pottery sherds are relatively well preserved and represent typical Iron Age IIB–C Edomite vessels (Figure 6.16a). No architectural remains are associated with the site. In a shallow crevice underneath a rock in the center of the site, we found a male clay figurine (inset to Figure 6.15 and Figure 6.16a,b). The figurine was found without its head and is ca. 13 cm in length. It has broken hands, one of which was found nearby and was restorable. The left hand is holding something (now broken), probably a staff or a sword, and on its back a gown-like extension supports the figurine and enables it to be free-standing. The unique location, the lack of architecture, and the figurine strongly suggest that the site represents cultic activity, maybe an open shrine for worshiping Qos, the main Edomite god (Bartlett 1989). The interpretation of FBRS Site 27 as a cultic site triggered us to survey the prominent rock dome located immediately in front of it (but separated with a chasm of 50+ m). After a very difficult climb through narrow cracks in the only passable path to the summit, we found only a sparse scatter of Early Bronze Age pottery sherds and a few ephemeral architectural features (FBRS Site 52).

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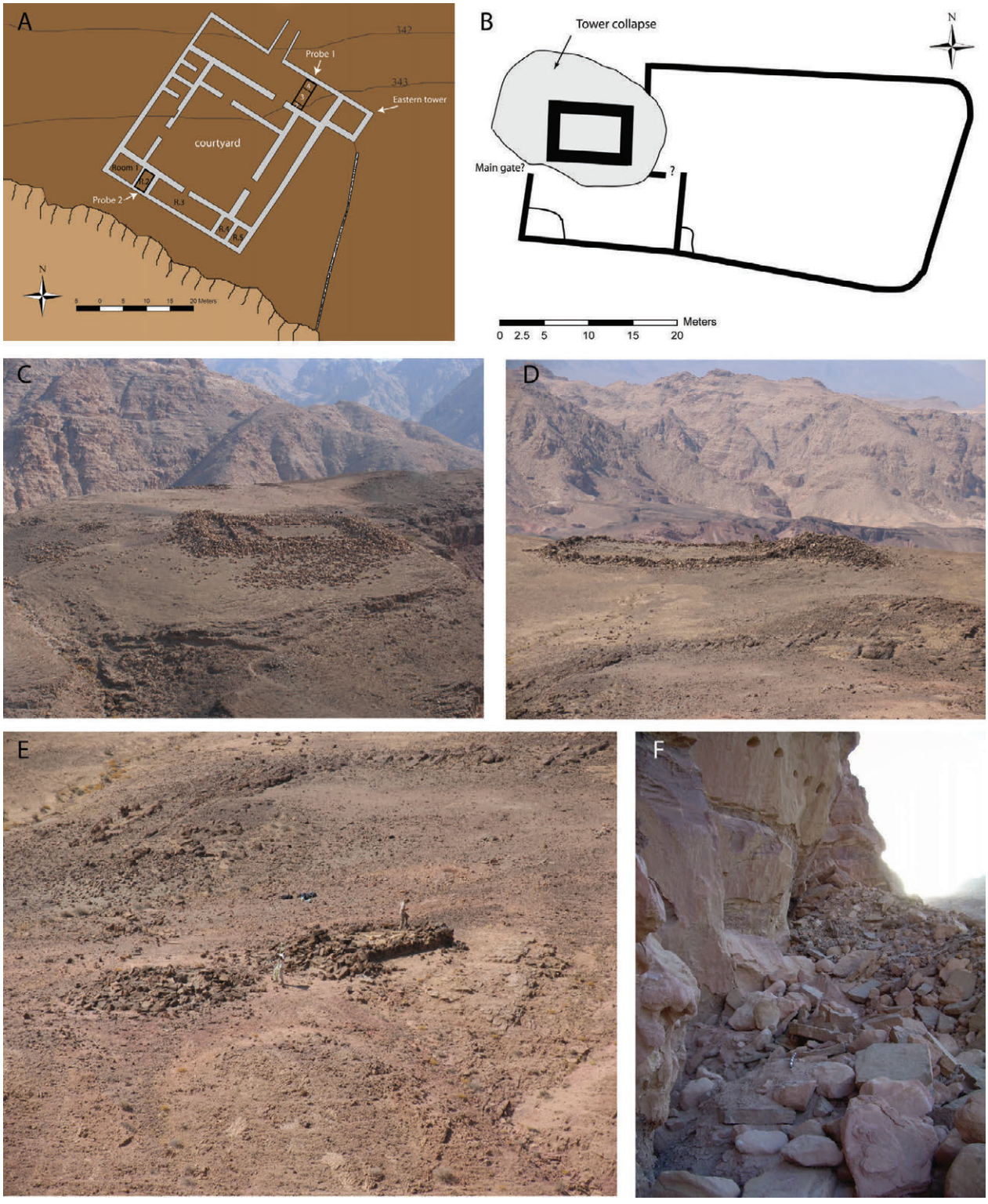

Figure 6.13 Ras al-Miyah Archaeological Complex (*a*, *b*, and *c* are from Ben-Yosef et al. 2009a and see additional figures there). (*a*, *c*) The fortress of Ras al-Miyah East (FBRS Site 3), an unfinished massive Iron Age II structure dominating the copper mines and oasis of ʻAin al-Ghuwayba (note the alignment of building stones prepared for construction in front of the northwestern wall). (*b*, *d*) The fortress of Ras al-Miyah West (FBRS Site 2), a massive tower and a courtyard made of local dolomite stones. (*e*) FBRS Site 22; small structures (circular and rectangular) made of the local dolomite stone near the fortress of Ras al-Miyah West and the mine Site 26. (*f*) FBRS Site 26; blocked copper mine shafts and a series of curved holes (support for hauling installations?).

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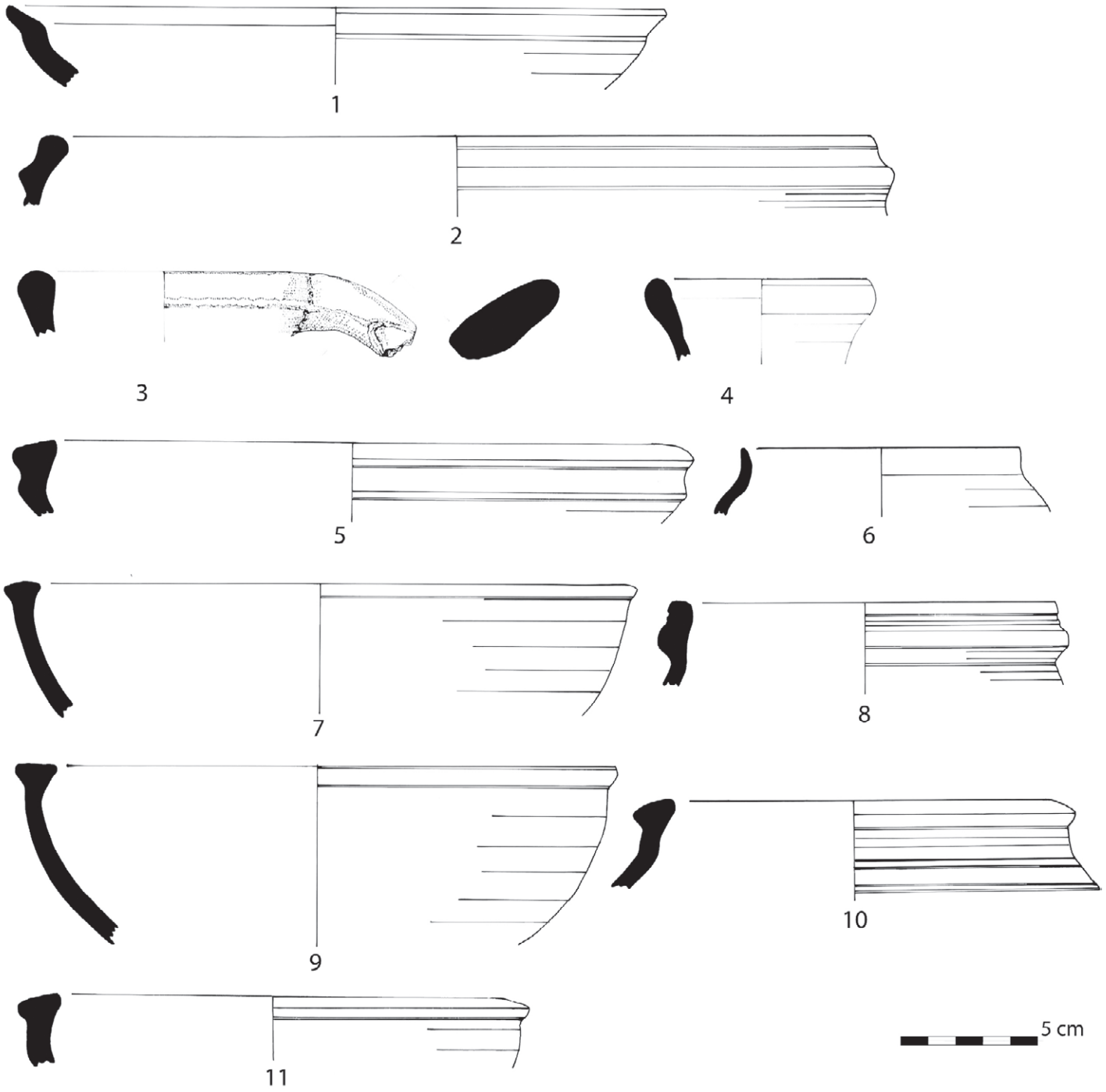

Figure 6.14 (*a*) Representative Iron Age IIB–C vessels from the Ras al-Miyah Archaeological Complex, collected by the FBRS (cf. Figure 6.11 and Table 6.3 for the location and description of sites); see also Ben-Yosef et al. (2009a:838, Figure 19) for additional types. (1) Bowl: FBRS Site 2, R161, cf. Chapter 4, BL30: Figure 4.30:2–3. (2) Cooking pot: FBRS Site 2, Rg.131; 3, cf. Chapter 4: Late Iron II CP30–35: Figures 4.31:10, 4.33:11; 4.36:2. (3) Jug: FBRS Site 3, Rg. 59, cf. Chapter 4: JG9, many examples. (4) Jug: FBRS Site 4, Rg.4. (5) Bowl: FBRS Site 22, Rg.185, cf. Chapter 4, BL3d: Figure 4.28:13. (6) Bowl: FBRS Site 22, Rg.176, cf. Chapter 4, BL20: Figures 4.28:21–26, 4.29:1–15, 4.32:3–5, 4.33:1, 4.34:3–4, 4.35:3–11; 4.36:4–5, 4.37:3–6. (7) Bowl: FBRS Site 22, Rg.193, cf. Chapter 4, BL3b/c: Figures 4.28:7–12, 4.32:1, 4.34:1–2, 4.36:1, 4.37:2. (8) Cooking pot: FBRS Site 22, Rg.167. (9) Bowl: FBRS Site 26, Rg.251, see parallels with Figure 6.14a:7. (10) Storage jar: FBRS Site 26, Rg.54. (11) Bowl: FBRS Site 40, Rg.224, see parallels with Figure 6.14a:7.

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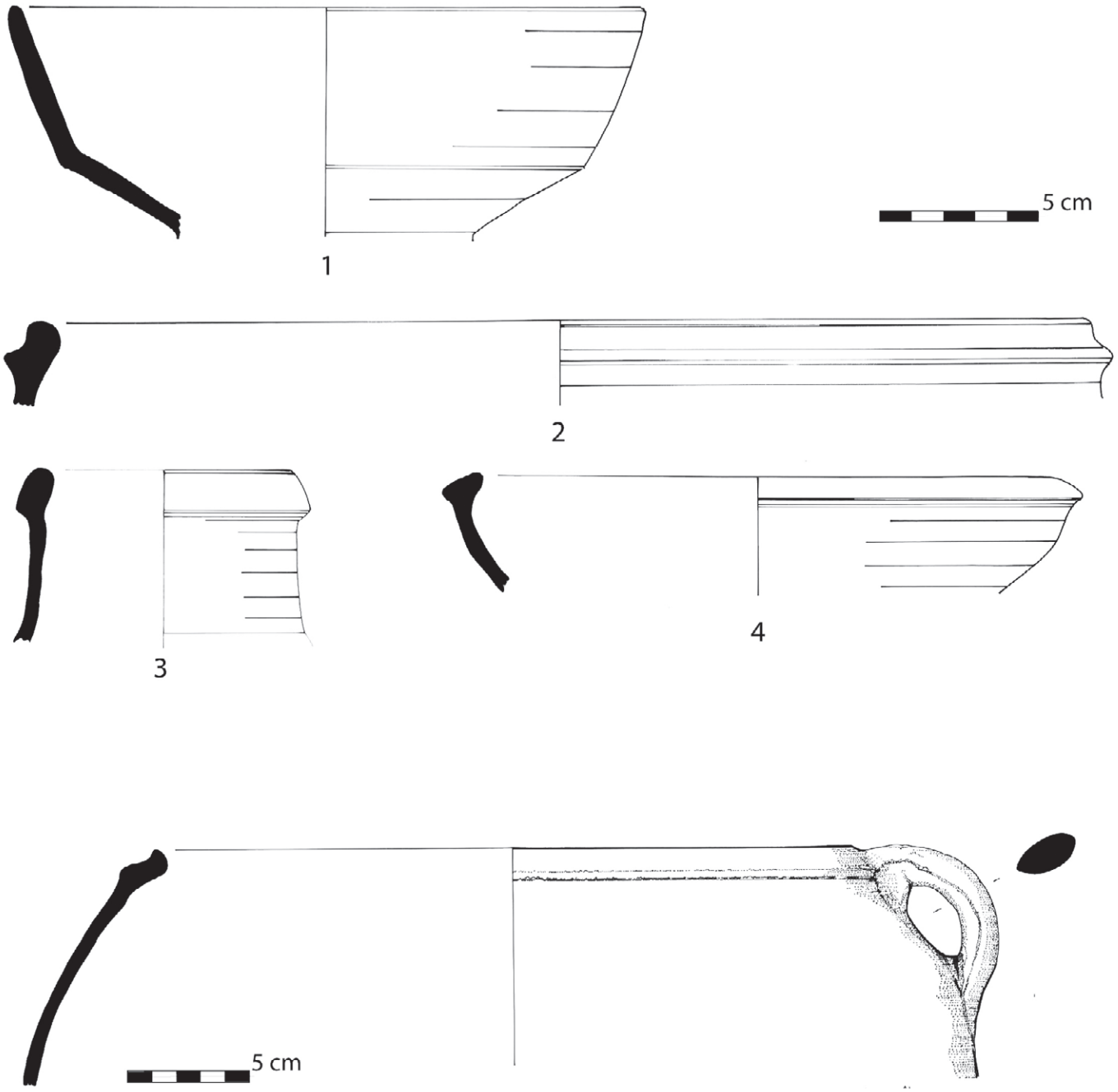

Figure 6.14 (*b*) More representative Iron Age IIB–C vessels from the Ras al-Miyah Archaeological Complex collected by the FBRS (cf. Figure 6.11 and Table 6.3 for the location and description of sites); see also Ben-Yosef et al. (2009a:838, Figure 19) for additional types. (1) Bowl: FBRS Site 45, Rg.231, cf. Chapter 4, BL10: Figure 4.35:2. (2) Cooking pot: FBRS Site 27, Rg.281, cf. Chapter 4, similar to CP1 found at KEN-S: Figure 4.24:11–12, but also see CP30: Figure 4.31:10 and CP35: Figure 4.33:11. (3) Jug: FBRS Site 48, Rg.80, cf. Chapter 4, JG3d: Figure 4.34:13. (4) Bowl: FBRS Site 48, Rg.78, see parallels with Figure 6.14a:7. (5) Cooking pot: FBRS Site 26, Rg.233, cf. Chapter 4, CP37: Figure 4.36:24.

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Figure 6.15 FBRS Site 27 in the area of the Ras al-Miyah Archaeological Complex. The site is a dense scatter of well-preserved Iron Age II pottery sherds (see Figure 6.16a) on a remote and high sandstone cliff (the figure in the photo stands at the center of the site). The unique location and the male figurine found in a shallow crevice (Figure 6.16a,b and inset above, showing the figurine and its broken hand [below the arrow] in situ, arrow is 20 cm) hint to a cultic function of the site. A survey of the conspicuous sandstone dome opposite the site (seen clearly in the picture and having only one extremely difficult access path) yielded only Early Bronze Age pottery sherds (FBRS Site 52).

The Faynan-Busayra Principal Road

The identification of Naqb al-Ghuwayba and Naqb al-Murab'a as the principal road connecting Faynan and Busayra is based on the Iron Age identification of many of the Ras al-Miyah archaeological features (above), finds along the road itself, topographical and geological considerations (Figures 6.17 and 6.18, respectively; see below), and the results of surveying alternative terrains.[13] The latter is represented mostly by FBRS Road Segments 11 to 13 that were recorded as part of a survey of the western ridges and slopes of Jabal al-Rumanna. No substantial road constructions or road-associated sites were identified in this region, and thus the routes through the main wadis seem to be preferable in antiquity. This is probably true also regarding the access to the main center at Khirbat Faynan, where main roads followed the wadi systems and not the mountain slopes. Table 6.5 and Figure 6.19 summarize the recorded road segments and sites along the road from Khirbat al-Ghuwayba to Busayra.

Between Khirbat al-Ghuwayba (ca. 175 m above sea level), which is the outermost copper production site in the northeastern Faynan district, and Busayra (ca. 1,160 m above sea level), the distance is 13.5 km as the crow flies and 20.3 km following the road. Although the road passes through three different wadi basins (Figures 6.17 and 6. 19), the elevation loss is minimal (60 m where crossing Wadi Jleila, a few tens of meters where crossing upper Wadi ad-Dahal, and ca. 140 m where the road descends toward Busayra in the upper Wadi al-Khanzira basin). The distance can be covered in one long day, and thus there was no need for caravanserais along the way. Most of the road segments seem to have been in use by local Bedouins in the past centuries and thus are clearly visible (the trodden paths are brighter than the surrounding rocks).

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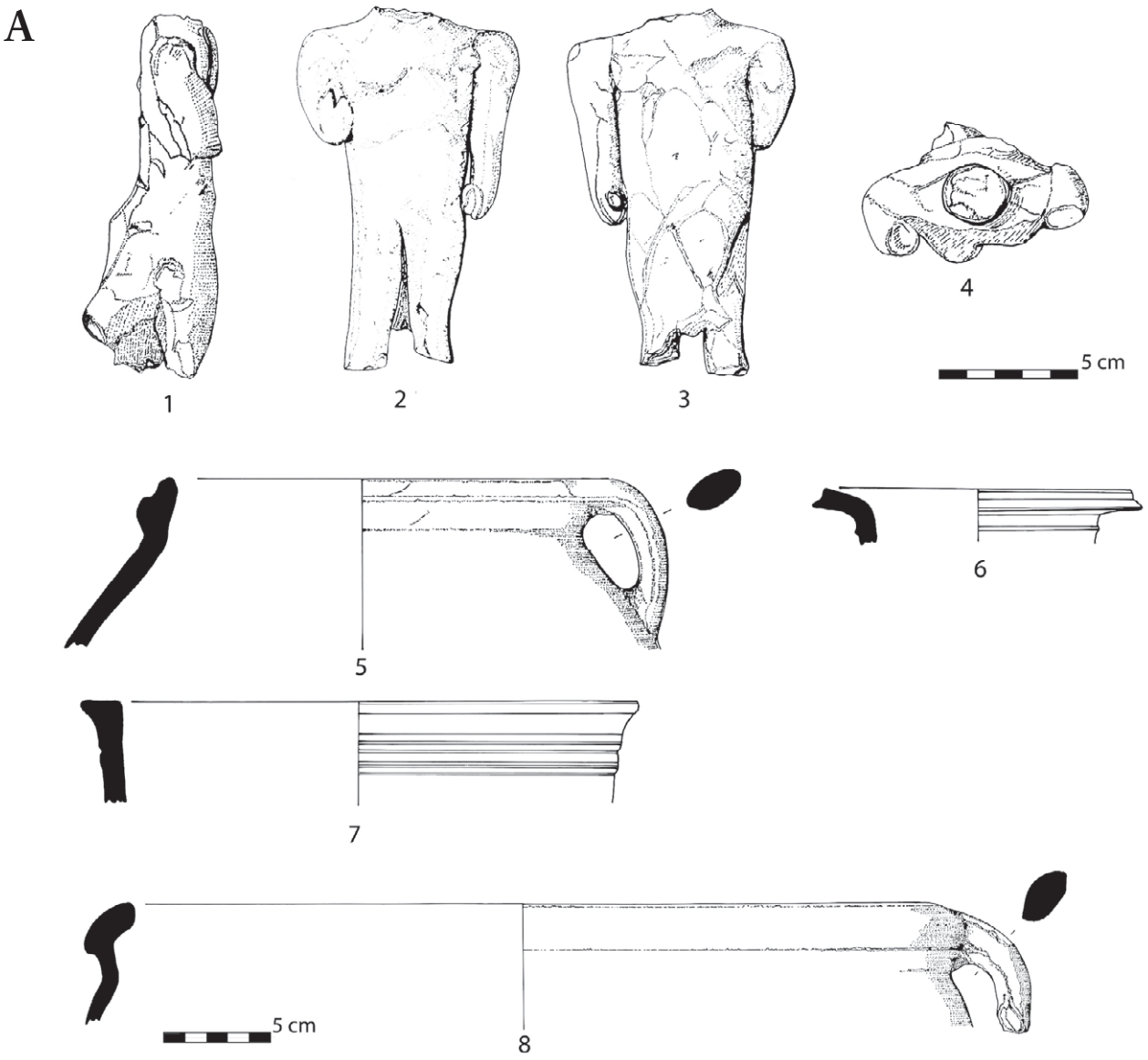

Figure 6.16 (*a*) Male figurine and representative vessel types from the cultic site FBRS 27 (cf. Figure 6.15 and Figure 6.16b). (1–4) Figurine, different views (EDM 8000). (5) Cooking pot: Rg.46, cf. Chapter 4, CP25: Figure 4.31:9 and CP34: Figure 4.31:14. (6) Bowl Rg.43, cf. Chapter 4, BL2: Figure 4.28:2. (7) Bowl: Rg.40, cf. Chapter 4, BL43: Figure 4.30:6–7. (8) Krater: Rg.44, cf. Chapter 4, KR17: Figures 4.30:18, 4.31:1–2, 4.32:18. (*b*) Photograph of the male figurine from FBRS Site 27.

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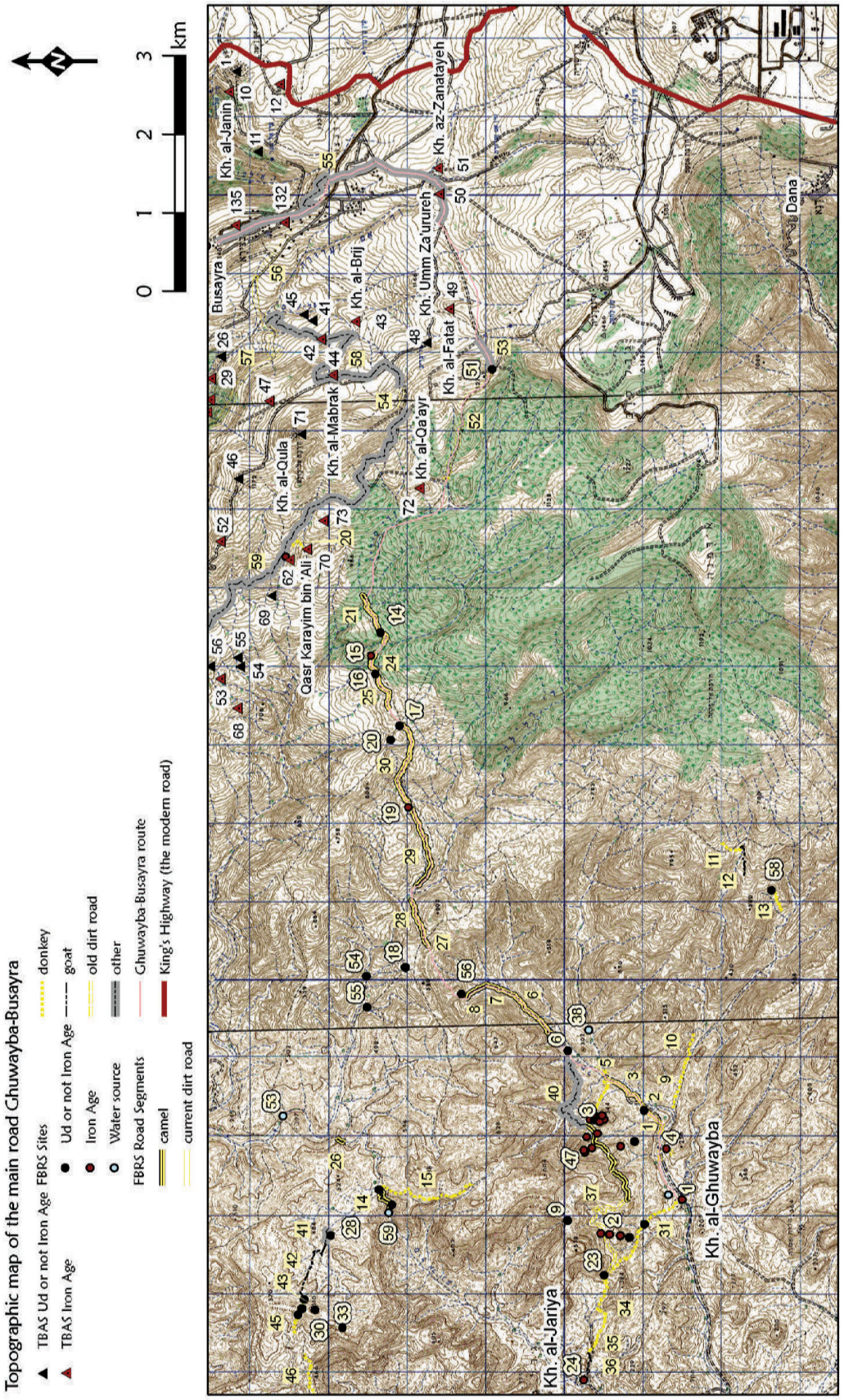

Figure 6.17 Topographic map of the main road between Faynan (Ras al-Miyah, 'Ain al-Ghuwayba, 185 m above sea level) and Busayra (1,160 m above sea level). The road follows the most reasonable topographic terrain; in the vicinity of Busayra, the road most probably passed by the sites of Khirbat Umm Za'ururen and Khirbat az-Zanatayeh (TBAS 50 and 51, respectively), two Iron Age settlements with watchtowers. Note also the upper segment of Naqb ad-Dahal (FBRS Road Segment 59), and the recorded portions of Naqb al-Jariya (FBRS Road Segments 14 and 26).

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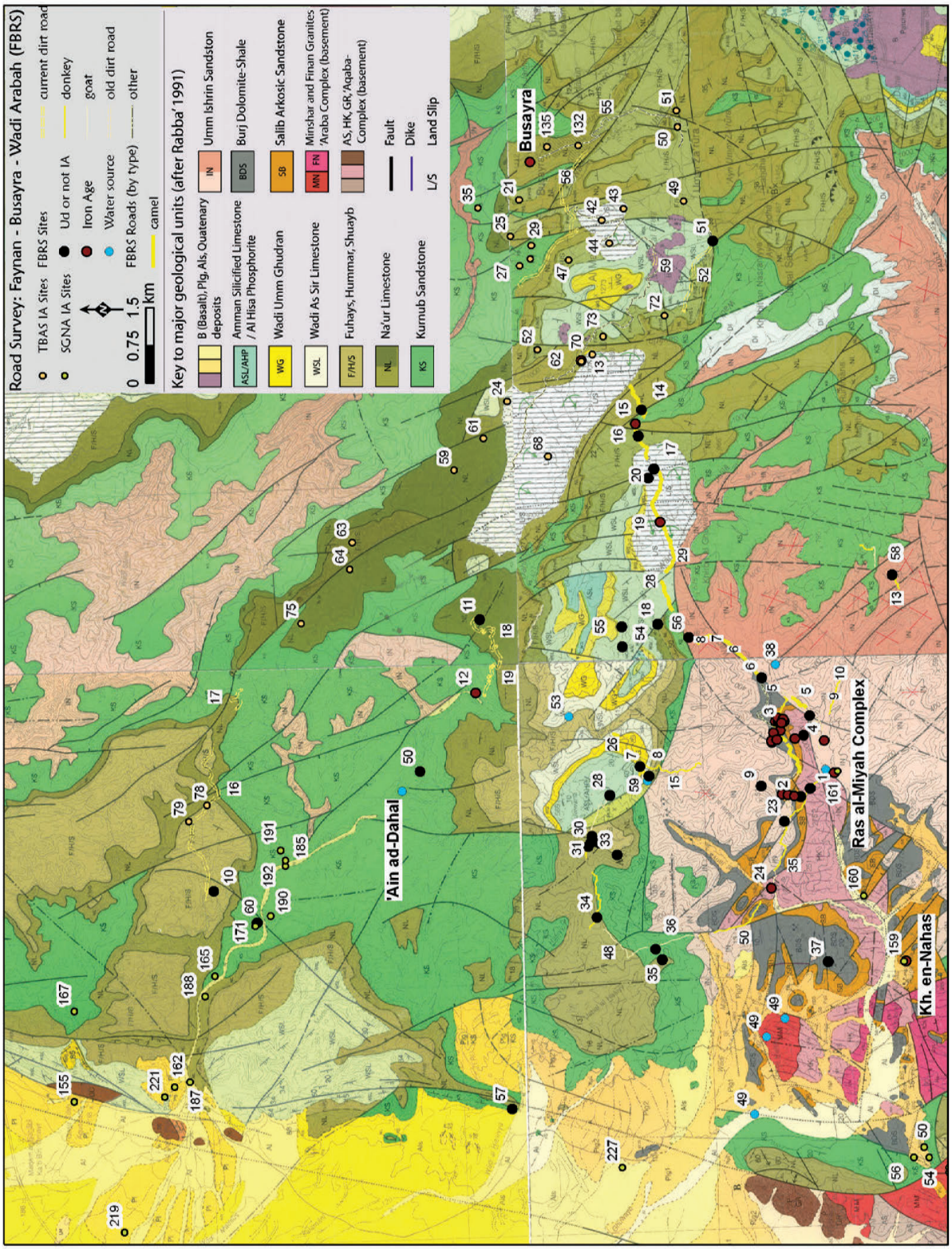

Figure 6.18 The geology of the FBRS area. Compilation of geological map sheets of Al Qurayqira (bottom left; Rabba' 1991), Ash Shawbak (bottom right; Barjous 1988), Fifa (top right; Tarawneh 1991), and At Tafila (top left; Tarawneh 1987); different colors are in the original maps. Note the limestone ridges and associated fault system west of Busayra (Naqb ad-Dahal and Naqb an-Na'ima), al-Ghuwayba fault (Naqb al-Ghuwayba, the first part of the main road from Faynan to Busayra), and the distribution of the Burj formation, the main copper ore body in Faynan.

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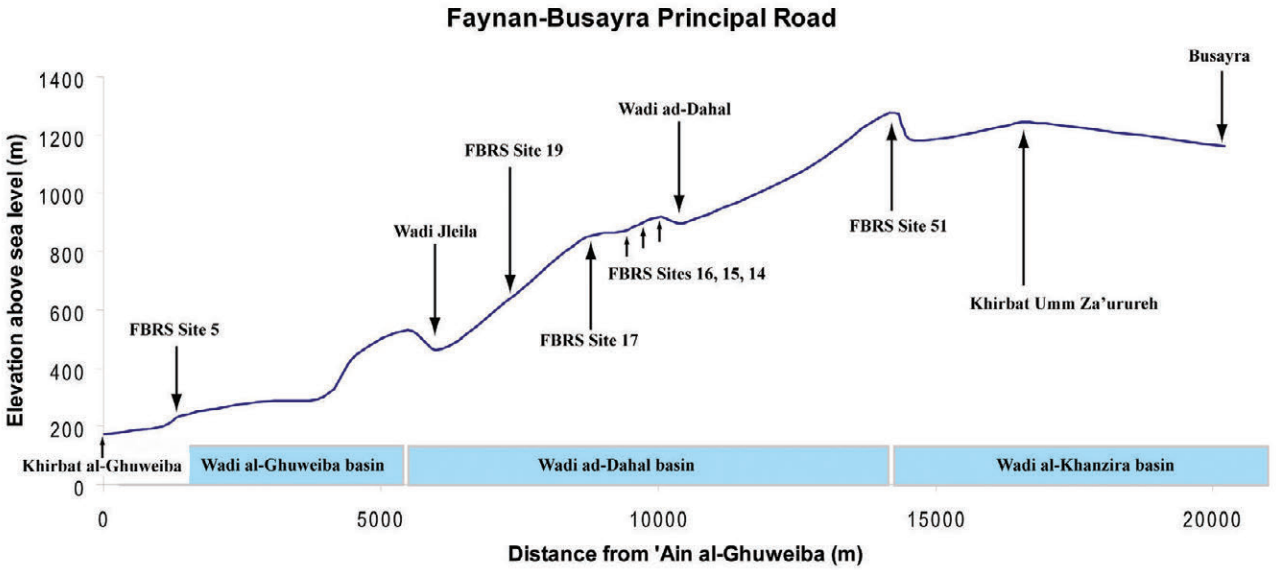

Figure 6.19 The profile of the main road from northeastern Faynan to Busayra as recorded by the FBRS. Compare Table 6.5 and Figure 6.18. Note the elevation difference of ca. 1,000 m from Khirbat al-Ghuwayba to Busayra.

The first part of the road (Naqb al-Ghuwayba) starts at Khirbat al-Ghuwayba above the freshwater spring and climbs along the northwestern bank of Wadi al-Ghuwayba (Figures 6.9c and 6.20a,b). The relatively easy ascent is a result of a large geological fault that created a weak zone in the massive hard sandstone of the Umm Ishrin formation (Figure 6.18), the rock unit that usually presents a serious topographic obstacle for travelers in Edom (see above and Figures 6.3 and 6.4). In the lower part, where there are still outcrops of the copper ore–bearing formation (Burj, Figure 6.18), the ancient road and some sites are interrupted by NRA prospecting roads and shafts (no longer accessible to trucks; the farthest point a truck can get to at the time of survey [2007] is near Khirbat al-Ghuwayba; see Figure 6.11). At the end of Road Segment 8, the Bedouin path continues directly north and the ancient road heads to the northeast for the final ascent of the upper reaches of the Wadi al-Ghuwayba (on some maps called Wadi al-Yhmar; see Table 6.1) (Figure 6.21). This segment, represented by FBRS Road Segment 27, is important (although not decisive) evidence that substantial road constructions were not a recent activity of the local Bedouin. The Bedouin path (recognized by its brightness, the result of recent use) that continues north is only a narrow, poorly delineated trail, while the ancient road is wide and consists of well-defined (although currently not very visible) switchbacks (Figure 6.21b). In this segment, we also found a typical Iron Age pottery sherd (see below).

From the upper saddle of Wadi al-Ghuwayba, the road descends toward Wadi Jleila (also called Wadi Ja'j'a; see Table 6.1) and gradually ascends on its other side, taking advantage of a limestone spur. This area is probably called al-Muraba'a (according to some local Bedouin; Table 6.1), and the ancient road in this area is almost certainly called Naqb al-Murab'a (Musil's nakb el-Murabba; see above). Along the road on the watershed of the limestone spur, we recorded a prominent alignment of huge boulders (Road Segment 29; Figure 6.20c) that were probably part of the road markers, although its exact purpose is unclear. The road passes through the fortlet/road station of FBRS Site 19 (Figure 6.22a, mixed Iron Age and Roman-Nabataean pottery sherds) and reaches the saddle (FBRS Site 17) with upper Wadi ad-Dahal through a series of switchbacks and a well-defined path. About 100 m to the west of the saddle and with no visibility line lies another fortlet, FBRS Site 20 (Figure 6.22b). Although the structure is relatively small, it is built out of massive blocks of local stones and surrounds a conspicuous limestone outcrop that makes it visible from a very long distance. The location of this fortlet on a prominent ridge overlooking the ascents of ad-Dahal, al-Murab'a, and al-Jariya suggests that this is Musil's fortress of el-Ebr (see above). The scarce identifiable pottery sherds collected were identified as Roman/Nabataean.

From the saddle of FBRS Site 17, the road continues along the slopes of upper Wadi ad-Dahal, designed not to lose elevation by following topographic contours.

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Figure 6.20 Segments of the principal road from Faynan to Busayra with some representative road constructions generally ordered from the lowlands to the highlands. (*a*, *b*) Parts of Naqb al-GhuWayba (Road Segment 6). (*c*) Distinct boulder alignment along the road on a limestone spur in Wadi Jleila basin (Road Segment 29). (*d*) Retaining wall (facing south, Road Segment 24). (*e*,*f*) Well-constructed parts of the main road (Road Segment 22). (*g*) Evidence of stone clearing and road delineation (width approximately 2 m). (*h*) High retaining wall constructed of large boulders and stones to protect the road from eroding by a small tributary of Wadi ad-Dahal; the massive constructions made this location a site (FBRS Site 14).

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Figure 6.21 Segments of Naqb al-Ghuwayba, part of the main road from Faynan to Busayra. (*a*) Road Segment 8 and ancient retaining wall. (*b*) Road Segment 27 looking toward Faynan; this part of the road is not used today by local Bedouin, making the ancient path is less bright and visually less distinct in the landscape; however, clear, wide switchbacks can be identified (an identifiable Iron Age sherd was found along this segment; see Figure 6.24).

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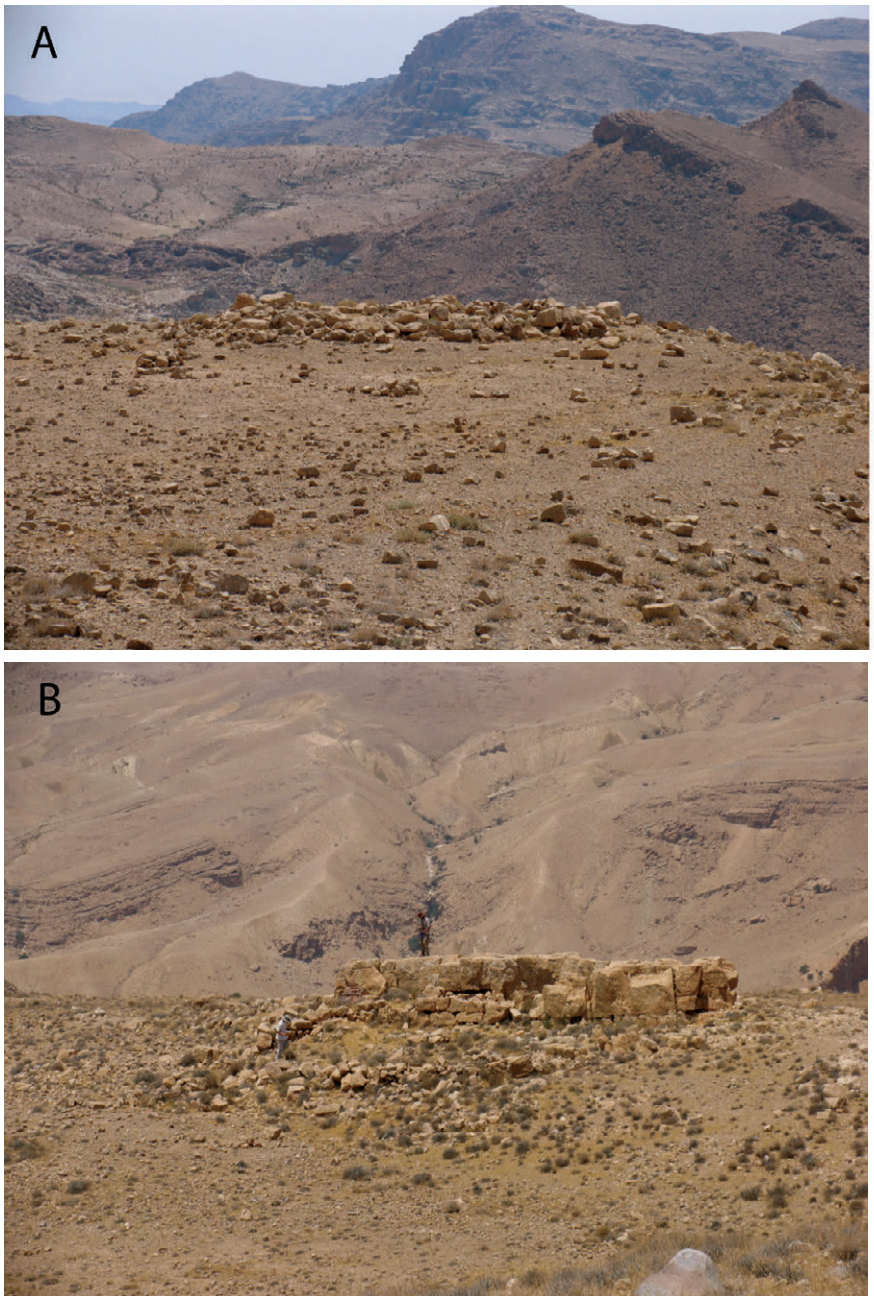

Figure 6.22 Fortlets along the principal road from Faynan to Busayra. (*a*) FBRS Site 19, a rectangular structure on a spur in Wadi Jleila basin (pottery sherds from the Iron Age, Roman, and Nabataean (?) periods). (*b*) FBRS Site 20, "The Outcrop Fortlet," massive structures surrounding a prominent rock outcrop on the ridge between Wadi Jleila and Wadi ad-Dahal, visible from long distances (Musil's el Ebr?; Roman/Nabataean pottery sherds).

This region is characterized today by terraced limestone slopes and natural sparse forest of oaks and junipers. It is different from the lowlands also by having more abundant archaeological remains related to agriculture—namely, built terraces (usually following the natural stratigraphic steps), cairns (for clearing fields and marking boundaries, e.g., FBRS Site 16), and small "farm" houses (e.g., FBRS 13 and see MacDonald et al. 2004). The ancient road is well preserved, in places semi-paved (Figure 6.20f), and with clear delineation of its margins (Figure 6.20g). The road has an average width of about 2 m, and where it crosses small tributaries (commonly in this terrain) it is supported by retaining walls (Figure 6.20d) that in places are very substantial (FBRS Site 14; Figure 6.20h). In a few locations, there is clear evidence of blazing through rocky outcrops (Figure 6.20e), and one location may have been a watchtower supervising this segment of the road (FBRS Site 15, foundations of a massive structure).

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From Wadi ad-Dahal (in this part called Wadi Sayrin; see Table 6.1), the road climbs to the main saddle with Wadi Umm Za'arura, a tributary of Wadi al-Khanzira. The saddle, where Busayra is visible for the first time (Figure 6.23), has a few stone features that may be related to the ancient road (FBRS Site 51). This landscape in the vicinity of Busayra is intensely disturbed with numerous new asphalt and dirt roads that probably cover ancient routes. In this area, the main road from Faynan probably follows the most reasonable topographic course toward Busayra, avoiding elevation loss by veering east and passing through a few Iron Age sites recorded by the TBAS (Figure 6.17), including Khirbat Umm Za'arura, a large Iron Age II site with a possible watchtower in its center (TBAS Site 50; MacDonald et al. 2004:204–205; see also overview of the hinterland of Busayra in MacDonald 2002). A more direct, albeit difficult route may have been through a more western saddle (FBRS Control 57) and Road Segments 58 and 56, also near some Iron Age sites (Figure 6.17).

The only identifiable pottery fragments collected directly from the road segments along the main road from Faynan to Busayra (and in fact along any recorded road segment of the FBRS) were typical Iron Age IIB–C (Figure 6.24). These pottery sherds and the contemporaneous Iron Age centers on both sides of the road imply traffic along this route at least during the Iron Age IIB–C.[14] The lack of substantial non–Iron Age sites on the Faynan end of the road suggests that the recorded road constructions are from the Iron Age and represent the quality of regional roads in this period. Even if this tentative suggestion is not correct, the recognition of Iron Age traffic along this route implies that regional roads of this period did not usually present construction efforts that are greater than the observable ones along the road described above. In other words, the recorded road features represent the *upper limit* of regional road construction efforts in Iron Age Edom even without being securely dated.



Figure 6.23 An overview of the modern village of Busayra and the Iron Age site (top of the hill at the front of the picture) as seen from the main road to Faynan (looking toward the north). It is the first sight of the settlement to those coming from the lowlands. The King's Highway is further to the east, bypassing the Wadi Khanzira basin along the edge of the Edomite plateau.

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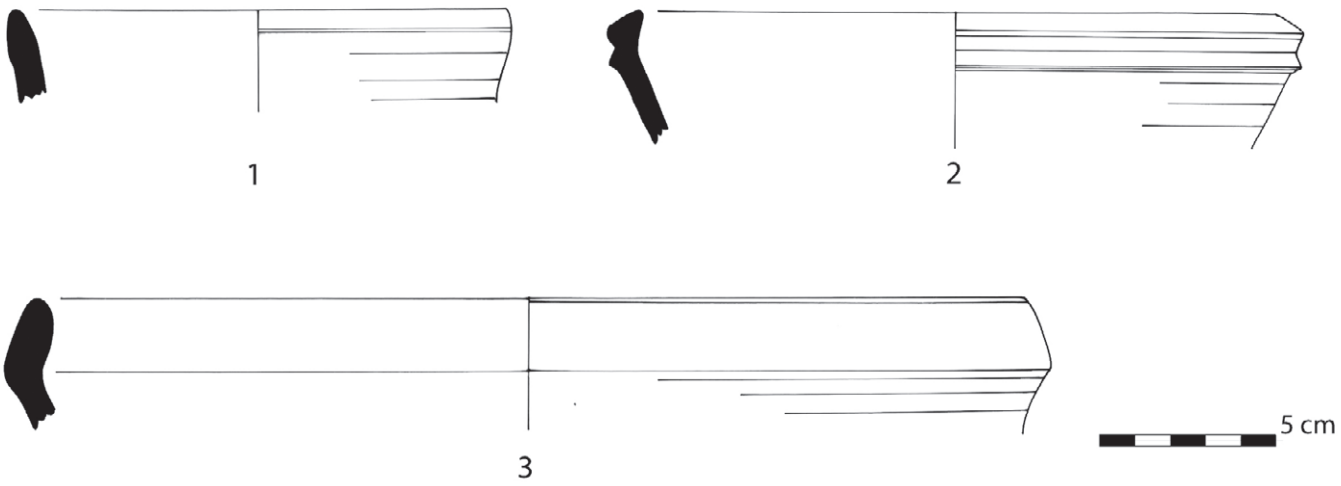

Figure 6.24 Diagnostic pottery sherds found along the principal road from Busayra to Faynan (cf. Figure 6.17 for location of the road segments). Although the collection includes only three sherds, all of them are from a single period—Iron Age (IIB–C). (1) Bowl: Road Segment 25, Rg.270. (2) Bowl: Road Segment 6, Rg.2, see parallels with Figure 6.14a:5. (3) Krater: Road Segment 27, Rg.60, cf. Chapter 4, KR15: Figures 4.30:14–17, 4.36:17–20.

Other Ascents Recorded by FBRS

The area of Khirbat en-Nahas and Khirbat al-Jariya in the lower Wadi al-Ghuwayba basin (Figure 6.10) is connected directly to Wadi ad-Dahal with a well-defined road—the Naqb al-Jariya. The road starts at Khirbat al-Jariya, a large (5-ha) Iron Age I to IIA smelting site with substantial architectural remains (FBRS Site 24; Ben-Yosef et al. 2010), and climbs gradually along the bed of Wadi al-Jariya. In this segment (called Sil al-Ja'ur on some maps; see Table 6.1), the almost flat and distinct wadi bed delineates the course of the road, and no associated constructions or markers were needed. The road passes by numerous remains of campsites and a series of ancient (mostly Iron Age) copper mines exploiting the outcrops of Burj formation on the eastern side of the wadi (Chapter 7, this volume). The gradual wadi bed ends abruptly at the head of Wadi al-Jariya, where major geological faults (Figure 6.18) brought together completely different rock units. The reddish sandstone of the Umm Ishrin formation is replaced by marls, limestones, and cherts of younger formations, and the contact area is characterized by a chaotic layout of stratigraphic beds, some with very steep dips. This abrupt change was recognized by the local inhabitants as demonstrated by the name "Jabal Um Suwwana" given to this region (Arabic for the "mountain of the mother of cherts"; see Table 6.1). It is also probably the reason for the small water source of Thmilat al-Jariya located right in the contact area (FBRS Site 59). The final ascent to the main saddle between Wadi al-Jariya and the wadi basin of Wadi ad-Dahal is steep (ca. 115-m elevation difference over a distance of less than 300 m), and substantial road construction appears here. The road (FBRS Road Segment 14) is constructed of well-defined switchbacks (Figure 6.25a) and in places takes advantage of the exposed dipping rock beds of the Wadi Umm Ghudran and Amman formations (Figure 6.25c). The constructions along the road are made of the local silicified limestone and cherts, including the idiosyncratic rock "bulbs" (rounded boulders that look like huge rock balls). In the lower part of this steep ascent there is a massive structure overlooking the switchbacks (FBRS Site 7; Figure 6.25a,b). The structure appears like an enormous retaining wall, 3 m high and 6 m wide, built against the slope and supports a flat platform that probably functioned as a watchtower/supervising post in this critical segment of the road. Unfortunately, we did not find any pottery sherds associated with this unique site; its location on the very entrance to the Iron Age mining valley of Wadi al-Jariya may indicate its age.

In the main saddle of Wadi al-Jariya, there is a historic/recent Bedouin cemetery and some rock features that may represent older graves (FBRS Site 8). From the saddle, the road continues toward the lower part of Naqb ad-Dahal through another short segment of well-constructed switchbacks (FBRS Road Segment 26; Figure 6.25D) and the water source of 'Ain J'aj'a

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in Wadi Jleila (FBRS Site 53). Although it is clear that the main road heads toward the area of ʻAin ad-Dahal, there are routes connecting Naqb al-Jariya with Naqb al-Ghuwayba and Naqb al-Murabʻa (described above) and a well-defined road heading west from the saddle of Wadi al-Jariya to Wadi al-Hasiya and the Arabah via the *tumulus* fields of FBRS Sites 28 to 32 (see below) and Road Segments 44 to 47 (Figure 6.10). The centrality of the Wadi al-Jariya–ʻAin ad-Dahal road is demonstrated also by the report of Major Kitchener (1884) and his map (1883), where this route, including the graves of FBRS Site 8 and the spring of FBRS Site 52, appears for the first time (and see discussion above).

The destination of Naqb al-Jariya was Naqb ad-Dahal, the main road from Busayra to the Arabah. The importance of Naqb ad-Dahal as a central route



Figure 6.25 Road constructions along Naqb al-Jariya. (*a*) The switchbacks at the head of Wadi al-Jariya (FBRS Road Segment 14) are dominated by a massive stone tower (*b*, FBRS Site 7). (*c*) Constructions along FBRS Road Segment 14 along dipping rock beds. (*d*) Constructions along FBRS Road Segment 26, frequently in use by local Bedouins to access the water source of ʻAin J'aj'a (FBRS Site 53).

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in Edom was recognized by several scholars (e.g., Ben-David 2009:727; MacDonald 2006:86), and MacDonald surveys documented many sites along the road (MacDonald 1992a; MacDonald et al. 2004). However, the central segment of the Naqb was not covered by these surveys (Figures 6.1, 6.2, and 6.10), and some important sites were recorded in this area by our team.[15] The road takes advantage of the moderate landscape of limestone ridges to the west of Busayra, a "geological window" in the rugged terrain of Edom (Figure 6.18 and see discussion above), and descends gradually toward the Arabah. In its upper part, the road probably had a few different branches, starting from the King's Highway and Busayra and heading northwest along both sides of the main ridge (FBRS Road Segments 59, the main modern dirt road, and 57, a newly blazed dirt road that covered a well-built Naqb, visible further to the northwest along the slopes of Wadi al-Khanzira). After about 5 km, the main road of Naqb ad-Dahal descends into the canyon of Wadi ad-Dahal, while an alternative route continues to descend gradually along the ridges all the way to the Arabah. The alternative "ridge option" is currently the modern dirt road of Naqb an-N'aima, partially recorded by us as Road Segments 16 and 17. The modern road probably covers an ancient route bypassing the canyon and spring of 'Ain ad-Dahal, as suggested by several Iron Age sites and dozens of campsites recorded along it by MacDonald's team (TBAS; MacDonald et al. 2004 and see Figure 6.10).

The segment of Naqb ad-Dahal immediately before the Naqb meets the wadi bed (FBRS Road Segments 18 and 19; Figure 6.10) is controlled by a small Roman fortlet/watchtower (FBRS Site 11) and was until recently a well-defined ancient path, descending with switchbacks and road constructions along the steep slope (C. Ben-David, personal communication, 2007 and see Ben-David 2009:727). Unfortunately, a dirt road was built recently directly on top of the ancient path (facilitating access to a small orchard, FBRS Road Segment 18) and destroyed one of the last ancient segments of Naqb ad-Dahal. In the area where the road meets the wadi bed and Naqb al-Jariya (see above), a massive structure is located on a high terrace (FBRS Site 12, Figure 6.10; see also Ben-David 2009:Figure 9). The structure consists of several rooms arranged as a semi-rectangle around a courtyard (Figures 6.26 and 6.27a). Its edges were severely eroded by the deepening of Wadi ad-Dahal, and a well-constructed path descending toward the wadi bed (possibly a segment of the main road) is abruptly cut by a sheer cliff (Figure 6.27b,c). Scarce pottery sherds indicate Iron Age occupation, and the location and shape suggest that the site functioned as a caravanserai (and/or as a defensive structure).

Approximately 2 km further down Wadi ad-Dahal, the road passes through a narrow sandstone gorge (Figure 6.28) with numerous inscriptions and rock drawings carved on its walls (FBRS Site 50). The inscriptions were first reported by Major Kitchener's expedition (1884:214),[16] but since were virtually forgotten (a brief reference is found in Ravek and Shmida 2000). Almost all of the inscriptions, including hundreds of signs, are located high above the wadi bed and cannot be reached easily today, and thus their examination is rather difficult (Figure 6.29). This situation is the result of the rapid deepening of the wadi bed (mentioned above regarding FBRS Site 12) and may be the key for dating the inscriptions if the rate of deepening is known from regional geomorphological studies (or conversely, if a date for the inscriptions is obtainable, the rate of deepening can be estimated).[17] The high location and the almost entire lack of Arabic indicate that the inscriptions are not recent and probably pre-Islamic. This is supported by crucifixes (Figure 6.30a,c) and some hints of Safaic or Nabataean or possibly Haurian, an ancient script predating but related to Nabatean (Figure 6.30a–d).[18] Some of the animals depicted on the walls (Figure 6.30e–g) appear also in the rock drawing of FBRS Site 54 and are discussed below.

The lower most part of Wadi ad-Dahal is rich with archaeological remains (MacDonald 1992a and Figure 6.10), including an additional small rock drawing site (FBRS Site 60). MacDonald (2006:82) summarizes the archaeological picture of this region:

> There are no major architectural sites associated with [lower] Wadi ad-Dahal. However, the large number of camping sites, cemeteries, and lithic and sherd scatters associated with the wadi [many of which are dated to the Iron Age, see Figure 6.10] are testimony to the fact that it has been the scene of human activity for millennia. Furthermore, the location of [a] former Police Post at a high point where Wadi ad-Dahahl enters the north-east Arabah indicates that it served as a monitoring site for traffic entering and exiting the wadi. This post is not unlike older structures at the western extremity of Wadis 'Isal, Hudeira, Feifeh, Umruq, and Khuneizir.

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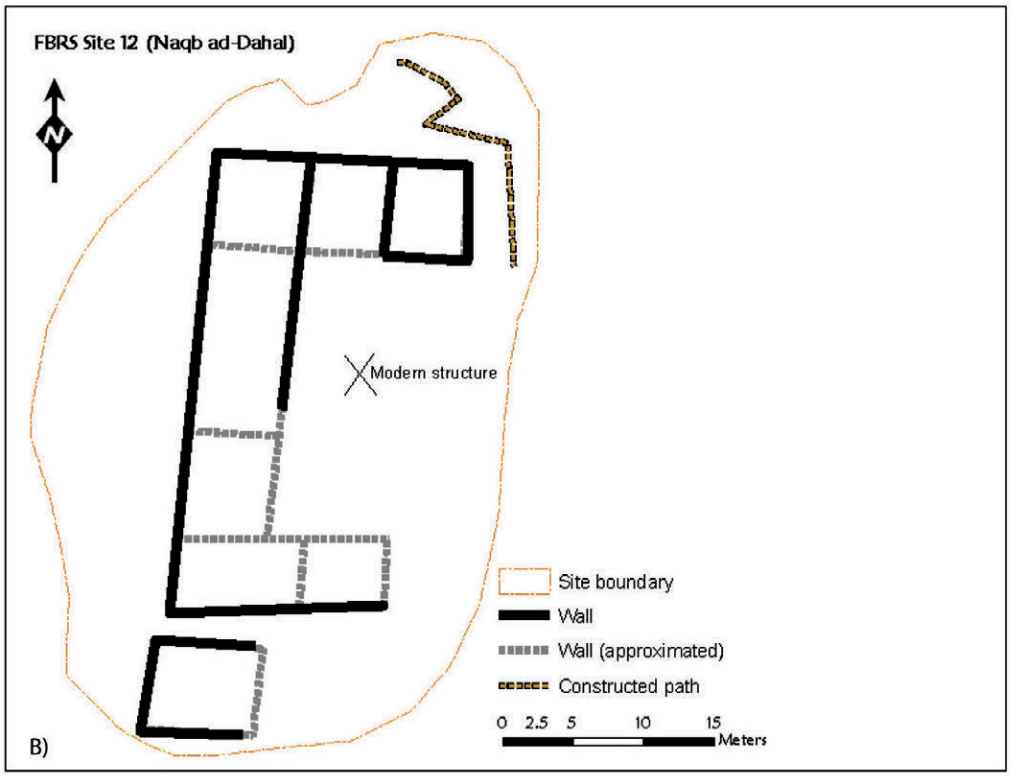

Figure 6.26 FBRS Site 12, an Iron Age caravanserai/encampment in Naqb ad-Dahal, the main road connecting Busayra to the Arabah Valley and further to the west. The site is located on the bank of Wadi ad-Dahal approximately 700 m above the spring and at the end of the long descent from the limestone ridge to the southeast. (*a*) Satellite image (Google Earth) and (*b*) schematic plan (note the well-built path descending toward the wadi bed and may represent an undisturbed segment of the Iron Age road; cf. Figure 6.27).

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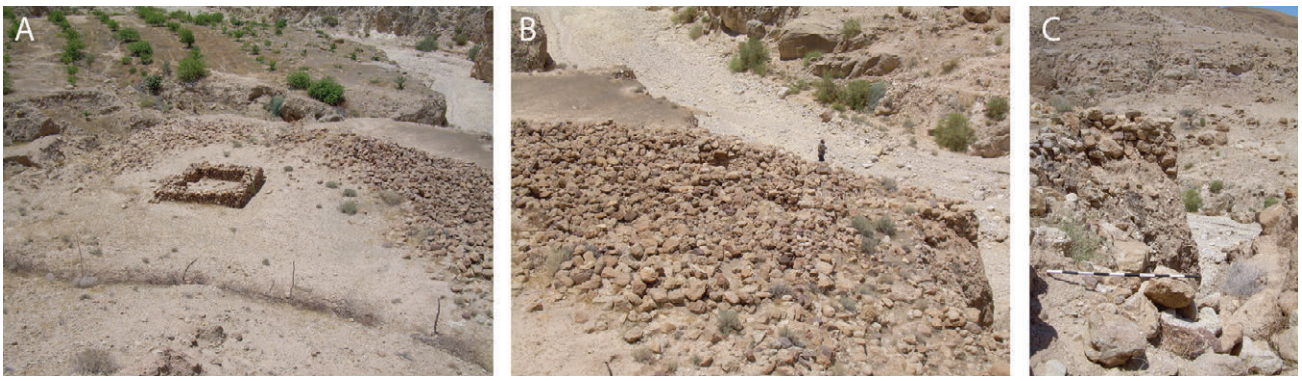

Figure 6.27 FBRS Site 12, an Iron Age caravanserai/encampment in Naqb ad-Dahal. (*a*) An overview of the site looking toward the southwest (the structure in the middle is part of the modern agricultural activities in the area). (*b*) The northern segment of the site sharply cut by erosion and deepening of the wadi bed (note person in the middle for scale). (*c*) Constructions along the path descending toward the wadi bed; it is cut by a ~5-m cliff and may represent the original constructions of the Iron Age main road.



Figure 6.28 The narrow sandstone gorge, a necessary pass of the main road from Busayra to the Arabah (Naqb ad-Dahal) and further to the west. On its walls, there are dense rock drawings and inscriptions (FBRS Site 50; see Figure 6.30).

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Figure 6.29 FBRS Site 50, rock drawings and inscriptions at the sandstone gorge of Wadi ad-Dahal (200 m above the spring head; cf. Figure 6.5a). The rock surface is covered with dense drawings, evidence of the centrality of the Naqb ad-Dahal road throughout the millennia (see text and Figure 6.30 for details). The rapid deepening of the wadi channel left the ancient drawing high above the wadi bed (scale stick is 1 m), protecting them from modern disturbances.

Naqb ad-Dahal is an example of a central road that was traveled for millennia, at least from the Chalcolithic (the earliest recorded sites in MacDonald 1992a) to the days of modern Jordan, in which a dirt road was blazed along the wadi (replaced by Naqb an-Na'ima and no longer in use), and a police station was built to supervise the entrance from the Arabah. It is difficult to assess the quality of the ancient road constructions in this area as modern dirt roads and agricultural fields obscure the archaeological remains. The centrality of Naqb ad-Dahal is evident by the numerous sites associated with the road, including the dense inscriptions of FBRS Site 50 made by travelers throughout centuries, and stems from the gradual and direct ascent from the Arabah to the Edomite plateau with the permanent water source of 'Ain ad-Dahal located in the midway. The abundant Iron Age sites, including the massive caravanserai of FBRS Site 12, emphasize the importance of the road in this period. Naqb ad-Dahal is probably one of the reasons for the location of Busayra (biblical Bozrah). Caravans and travelers heading from Busayra to the Arabah and the Negev would definitely use this route and would not travel through Wadi al-Ghuwayba, as was recently suggested by Finkelstein and Singer-Avitz (2009:215) to explain the location of their preposterous suggestion that an "Assyrian" fortress existed at Khirbat en-Nahas.[19]

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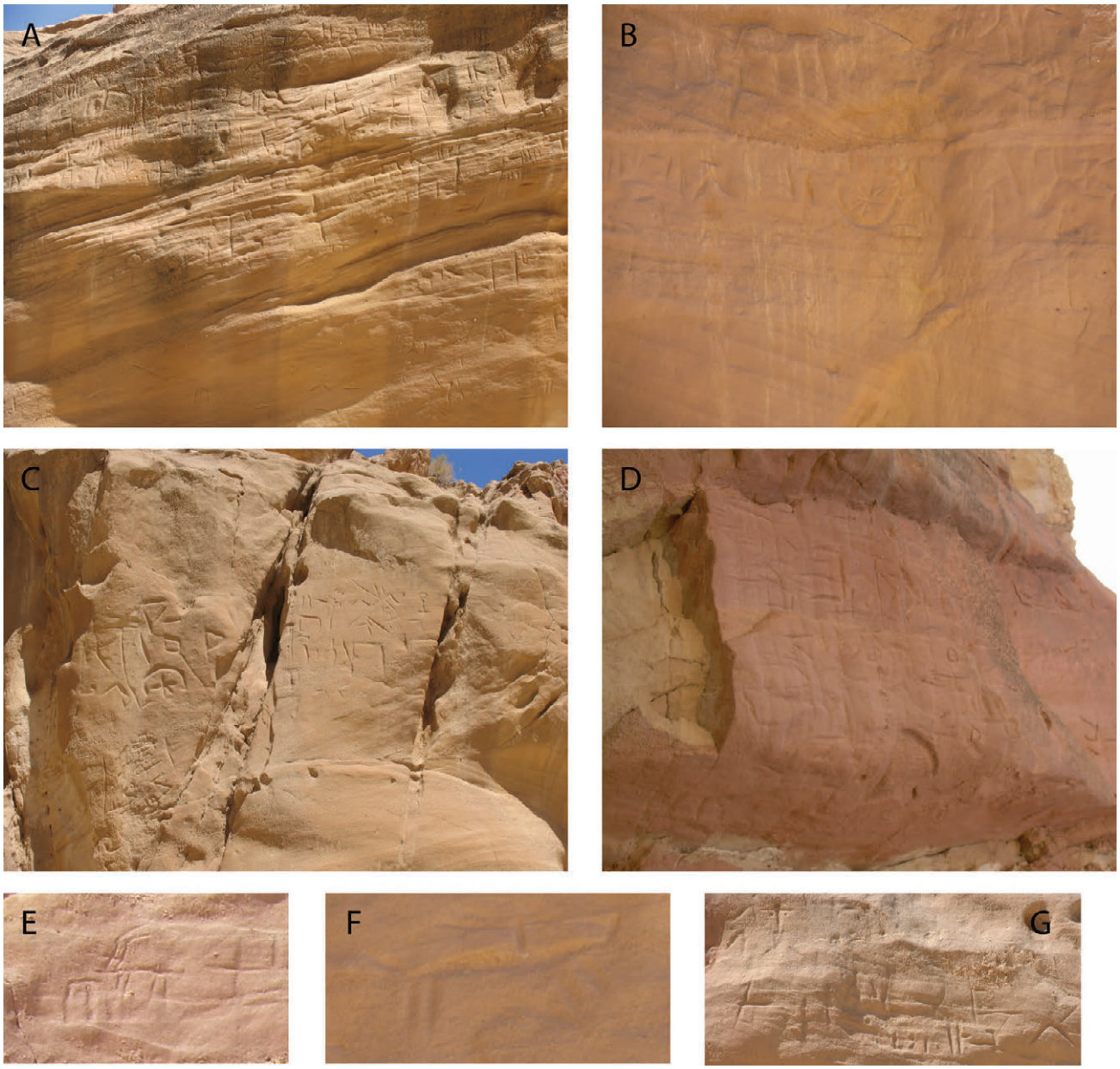

Figure 6.30 FBRS Site 50, rock drawings and inscriptions, details (no exact scale available, the photos were taken with telescopic lenses). (*a*) Various rock drawings; some may be identified as crucifix. (*b*) A star and a circle symbol. (*c*) Various rock drawings; some may represent Thamudic/Safaic inscriptions. (*d*) Various rock drawings and eroded segment that may help dating the drawings using cosmogenic isotopes (cf. Figure 6.29). (*e*) An eland, now extinct in the southern Levant. (*f*) A donkey/mule (?) with a schematic rider (?) (cf. Figure 6.35). (*g*) Various drawings.

Other Sites Recorded by FBRS

In addition to the well-known main water sources in the area covered by the FBRS ('Ain ad-Dahal and 'Ain al-Ghuwayba; Figure 6.10), we recorded a few small springs, mostly in the form of a *thmila*, a simple pit dug into the wadi bed exposing the high water table. The springs include Thmilat al-Ghuweba (FBRS Site 38) along Naqb al-Ghuwayba (not far from 'Ain al-Ghuwayba itself, probably the main water source for the fortress of Ras al-Miyah East), and Thmilat al-Jariya (FBRS Site 59) and 'Ain Ja'aj'a (FBRS Site 53), both located along Naqb al-Jariya (Figures 6.10 and 6.31). Although it is difficult to assess the level of underground water in antiquity and to evaluate if these small springs (or similar pits dug in other locations) also served as a water source in the Iron Age, there are a few indications for a similar, if

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not better, water supply in the twelfth to ninth centuries BCE. These indications include a dry well at Khirbat en-Nahas (Chapter 2, this volume) and the extensive use of hydrophilic plants as a fuel source in the major Iron Age smelting sites in the area. In the hinterland of Busayra, there are several permanent springs, some associated with archaeological remains (MacDonald 2002; MacDonald et al. 2004). Toward the Arabah, in the lower Wadi al-Ghuwayba basin, there are indications of a high water table in various spots (FBRS Site 49; Figure 6.10), although these are usually without an exposed water source (FBRS Site 49B) or they exhibit salty water suitable only for pasture animals (FBRS Site 49A). In the Arabah itself, there are typical modern artesian wells (FBRS Site 49C; Figure 6.9b).

We recorded a number of campsites (Figure 6.32), some of which have the typical shape and dimensions (Figure 6.32c,d) of dozens of similar sites recorded by TBAS (MacDonald et al. 2004). They are not necessarily associated directly with major roads (TBAS "observed from afar" several similar campsites in the upper Wadi at-Tilah basin, FBRS Site 35 is located in a secluded valley, etc.), and they are difficult to date because of the scarcity of ceramic and other finds (however, one site, FBRS Site 4, yielded identifiable Iron Age sherds).

A small watchtower was recorded on the hill above the Nabataean caravanserai of SGNA Site 229 (FBRS Site 57; Figure 6.10). The pottery sherds collected around the structure and on the slopes below it were all late; however, two fragments were identified as Iron Age. Iron Age sherds were also collected at other Nabataean caravanserai along the Arabah Valley (e.g., Qasr at-Tilah, MacDonald 2006:82, 1992a:265, 92–93; cf. Glueck 1935:12–17), and while these cannot be used to date the structures, they indicate Iron Age north–south traffic along the eastern margins of the Arabah Valley (and see discussion below).

The area covered by FBRS has numerous "leopard traps" (Figure 6.33b) and *tumuli* (Figure 6.33c); the latter appear in places as substantial clusters (or "*tumulus* fields"; see especially FBRS Sites 28–33) and are probably part of the wider Early Bronze Age phenomenon related to burial and territorial markers, well documented in the southern Levant (e.g., Haiman 1992, 1994). Additional finds relating to a wider phenomenon and also characteristic of the desert landscape of the southern Levant are the lines of standing stones and other rock features sprawling over the terraces to the east of SGNA Site 232 (Figure 6.33a). These are usually interpreted as cultic installations and dated anywhere in the sixth to third millennia BCE and sometimes even later (e.g., Avner 2002). As we focused on roads and prominent sites (i.e., having visible architectural remains), we did not record Paleolithic sites except from the dense lithic scatter of FBRS Site 6. The concentration of hundreds of flint tools and debitage fragments, probably associated with small stone features, is easily noticeable on a terrace of Wadi al-Ghuwayba. The flint source must have been located

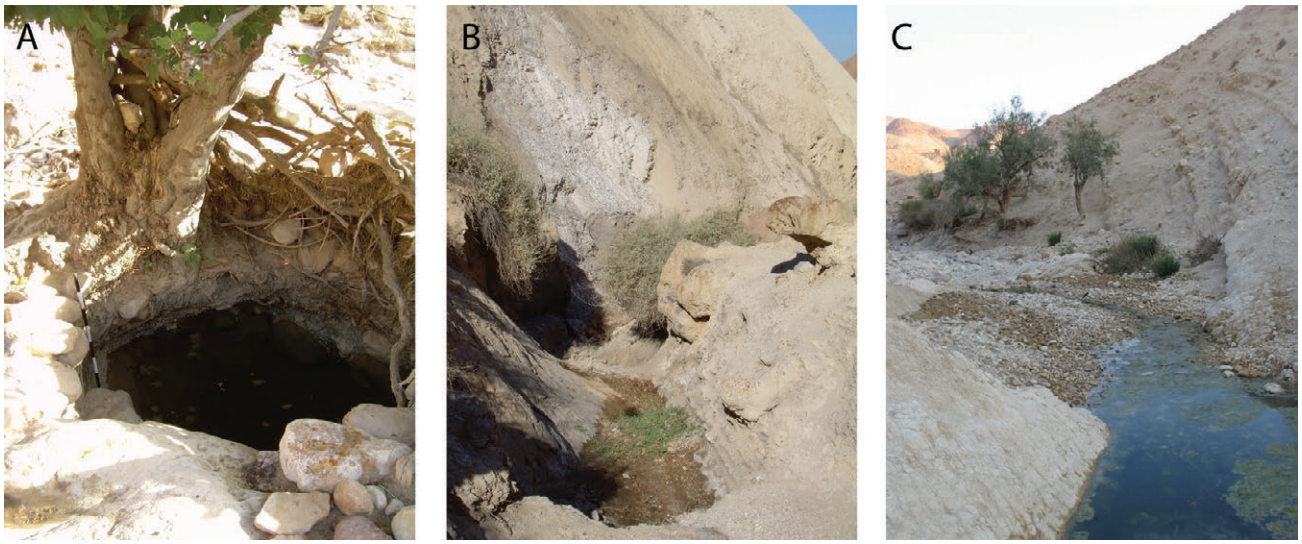

Figure 6.31 Water sources in the area covered by the FBRS are usually in the form of small *thmila*, dug pits in wadi beds exposing fresh water. (*a*) Thmilat al-Ghuwayba (FBRS Site 38), (*b*) Thmilat al-Jariya (FBRS Site 59), and (*c*) Thmilat/'Ain J'aj'a in lower Wadi Jleila (FBRS Site 53) (see Figure 6.10 for locations).

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rather far away, as no significant outcrops of chert are located nearby (Figure 6.18).

Another interesting site recorded by our team is the dense scatter of petroglyphs of FBRS Site 54, located on a smooth limestone rock face of the paleo wadi bed of Wadi Jleila (Figures 6.10 and 6.34). The dozens of signs engraved into the rock (Figure 6.35) probably represent more than one period, as indicated by different stages of patination (Figure 6.35d). The lack of Arabic inscriptions and the absence of camels in the motifs, as well as some parallels in other sites in southern Jordan and the Middle East, suggest a pre–Iron Age date, possibly Neolithic or Early Bronze Age. Transjordanian rock drawings have attracted the attention of scholars since the early twentieth century (e.g., Hrorsfield et al. 1933). However, although intriguing petroglyphs present a great challenge for dating and interpretation, speculations constitute a substantial part of the available literature. Some of the symbols (e.g., the cross in Figure 6.35a and the "snake and staff" in Figure 6.35e) may be *Wasms*, a tribal identity mark still branded on camels and goats by local Bedouins to represent ownership. Wasm marks may appear on rocks, usually in mortuary contexts (see FBRS Site 8 and Creighton et al. 2007:140), and usually consist

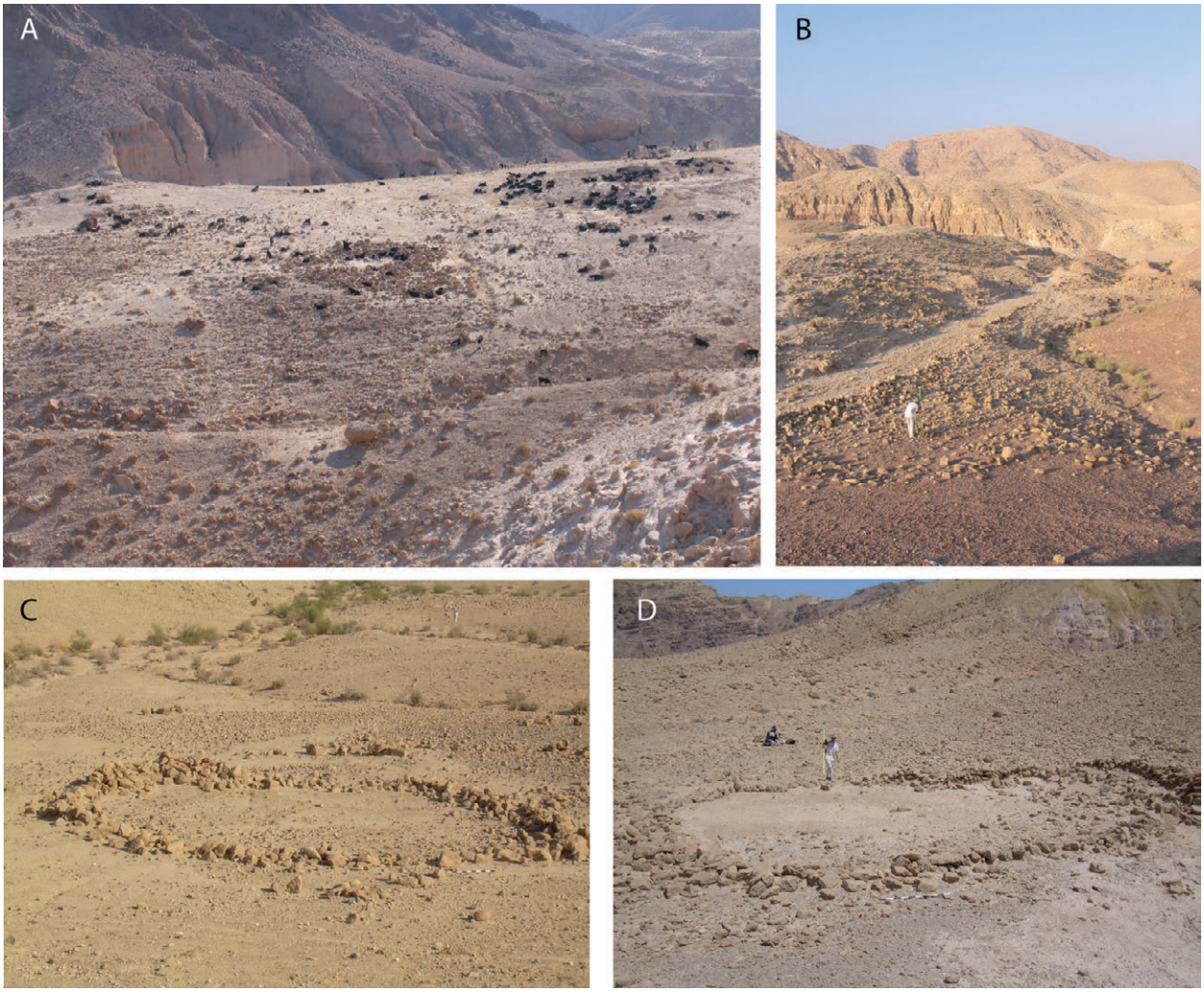

Figure 6.32 Campsites recorded in the area of the FBRS. (*a*, *b*) FBRS Sites 4 and 5, respectively, are small circular stone features along the main road from Faynan to Busayra close to 'Ain al-Ghuwayba (Site 4 yielded indicative Iron Age II sherds; also visible in *b* is the NRA road, probably located right above the ancient route to Busayra). (*c*, *d*) FBRS Sites 10 and 35, respectively (Site 10 is also TBAS Site 80; see MacDonald et al. 2004:228), are distinct circular structures (ca. 12 m in diameter) with some small stone features associated with them. The TBAS recorded five such structures along Naqb an-Na'ima and spotted from a distance "at least half a dozen" more similar structures. They are probably seasonal camps in pastor areas, not necessarily along major routes.

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Figure 6.33 Archaeological sites identified by the FBRS. (*a*) A line of standing stones in the upper Wadi al-Hassiya, part of scattered stone features north and east of SGNAS Site 232, similar to cultic sites recorded in the Negev (see e.g., Avner 2002) from the sixth to third millennia BCE. (*b*) Typical leopard trap (FBRS Site 55, similar to FBRS Sites 9, 56, and 58). (*c*) Typical *tumuli* structures (FBRS Site 32, similar to FBRS Sites 28–31, 33, and 36; somewhat different from the *tumuli* of FBRS Sites 42 and 56) on the ridge above Wadi al-Jariya (edge of Jabel el-Mahash), probably Early Bronze Age tombs used also as territorial markers (e.g., Haiman 1994).

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Figure 6.34 The limestone gorge of Wadi Jleila with the surfaces on which the rich rock drawings of FBRS Site 54 were inscribed (these surfaces are the paleo wadi bed, now located on both sides of the gorge; cf. Figure 6.35).

of geometrical shapes. The pictographs of ibexes (Figure 6.35b,e) are very common in other rock drawing sites of southern Jordan and Faynan (cf. FBRS Site 50, and e.g., Barker, Adams, et al. 2007:262–267; Barker, Hunt, et al. 2007:220–225); in contrast, we could not find parallels to the human figures of Wadi Jleila (Figure 6.35a,c), or to the unique drawings of human footprints (see photographs by B. Langford in the supplementary digital material of this chapter, Site 54), although anthropomorphic pictographs do appear at many sites. In their chapter concerning the rock art of WF400 in lower Wadi Ghuweir (in the vicinity of Khirbat Faynan), Pinkett and Mithen (2007) discuss similar pictographs and provide many relevant references from Jordan, the Negev, and the Middle East.

One of the main discoveries of the FBRS not related to the road system was the copper pit mine field of Jabal al-Jariya (Ben-Yosef et al. 2009b). Intrigued by an indication of walls on the UTM topographic map, we set out to explore this location in the field, and while climbing a low hill, hundreds of "plate-shaped" depressions became visible in the valley below (Figure 6.36). The striking similarity to mine fields in the Timna Valley and the geological setting (Figure 6.18) suggested that these were also mines, here in the shape of open pits, the result of sorting ore nodules from the colluvial deposits. The walls indicated on the map were found to be part of an extensive architectural complex (FBRS Site 37; Figures 6.36 and 6.37). The mines and the structures did not yield any identifiable pottery sherds and were tentatively dated to the Iron Age because of their proximity to the major smelting sites of Khirbat en-Nahas and Khirbat al-Jariya dated exclusively to this period (Figure 6.10).[20]

The Iron Age Road Network Faynan and Beyond

Our research in Faynan corroborates Ben-David's assertion that Moab and Edom are "a unique field laboratory in which to examine the physical remains of built-up roads which pre-date the Roman period" (2009:728). In several locations in the desert landscape of southern Jordan, remains of ancient roads were not obscured by the massive constructions of the later

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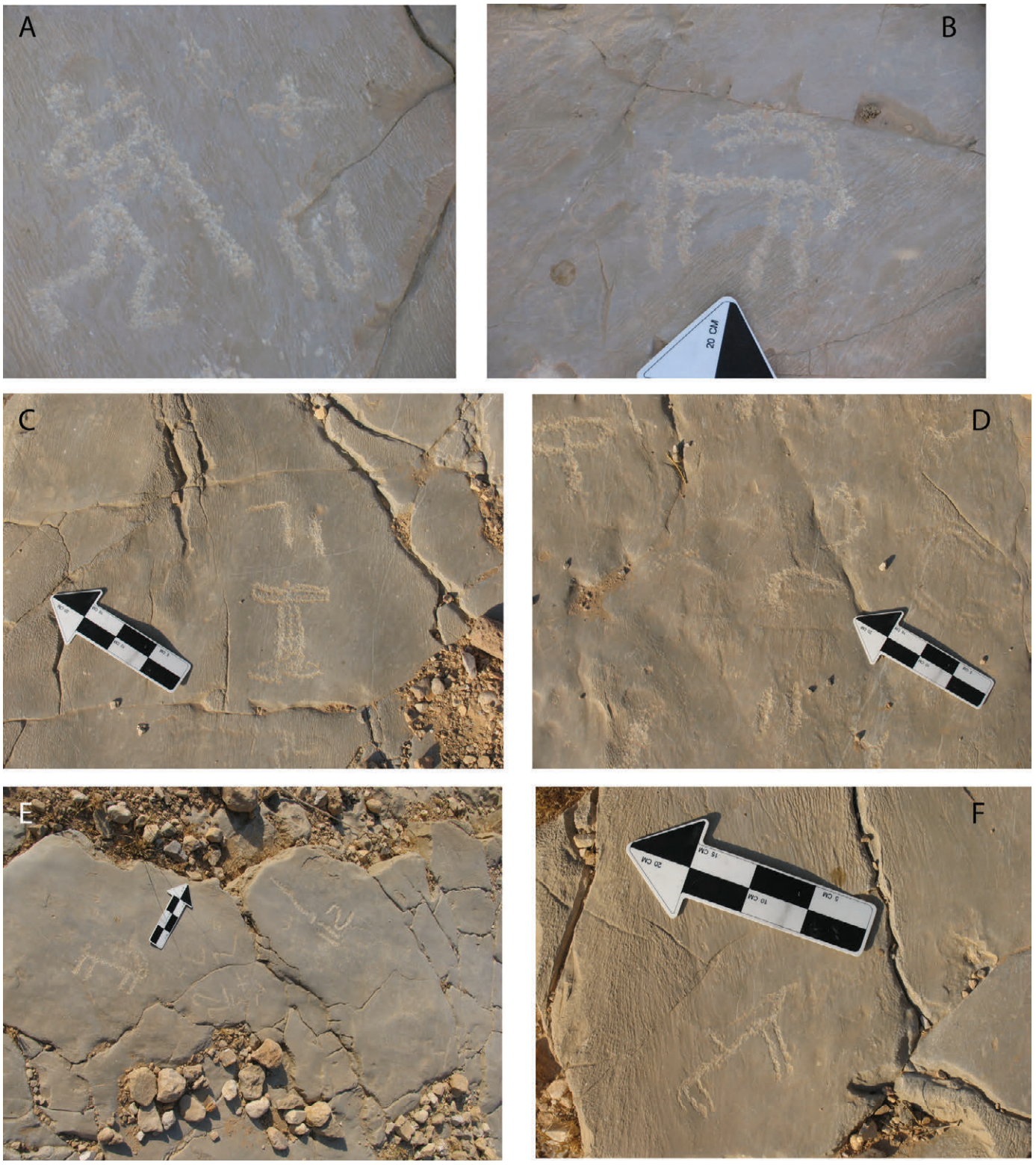

Figure 6.35 FBRS Site 54, various rock drawings in Wadi Jleila. (*a*) A male figure (distinct phallus) with a sheathed sword (?) holding a staff (staff approximately 10 cm). (*b*) A male ibex (arrowhead 5 cm). (*c*) Schematic human figure (arrow is 20 cm). (*d*) Various symbols in different stages of patination, evidence of multiperiod drawings (note the ibex [?] near the arrowhead). (*e*) Ibex, "snake and staff," and other drawings (cf. Pinkett and Mithen 2007). (*f*) A donkey/mule (?) with a schematic rider (?). Some of the symbols may be tribal *Wasams*.

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Figure 6.36 FBRS Site 37, a scatter of structures on a small dolomite ridge (Burge formation) north of Wadi al-Ghuwayba. When our team climbed the ridge, we observed the depressions of a vast pit mine field in the valley below (Jabal al-Jariya 1 Mine Field, 30.695°N, 35.430°E; see Ben-Yosef et al. 2009b).

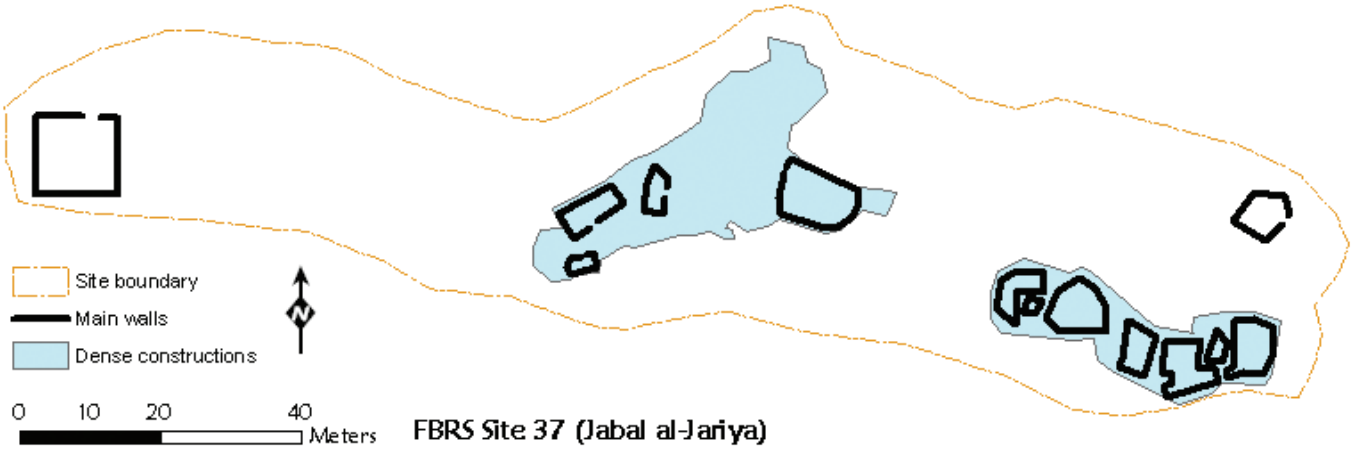

Figure 6.37 Plan of FBRS Site 37 (cf. Figure 6.36). No identifiable pottery sherds were found; the square structure in the west part of the site is used for horticulture by local Bedouins.

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Roman and Byzantine Empires or modern development, and Iron Age features can be identified (e.g., Ben-David 2009; Kloner and Ben-David 2003). This is probably the case of Naqb al-Ghuwayba, Naqb al-Murab'a, and Naqb al-Jariya, recorded and documented by the FBRS (Figure 6.38). As detailed above, there is some evidence in support of Iron Age dating of these roads, especially the fact that their destination in the Faynan area is dominated entirely by Iron Age sites. The roads are built to facilitate the traffic of camels with switchbacks in steep locations, retaining walls (in some places more than 2 m high), curb stones, and other road markers of various types. There is no evidence of deliberate pavement, although the main road between Faynan and Busayra is clearly delineated also in moderate terrain by alignments of stones along its margins (cf. Isaiah 62:10: "Build up, build up the highway, clear it of stones"). The width of these roads varies considerably, from relatively narrow paths where traversing rough landscape to more than 2 m in width where the terrain is less challenging.

It is difficult to assess the characteristic of Iron Age traffic between the large administrative center of Busayra and the economic center of Faynan. In the Iron Age IIB–C, the heyday of Busayra, the main securely dated sites in Faynan are the fortresses of Ras al-Miyah and the associated mines and small structures (the small watchtower of Rujm Hamra Ifdan and some radiocarbon-dated strata at Khirbat Faynan are also dated to this period; see Ben-Yosef et al. 2010). Although the activities at Ras al-Miyah may represent only a short occupation time, as suggested by the unfinished fortress of Ras al-Miyah East (Ben-Yosef et al. 2009a), they indicate substantial centralized efforts that probably correspond to the construction of the main road. The late Edomite pottery assemblage of Ras al-Miyah also supports the connection with the highland centers, and one should imagine constant traffic of camel caravans along the road (for the dominance of camels in the Edomite economy of this period, see Knauf 1995; for abundant camel figurines from Busayra, see Sedman 2002).

The well-planned construction and maintenance of roads in the Iron Age II is well attested in Egyptian, Mesopotamian, and biblical accounts (Aharoni 1979:43–63; Dorsey 1991:1–51), including the striking description in the Mesha Stele, detailing the endeavors of King Mesha of Moab, including building the road crossing the major canyon in the Moabite landscape: "And I made the highway in the Arnon [Hebrew for Wadi al-Mujib]" (Dearman 1989; Routledge 2000). Analogous to the works done in the kingdom to the north, the road constructions along the Faynan-Busayra route may represent the works of the silent King of Edom. Alternatively and contingent on the robustness of dating, the recorded road constructions may only stand for a *maximum probable effort level* invested in construction of roads between two important centers (of the caliber described above) of the Iron Age Edomite kingdom: such road construction efforts cannot be more intense than those documented by the FBRS, even if the dating of the latter to the Iron Age is incorrect.

Figure 6.38 summarizes the local road network in the region of the copper ore district of Faynan and the Edomite highlands to the east. In addition to the ascents recorded by the FBRS (and described above), other local roads that negotiate the cliffs of the Edomite mountains include Naqb as-Samer (currently an impassable dirt road connecting Khirbat en-Nahas and Khirbat Faynan, probably part of Musil's nkejb Asemer), Naqb Dana (along a major geological fault; easy ascent to the plateau near the village of Dana), Naqb Umm al-'Amad (local, well-constructed Roman road leading to a large copper mine; see Meshel 2006), Naqb Feid (well-built ascent connecting Faynan to upper Wadi Feid and the Edomite site of Qurayat Mansur), and Naqb an-Namala (major route, currently mostly covered by the modern asphalt road, leading to Petra and may be one of the central Roman-Nabataean ascents to the city; in turn, this road probably covers earlier Iron Age roads to Edomite settlements such as Baja, Tawilan, and Umm al-Biyara). As a major Roman-Byzantine industrial center was located at Khirbat Faynan and its vicinity, the archaeological remains along these roads are probably late, except possibly from Naqb Feid (Haviv 2000:155, there as Naqb Shdayeid) that leads locally to an important Edomite site.

As noted at the beginning of this chapter, the reconstruction of the general Iron Age road network in the Negev and southern Jordan (Figure 6.39) is based on the fragmentary and sometime contradictory descriptions found in the biblical accounts, geographical consideration, and some archaeological data (e.g., Aharoni 1979; Aharoni et al. 2002; Beitzel 1992; Meshel 1979; Rainey and Notley 2006). A principal source of information regarding routes (and their names) in this region is the accounts of the Exodus and the Israelite travels through the desert landscape of the southern Levant. Regardless of the historicity of the described events, these accounts probably do retain some (late) Iron Age realia and may

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be used to reconstruct the road system of this period. However, most of the place names and road stations are difficult to identify today, and some of the routes have only a vague description. Among the very few securely identified stations along the route of the Israelites to Canaan are Punon (Faynan) and Kadesh Barnea (Aharoni 1979:202), indicating important road junctions at these desert locales in the Iron Age. Another important road junction is biblical Tamar, identified with the Iron Age site of 'Ain Haseva (Cohen and Yisrael 1995) on the western side of the Arabah opposite Wadi ad-Dahal (Figures 6.38 and 6.39). Haseva is located on the main route that connects southern Transjordan with the northern Negev, Gaza, the southern Negev (Kadesh), and Egypt. The most direct way from Haseva eastward to Busayra (biblical Bozra) is through Naqb ad-Dahal, and the most direct way westward to the Beersheva Valley and the important sites of 'Aroer (where an Iron Age caravanserai was recently identified; see Thareani-Sussely 2007) and Tel Masos (on the role of this site in the regional trade and road system, see Finkelstein 1988; Jasmin 2006) is through Ma'ale Aqrabim. The main road from the central hill country to Edom, "The Way to Edom" (2 Kings 3:8), was identified in the southern Judea Desert and the southwestern tip of the Dead Sea, including a sequence of small Iron Age fortresses and watchtowers (from Arad through Khirbat 'Uza, Radum, Zohar, and Gozal, see Aharoni and Rothenberg 1960; Aharoni et al. 2002:98).[21] The literal translation of the Hebrew name for "The Way to Edom" (דרך אדום) is virtually "The Way of Edom," and it is commonly accepted that the Hebrew road name follows its destination, that is, the Hebrew "the way of (place name)" means "the way (leading) to" (e.g., Aharoni et al. 2002:17). This is partially the reason for the common identifications of "Way to the Arava" (דרך הערבה), "Way to the Red Sea" (דרך ים סוף), and "Way to Moab" (דרך [מדבר] מואב) (Figure 6.39).

The elongated north/south Arabah Valley is a dominant feature in the landscape of the southern Levant. The term appears in the biblical accounts (Hebrew *ha'aravah*; see detailed discussion in Bartlett 2006) but there probably as a reference to a different geographical region that includes only the northern part of what is today the Arabah Valley (from around 'Ain Haseva and northward). Meshel's (2007) suggestion to identify the biblical term with the badlands of the 'Ghor (the Lisan formation) is compelling and supports the common reconstruction of the "Way to the Arabah." Although the Arabah Valley is a moderate and easily passable terrain and water sources are found in several places along it, for many years there was a near consensus that no ancient road or no important road ever passed there from north to south, based on historical and geographical arguments (e.g., Bowersock 1983:179; Karmon 1968; Meshel 1979).[22] Avner (Avner 1997, 2002:127; Avner and Roll 1996, 1997) pointed out this misconception and reported the discovery of several sections of ancient roads along the Arabah Valley. These are mostly dated to the Roman period, and as noted above, in flat terrains, we should not expect significant road construction in earlier periods, even if it was an important traffic route. The existence of a major road along the Arabah Valley in the Iron Age may be supported by the site of Barqa al-Hitiyeh in the Faynan region (Fritz 1994), dated to the ninth century BCE (Bienkowski 2001). The site may be interpreted as a small caravanserai or some kind of a road station, and its location (Figure 6.38) far from the center of copper production and the latitudinal roads suggests that it was part of the north–south road along the Arabah Valley, maybe a station on the road heading toward Tell el-Kheleifeh (Glueck 1940b) on the shores of the Gulf of Aqaba. We suggest that in the northern Arabah, the main longitudinal road passed along the eastern side of the valley (Figure 6.39), as there are abundant water sources in almost each of the wadi outlets into the plain (to name a few from north to south: Wadi at-Tila, Wadi Suleimana, Wadi Fidan, Wadi Feid, and Bir Madhkur). In addition, the distribution of Nabataean caravanserai along this route, including Qasr at-Tilan, SGNA Site 229 (with the possibly Iron Age nearby watchtower of FBRS Site 57), and others, supports an eastern course of the main road along the Arabah (maybe the "Way to the Red Sea"). It is possible that additional waystations or fortresses are situated below the massive sand dunes of the Barwarda springs to the south of Barqa al-Hitiyeh—a theory we hope to test in the near future with remote sensing tools.

Another important and well-known longitudinal road bordering the Faynan region is the King's Highway (Carroll 1992) passing along the edge of the Jordanian plateau through the narrow strip of cultivable land between the desert to the east and the steep slopes to the west (Figure 6.39). This road was probably part of the Arabian trade that may have started to flourish as early as the Late Bronze Age (Finkelstein 1988; Jasmin 2006) and that had enormous influence on the sociopolitical development of this region (e.g., Finkelstein 1988; Jasmin 2006; Singer-Avitz 1999; Tebes 2006, 2007). The main "Incense Road" may had several outlets, including in the

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Figure 6.38 The ancient road network in the area of Faynan, including the routes recorded in the FBRS (on Google Earth satellite image). The two main north–south roads are the King's Highway (e.g., Num. 21:22) on the edge of the Edomite plateau and the "Way to the Red Sea" (e.g., Num. 21:4, 14:25, Deut. 1:40) (or possibly "The Arava Road" [e.g., Deut.2:8, 2 Kgs.25:4]), here suggested to be following the eastern margins of the Arabah Valley that is richer in water resources than its western parallel. The main road from Busayra down to the Arabah and further to the oasis of 'Ain Haseba is Naqb ad-Dahal. For other local routes in the Faynan area, see text; for the location of these roads within the larger southern Levantine region, see Figure 6.39.

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Figure 6.39 The ancient road network in the Negev and the Arabah Valley, including biblical identifications (on Google Earth Satellite image; after Aharoni 1979 and Aharoni et al. 2002). For details of the Faynan region, see Figure 6.38.

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northern Jordan Valley (e.g., Artzy 1994), but it seems that its main destination was the southern coastal plain through the region of the northern Negev's Beersheva valley where Tel Masos and Tel Beersheva are situated. One of the preferable routes must have been the easy descent from Busayra and the King's Highway to the Arabah Valley through Naqb ad-Dahal and then from 'Ain Hazeva to the Beersheva valley through the Aqrabim Ascent (Figure 6.39). If taking the interpretation of the Hebrew ארם as אדום (Greenberg 1997), the flourishing trade in this region in the (Late) Iron Age is well attested by the descriptions in Ezekiel (27:17, 21–22):

> Edom did business with you because of your abundant goods; they exchanged for your wares turquoise, purple, embroidered work, fine linen, coral, and rubies … Arabia and all the princes of Kedar were your favored dealers in lambs, rams, and goats; in these they did business with you. The merchants of Sheba and Ra'amah traded with you; they exchanged for your wares the best of all kinds of spices, and all precious stones, and gold.

Interestingly, copper is not mentioned in regard to trade with Edom. However, as shown by ELRAP's excavations and surveys in the Faynan region (see Ben-Yosef 2010 and chapters in this volume), in the early part of the Iron Age (I–IIA), copper was the major product exported from its territory through the routes discussed above, and this thriving trade was the economic core around which the Edomite polity developed. The early commercial skills and knowledge of the desert trade routes facilitated the simultaneous development of the long-distance Arabian trade. This engagement in long-distance trade with control over important junctions of the desert roads was at the heart of the Edomite economy in its heyday and should be seen as a direct development of the early Iron Age engagement in trade at this region.

Conclusions

The FBRS recorded and documented construction remains of local roads in the Faynan copper ore district and some previously undocumented features to the north of the district, along Naqb ad-Dahal, the main road from Busayra to the Arabah. Supporting evidence suggests an Iron Age date for the local roads, and the remains are considered to represent the technological quality and characteristics of road construction between important centers in Edom, at least during the seventh to sixth centuries BCE if not earlier.

The recorded roads, located in the heart of the emerging Edomite polity, were part of the flourishing trade network of the southern Levant. They are intimately related to the local geography that in southern Jordan presents challenges to traffic and transportation. The current study shows that the actual location of roads, trails, and paths obeys the "principle of least effort" introduced by George Zipf (1949) and employed in archaeological studies of architecture and settlement pattern studies since the mid-twentieth century (e.g., Levy and Alon 1987; Trigger 1990). This network of traffic veins is embedded with cultural meanings. While the ancient Iron Age industrial complex at Faynan may have served as the driving force in the establishment, use, and maintenance of routes, ancient symbolic and cultural perceptions of the landscape are reflected at certain junctures in the road systems identified in our survey.[23]

The FBRS also resulted in the documentation of major archaeological sites in the area between the intensely surveyed Faynan district and MacDonald's survey areas to the north and northeast, including *tumulus* fields, rock drawings, and fortlets. These new data enhance the previously available regional archaeology data set and facilitate future research.

Acknowledgments

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Table 6.1 Toponyms and their sources

Toponym*	Arabic	Translation	Source	Location
Jabal al-Jariya	جبل ألجارية	The mountain of the running water	IL/JD UTM	0.5 km northwest of Khirbat en-Nahas (KEN).
Wadi al-Jariya (Wadi el-Jariya)	وادي ألجارية	The seasonal river of the running water	IL/JD UTM	Main tributary of Wadi al-Ghuwayba. In our survey—WAJ.
Sil al-Ja'ur	سيل ألجاعور	The rumbling seasonal river	IL UTM	Upper part of Wadi al-Jariya (WAJ).
Wadi al-Ghuwayba Wadi Ghuwayb	وادي ألغويبة	Ghuwayba seasonal river	IL/JD UTM	Main wadi in the northern area of Faynan district. Khirbat en-Nahas (KEN) and Khirbat al-Ghuwayba (KAB) are located on the wadi banks
'Ain Ghuwayba	عين ألغويبة	Ghuwayba water spring	IL UTM	A permanent water source in the upper part of WAG, in the area of KAG.
Wadi al-Yhmar	وادي أحيمر	The Redish Wadi	IL UTM	Upper part of Wadi al-Ghuwayba (WAG)
Wadi Jleila	وادي جليلة	Jleila (female name) seasonal river	IL UTM	Main tributary of Wadi Dahal, from Jabel Rummana toward northwest.
Wadi J'aj'a	وادي جعاجعة	Ja'aj'a (Clan name) seasonal river	Local Azazme Bedouin	The local name of Wadi Jleila. The Bedouins were not familiar with the name "Jleila."
'Ein J'aj'a	عين جعاجعة	Ja'aj'a (clan name) water spring	Local Azazme Bedouin	The upper-most spring in Wadi J'a'ja.
Wadi Sayrin			IL UTM	Upper most part of Wadi Dahal; where the ancient road crosses.
Wadi Dahal	وادي ظحل	Dhahal seasonal river	IL UTM	Main wadi to the north of Wadi al-Ghuwayba
Naqeb Dahal Naqeb ed-Dahal	نقب ظحل	Dhahal pass	IL UTM Musil 1907	
Wadi al-Haysha	وادي ألهيشة	Al Haysha (thick trees) seasonal river	IL UTM	Lower part of Wadi Dahal.
Naqeb an-Naima	نقب النايمة	Al-Naima (sleepy) pass	Local Sa'idyin Bedouin ('Aweid)	The name of the old Naqeb north of Wadi Dahal, where the current dirt road connects Busayra to the Arabah Valley.
Jabel ad-Dhahara	جبل ألظهرة	Al-Dhahara (the back) mountain	IL UTM	Main ridge north of Wadi Dahal, where Naqeb an-Naima and the current dirt road descend toward the Arabah Valley.
Jabel Tar al-Kader	جبل طور القادر		IL UTM	Ridge north of Wadi Dahal (Wadi al-Haysha), where Naqeb an-Naima and the current dirt road descend toward the Arabah Valley.
Wadi Umm-Za'arura	وادي أم زعرورة	The seasonal river of the berry tree	IL UTM	A tributary of Wadi Khanzira; the last topographic obstacle of the road from Faynan. Khirbat Umm Za'arura and 'Ein Umm Za'arura are in close vicinity.
Wadi al-'Atat	وادي عطاط		IL UTM	A small tributary of Wadi Umm-Za'arura.
'Ein al-Burge	عين ألبرج	The tower water spring	IL UTM	Small spring in the upper segment of Wadi al-'Atat.
Wadi al-Mahash	وادي ألمحاش		JD UTM The current survey	A tributary of WAG, west of WAJ.

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Table 6.1 Toponyms and their sources *(continued)*

Toponym*	Arabic	Translation	Source	Location
Jabel el-Mahash	جبل ألمحاش		Jordanian UTM	The ridge between WAJ and Wadi al-Mahash.
Jabel el-Marzuka	جبل ألمرزوقة		Jordanian UTM The current survey	The ridge between WAJ and WAG.
Jabel Huneik	جبل حنيك	The jaw mountain	Jordanian UTM	Ridge between Wadi el-Mahash and WAG, near ‘Ein Huneik.
‘Ein Huneik Bir Huneik	عين حنيك بير حنيك	The jaw water spring The jaw water well	Local Sa’idyin Bedouin (‘Aweid)	A spring and a modern drilled well in the vicinity of Jabel Huneik.
Thmilat Jariya ?	ثميلة ألجارية	Water collecting hole in the Wadi bed	Local Bedouin (insecure)	A small spring in the upper most part of WAJ. Its water accumulates in a small dug pit, thus *Thmila* in Arabic.
Thmilat Ghuwayba? Thmilat es-Zueida?	ثميلة ألغويبة ثميلة ألزويدة	Ghuwayba and Zueida Water collecting hole in the Wadi bed	Local Bedouin (insecure) Local Sa’idyin Bedouin (‘Aweid)	A small spring in a tributary of WAG. Its water accumulates in a small dug pond, thus *Thmila* in Arabic.
“The Canyon”	السيق	The Canyon	The current survey	A deep gorge in a tributary of WAG (after “The Donkey” and “The Difficult” wadis coalesce).
“The Donkey Wadi”	وادي الحمار	The Donkey Wadi	The current survey	Upper segment of a tributary of WAG.
“The Difficult Wadi”	وادي الصعيب	The Difficult Wadi	The current survey	Upper segment of a tributary of WAG.
“Wadi Thmila”	وادي ألثميلة	The water collecting hole in the wadi bed Wadi	The current survey	A tributary of WAG. Thmilat Ghuwayba is located in its lower segment.
“The Cliff Wadi”	وادي الطور	The Cliff Wadi	The current survey	A tributary of WAG in the upper-most part of it.
Al-Muraba’a Naqeb el-Murabba’	ألمربعة نقب ألمربع	The square The square pass	Local Azazme Bedouins Musil 1907	Name of a region along the ridge between upper WAG, upper WAJ, and Wadi Ja’aj’a. Its exact boundaries are not clear; couple of sources claim significant ruins in the area, including “qal’a” or “qasar,” namely, fortress. This area was surveyed extensively by our team (although, as mentioned, we might have not identified it correctly).
Ras al-Miyah	راس ألمية	The head of water	Local Azazme Bedouins	The name of the region in the close vicinity of the spring of Ghuwayba (‘Ein al-Ghuwayba). Literally means “head of the water.”
Jabel aba-I-Hazuk	جبل ابو ألخازوق	The obelisk mountain	Musil 1907	In the area of Naqeb as-Samer (Nakejb Asemer in Musil’s description), maybe toward WAG?
Jabel el-Hesen	جبل الحصن	The fortress mountain	Musil 1907	In the area of Naqeb as-Samer (Nakejb Asemer in Musil’s description), maybe toward WAG?
Naqeb el-Rwetbe	نقب ألرويطبة	The damp pass	Musil 1907	?
W. el-‘Ebr / Festung el-‘Ebr	وادي ألإبر	The Wadi of the needles	Musil 1907	Musil mentioned a fortress in this location; it should be located somewhere on the upper parts of WAG or WAJ, but it is not clear enough.

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Table 6.1 Toponyms and their sources *(continued)*

Toponym*	Arabic	Translation	Source	Location
W. es-Salamani bildet	وادي السلماني	Salamani seasonal river	Musil 1907	?
Nakb el-Garijje	نقب القريجة	Graijje pass	Musil 1907	Probably the well-built naqeb up WAJ to its saddle and to Naqeb Dahal.
Wady Ghweir	وادي غوير	The small dropping seasonal river	Kitchener 1884	Wadi ad-Dahal in the area of ʻAin ad-Dahal.
Jebel Um Suwwana	جبل أم صوانة	Mother of flints mountain	Jordan UTM	Elongated ridge to the northwest of Wadi al-Jariya.

*Jabal (Jebel) = mountain; Khirbah = ruins (Khirbat = [the] ruins of); Wadi (Wady) = dry stream, valley (note that each segment of a wadi basin is marked by a different name: Wadis Fidan and Faynan are different segments of the same dry stream); Naqb (Nakb) = well-built trail, an ascent constructed for camel traffic; ʻAin = spring.

Table 6.2 Road segment categories.

Category	Description	Examples
Goat	Rough trail, sometimes might be well defined by goat footprints but lack any constructions.	R-S-12,36
Donkey	The constructions along the trail are limited, and the road's width and quality do not suit caravans with camels. Examples of idiosyncratic constructions are stone alignment for getting over rock steps, stone boundaries in steep location, and so on.	R-S-9,10,11
Camel	Well-built road with defined boundaries, retaining walls, gradual slope, and switchbacks. Camel could pass through. In Arabic: "Naqb."	R-S-6,7,8,14
Old dirt road	Segment of dirt roads that cannot be in use anymore. In the research area, many segments belong to the NRA project in Faynan and to the old army road of Naqb ad-Dahal.	R-S-1,2
Current dirt road	Segment of current dirt road.	R-S-16,17
Other	When the definition of the road category is not decisive; sometimes in plan area, where there is no need of construction and the terrain might suit any of the other categories (see text).	R-S-41

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Table 6.3 FBRS sites summary (more details in the GIS database) 3 FBRS sites summary (more details in the GIS database).*

Site Number Date Visited Wadi Basin Map Reference Elevation	Toponym, if Any Site Type Site area (m^2) Ceramic Age	Location	Description	Comments
1 7/7/2007 Ghuwayba 737153/3398285 175	Kh. al-Ghuwayba Archaeological complex/smelting site 70967 Iron Age, Nabataean (?)	Extensive archaeological complex sprawling on wadi terraces on both sides of Wadi al-Ghuwayba near the spring.	Small fragments of slag are scattered all over the site; structures and installation are visible on the surface. Modern Bedouin campsite is located in the middle of the north bank portion of the site.	The site was surveyed as part of SGNA (MacDonald 1992a:76, Site 161, "Iron Age II") and by the German expedition (e.g., Hauptmann 2007:132, "Iron Age"); more precise dating is needed, especially in regard to the mining complex of Ras al-Miyah. A few sherds were identified by our team as Roman.
2 7/7/2007 Ghuwayba 736692/3399076 319	Ras al-Miyah - West Fortress 1656 Iron II	On the edge of the Burj dolomite plateau, ca. 150 m above 'Ain al-Ghuwayba.	Fortress built out of local dolomite stones.	See detailed description in Ben-Yosef et al. (2009a)
3 7/7/2007 Ghuwayba 738148/3399341 350	Ras al-Miyah East Fortress 5119 Iron II	On the edge of the Burj dolomite plateau, ca. 175 m above 'Ain al-Ghuwayba.	Massive unfinished fortress built out of brown sandstones from the nearby vicinity.	See detailed description in Ben-Yosef et al. (2009a); a few sherds were identified as Nabataean.
4 7/7/2007 Ghuwayba 737799/3398483 215	Campsite 264 Iron II	On a plain of a wadi terrace, ca. 30 m above Wadi al-Ghuwayba and about 800 m from the spring.	Elliptical courtyard (41 × 72 m inner dimensions) and a large concentration of collapsed stones (local brown limestone, brought from nearby the terrace plain). In the surrounding area, there are other small stone features such as semi-circles 1 m in diameter and small cairns. The site seems to be directly related to the nearby Kh. al-Ghuwayba and may have had a role in controlling the access to the smelting area from the east (the main road to Busayra).	There is no direct view from the site to either the wadi or the spring. Pottery sherds are scattered in the courtyard and the site vicinity; copper ore was also collected. To the north, near the wadi bed, there are extensive remains of recent Bedouin occupation.
5 7/8/2007 Ghuwayba 738291/3398771 240	Campsite 168 Ud	On a granite bedrock, adjacent to the main road of Naqb al-Ghuwayba where it crosses a local saddle ca. 120 m from the wadi bed.	Circular structure made of local lime/sand/dolo stones, 16 m in diameter, one course, roughly built. One wall may be partially covered/destroyed by the old dirt road.	
6 7/8/2007 Ghuwayba 739041/3399726 283	Lithic scatter 1652 Ud	On a flat plain above wadi al-Ghuwayba.	Dense concentration of flint tools and flakes. There are also small stone structures scattered in an area of 20 × 20 m.	Flint nodules are available only in the wadi gravel or outcrops of Cretaceous formations far from the site.
7 7/11/2007 Jariya 737087/3401978 335	Watchtower/retaining wall 84 Ud	Located near the bottom of a steep slope at the head of Wadi al-Jariya, where the road (Naqb) takes a sharp turn and ascends in a series of switchbacks.	A massive wall, 3.2 m high and 6 m wide, made of large unworked boulders (many over 1 m wide). The wall is situated just above the path of Naqb al-Jariya and seems to support a flat small platform (a watchtower?). In front and beneath the wall, there may be some remains of a courtyard (5 × 5 m).	
8 7/11/2007 Jariya 737280/3402148 424	Cemetery 3792 EB?	On a flattened, chalky saddle at the head of Wadi al-Jariya (main division between al-Jariya and ad-Dahal basins).	Cemetery that probably represents more than one period, but mostly late, Bedouin. On some rocks, there are patinated rock carvings of wassems (?).	

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Table 6.3 FBRS sites summary (more details in the GIS database)* *(continued)*

Site Number Date Visited Wadi Basin Map Reference Elevation	Toponym, if Any Site Type Site area (m^2) Ceramic Age	Location	Description	Comments
9 7/11/2007 Jariya 736888/3399743 437	Leopard trap 46 Ud	On a saddle in the high MB sandstone ridge separating Wadis al-Jariya and al-Ghuwayba.	Small leopard trap build of local stones.	
10 7/13/2007 Dahal 734793/3410621 259	Rectilinear structure 3685 Ud	South of Naqb an-Na'ima, on the slope of a local valley.	An elliptic structure made of brown limestone with an outer dimensions of 15 × 11 m. Some smaller structures surround the central one; no pottery, one hammer stone and some flint flakes.	TBAS Site 80 (MacDonald et al. 2004:228); there the ceramic described as late (Byzantine/Islamic) and similar structures along Naqb an-Nai'ma and elsewhere are mentioned. See also Site 35.
11 7/13/2007 Dahal 740197/3405339 602	Watchtower 957 Roman (Gazaware)	On a prominent knoll south of naqb ad-Dahal before it descends steeply from the ridge into the wadi.	A square (7 × 7 m) watchtower built out of relatively large limestones. Stone collapse all around (but mostly to the west and south, where it is steeper) suggests a massive construction. To the north and east are at least three small architectural features, circular or oval, that are roughly built (later?), though maybe not all from the same period. Abundant ceramic.	
12 7/13/2007 Dahal 738741/3405422 219	Caravanserai 1409 Iron II	On an elevated wadi terrace on the east bank of Wadi Daha, just before the road starts to ascend from the wadi to the ridge; edges of site were completely eroded by the deepening of the wadi channel.	A U-shaped small caravansrai built of local limestones; may have had a defensive role as well. At the northeast corner of the structure, there is a well-preserved segment of the ancient trail that went down to the wadi; its lower part was completely washed out and now a steep cliff borders the site. Probably other parts of the site were washed out as well. Abundant ceramic.	Robbery excavations are visible in at least two locations in the structure. In the middle of the courtyard, there is a modern Bedouin structure, and to the south, there is an orchard.
13 7/15/2007 Dahal 745346/3403325 1070	Qasr Karayim bin 'Ali Fortlet? 551 Iron II, Islamic	On a spur near Naqb ad-Dahal overlooking the valleys of upper Dahal and the roads to Faynan.	A rectangular structure (18.5 × 8.8 m) built of local limestone, preserved to a height of several courses. Abundant ceramic.	TBAS Site 62; see more detailed in MacDonald et al. (2004:213–214). Pottery indicates mostly late (Islamic) occupation. Some Iron Age sherds may suggest some earlier activity at this "vista point."
14 7/15/2007 Dahal 744375/3402121 921	Retaining wall 78 Ud	Part of the main road from Busayra to al-Ghuwayba, where the path crosses a small tributary in the upper ad-Dahal basin.	A well-preserved (though breached in middle) retaining wall supporting the road when it crosses a tributary (2.2 m high × 20 m long) with seven courses of stones at highest point; unworked rocks and boulders of differing sizes were used, showing massive investment.	
15 7/15/2007 Dahal 744088/3402243 893	Watchtower 530 Iron Age/Roman?	On a small spur to the west of the ancient road.	Small square watchtower built of massive limestones. The north and northwest walls are well preserved, up to two courses; other side much less and seemed to be deliberately robbed. To the northwest, there is a small circular structure.	
16 7/15/2007 Dahal 743849/3402187 871	Cairn 158 Ud	On a defined terrace to the west of the ancient road.	A rujm (pile) of stones, "organized" on the bedrock; its edge is confined by bigger rocks; rocks taken from small nearby fields (terraces along the nearby slope) and the pile seem to be a result of the agricultural activities. Some unidentifiable ceramic sherds were collected.	
17 7/16/2007 Dahal 743190/3401879 839	Cemetery 2689 Ud	On a broad saddle overlooking Wadi Jleila.	A cemetery of mostly Bedouin-type graves, but some possibly older. Some unidentifiable body sherds were collected.	

Table 6.3 FBRS sites summary (more details in the GIS database)* *(continued)*

Site Number Date Visited Wadi Basin Map Reference Elevation	Toponym, if Any Site Type Site area (m^2) Ceramic Age	Location	Description	Comments
18 7/16/2007 Dahal 740102/3401796 549	Structure 248 Ud	On a narrow local saddle above Wadi Jleila, near the ridge line between Wadis Jleila and Ghuwayba.	Architectural remains of unclear purpose, maybe a shelter for hunters. There is a defined half-circle line of rocks on the east and some wider lines of rocks on the west. No ceramic sherds.	The location and characteristics suggest that it is not recent Bedouin remains.
19 7/16/2007 Dahal 742141/3401757 549	Fortlet 101 Iron, Roman, Nabataean?	Near the ancient road, on a moderate slope along which the road ascends from Wadi Jleila.	A small rectangular fortlet built of local limestones.	
20 7/16/2007 Dahal 743013/3401992 842	Fortlet 525 Roman, Nabataean	On the ridge line between Wadi Jleila and upper Wadi ad-Dahal, adjacent to a prominent rock outcrop that constitutes parts of the structures.	A small rectangular fortlet built onto the southern side of a prominent limestone outcrop, made of limestone with some of the blocks being relatively large. Abundant ceramic.	
21 7/18/2007 Ghuwayba 736841/3398764 211	Fortlet 194 Ud	On a granite bedrock in a small valley between the spring of 'Ain al-Ghuwayba and the fortress of Ras al-Miyah West.	A small fortlet (5.2 m square) built of local stones (granite, dolomite, sandstone). Each wall consists of ca. 10 to 13 stones; only lower courses were preserved.	
22 7/18/2007 Ghuwayba 736712/3399212 314	Structure complex 314 Iron II	On the top of a plateau made of the dolomite shale unit, just north of Site 2.	A small rectangular structure made of the local shale-dolomite stones, fairly well preserved. Nearby there are remains of a small circular structure.	
23 7/18/2007 Ghuwayba 736190/3399275 348	Smelting site 69 Ud	On the slope ca. 20 m above and to the northeast of the saddle separating Wadi al-Ghuwayba and Wadi al-Jariya.	A copper smelting site with a concentration of solid small pieces of slag but no discernable structure or installations; small pieces of slag are found all along the slope from the site center to the saddle below.	
24 7/18/2007 Jariya 734857/3399539 173	Kh. al-Jariya Archaeological complex/smelting site 52636 Iron II	Extensive site on both sides of Wadi al-Jariya.	This site was surveyed by the German team during the late 1980s and was excavated in 2006 as part of the ELRAP. See Ben-Yosef et al. (2013).	
25 7/21/2007 Ghuwayba 736672/3398960 238	Retaining wall 15 Ud	On the salib sandstone slope to the south of Site 2 (below Ras al-Miyah West).	A small retaining wall built of massive dolomite stones; the construction characteristics seems to indicate that the site is not recent Bedouin (part of a route up to the fortress? or part of a local terrace for other purposes?).	
26 7/22/2007 Ghuwayba 736718/3399319 318	Mining complex 11991 Iron II	On the lower slope of the massive brown sandstone formation, in the vicinity of Site 2.	The slopes are covered with an ample amount of archaeological remains related to copper mines. The location of the shafts can be identified by the black tailings (residue of the shale unit). Below the tailings and other mining debris (which create artificial piles and shape the current slope), there are some constructions—small structures made of black dolomite in the lower part of the slope (not well defined in shape, maybe simple shelters for the miners). Above what seems to be the main shafts, there is a line of holes (about 18 and 12 cm in diameter) carved into the sandstone, probably part of the installation that helped with carrying out the dug material. Abundant ceramic all over the slope with concentrations near the mine shafts.	

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Table 6.3 FBRS sites summary (more details in the GIS database)* *(continued)*

Site Number Date Visited Wadi Basin Map Reference Elevation	Toponym, if Any Site Type Site area (m^2) Ceramic Age	Location	Description	Comments
27 7/22/2007 Ghuwayba 737832/3399069 312	Cultic 1287 Iron II	On a ledge in the cliffs above Wadi al-Ghuwayba overlooking the fortress of Ras al-Miyah East and ca. 20 m below the route connecting the two fortresses of Ras al-Miyah.	Extensive pottery scatter, no architecture. More than 100 fragments were collected; more than 80 are identifiable. A small male figurine was found trapped in a crack between rocks.	GPS location of figurine—EDM 8000. The prominent sandstone dome facing the site (Site 52) does not have clear Iron Age remains.
28 7/24/2007 Dahal 736700/3402756 464	Tumuli field 1112 Ud	On the slope of a local hill in a fairly wide chalky valley.	Tumuli field near road (six in site perimeter and two nearby). They consist of concentric rings of stones that build up a small mound (between 0.5 and 1.5 m high) with an open area in the center (though there may be a stone covering in some cases). All were recorded separately; Tumulus 4 is one of the biggest tumuli that was robbed and seems to have had a rectilinear burial chamber with a large stone covering in its center. Tumulus 6 is the biggest with adjacent structures. Some rock drawings are present, pictographs/wassams.	
29 7/24/2007 Dahal 735883/3403099 562	Tumulus 95 Ud	On a local saddle, near the main route that leads from Naqb al-Jariya to the Arabah.	Large tumulus consisting of concentric rings of stones that build up a small mound (around 1.5 m high) with an open area in the center.	
30 7/24/2007 Dahal 735762/3403127 599	Tumuli field 191 Roman	On the prominent limestone ridge between Wadi al-Jariya, Wadi al-Hassiya, and tributaries of Wadi ad-Dahal. Just above and south of the saddle where the route to the Arabah crosses.	Two tumuli consisting of concentric rings of stones that build up a small mound (around 1 m high) with an open area in the center. More than 30 body sherds and 2 identifiable fragments.	Similar in characteristics to nearby sites (28, 29, 30).
31 7/24/2007 Other 735688/3403177 565	Tumulus 76 Ud	Near the route to the Arabah, along the slope toward Wadi al-Hassiya.	One small tumulus by the road, consisting of concentric rings of stones that build up a small mound (around .5 m high) with an open area in the center.	
32 7/24/2007 Dahal 735753/3402960 624	Tumuli field 406 Ud	On the prominent limestone ridge between Wadi al-Jariya, Wadi al-Hassiya, and tributaries of Wadi ad-Dahal.	Two large tumuli (possibly three) on a peak on the ridge above and south of the saddle (through which the road to the Arabah passes) and Site 30, consisting of concentric rings of stones that build up a small mound (around 1 m high) with an open area in the center.	
33 7/24/2007 Dahal 735521/3402609 601	Tumuli field 148 Ud	On the prominent limestone ridge between Wadi al-Jariya, Wadi al-Hassiya, and tributaries of Wadi ad-Dahal.	Two tumuli on the ridge south of Site 32, consisting of concentric rings of stones that build up a small mound (around .5–1 m high) with an open area in the center.	
34 7/24/2007 Other 734272/3403007 414	Cairn field 3811 Ud	In the head of a small valley and a local saddle.	Scatter of about 100 small rock piles (a few almost 1 m in diameter).	May be recent; it is located on the limestone slopes toward the Arabah.

Table 6.3 FBRS sites summary (more details in the GIS database)* *(continued)*

Site Number Date Visited Wadi Basin Map Reference Elevation	Toponym, if Any Site Type Site area (m^2) Ceramic Age	Location	Description	Comments
35 7/24/2007 Other 733431/3401710 174	Rectilinear structure 471 Ud	In a broad valley on the margins of the Arabah.	Rectilinear/circular structure built of uncut stones and preserved up to a few courses.	Similar to Site 10 and other structures observed from a distance but not visited (one in Wadi at-Tilah). TBAS describes a few similar structures (interpreted as campsites), and it appears like a wide phenomenon.
36 7/24/2007 Other 733643/3401838 172	Tumulus 155 Ud	In a local saddle near a fairly open valley of a small wadi just west of Wadi Makhash and near a local trail.	Small tumulus/stone pile in the saddle with another small stone pile just out of the saddle to the west.	
37 7/24/2007 Other 733392/3398407 148	Structure complex 6170 Ud	On a dolomite plateau of the Burj formation, part of Jabal al-Jariya.	Four structures/structure complexes. "Feature 1" is the largest complex, made up of over 10 different rooms. Walls are made of a double line of stones and preserved up to five to six courses high in some places. "Feature 2" is the second largest and is made up of about five rooms. "Feature 3" is a single rectilinear/circular structure with a small chamber on the west side. "Feature 4" is a rectilinear structure. A few body sherds were collected; none is identifiable.	The site is located above the valley of the copper mine field Jabal al-Jariya 1 (Ben-Yosef et al. 2009b) and may be related to the mining activities there. In the rectangular structure ("Feature 4"), there were signs of recent irrigation and gardening (similar activity was observed in a few of the mine pits).
38 7/27/2007 Ghuwayba 739303/3399463 255	Thmila 168 Ud	In a small tributary of Wadi al-Ghuwayba (200m from Wadi Ghuwayba itself). It is visible from Ras al-Miyah East.	A built thmila under a ficus tree. Except for small constructions near the spring itself, there are no significant other ancient remains and no pottery.	Site center was recorded 6 m west of the spring due to the tree. Spring seems to be intensely used by local Bedouins. The wadi from the spring downward is rich with water vegetation.
39 7/27/2007 Ghuwayba 738243/3399415 350	Structure complex 534 Iron II	Structures located about 50 to 60 m from the fortress of Ras al-Miyah East (Site 3).	A small complex of dolomite structures composed of four rectangular spaces, the biggest of which is probably a courtyard. A small circular feature is adjacent to the northeast of the structure complex. In the courtyard, there is a broken sandstone slab. In some places, the walls are preserved up to five courses.	
40 7/27/2007 Ghuwayba 738223/3399307 357	Structure complex 581 Iron II	Situated on shallow residue of brown sandstone formation in the middle of the dolomite plateau (Burj formation).	Structures constructed mostly of lousily built and defined walls. Most of the buildings are of dolomite rocks, but in the center there is a structure composed mostly of sandstone. Most of the space of complex/line of structure was hard to define. The main complex is composed of four to six connected spaces. Ten meters to the south, there is a smaller complex composed of two spaces. Abundant ceramic sherds. Manganese nodules were also collected from nearby the site (they are scattered all over the dolomite plateau).	
41 7/27/2007 Ghuwayba 738174/3399285 351	Structure 108 Iron II	In close vicinity to the fortress of Ras al-Miyah East (Site 3), on the edge of the cliff above Wadi al-Ghuwayba.	Structure is probably rectangular (we could identify some wall lines in its western and southern boundaries) and is rich with pottery. On other side of line feature of fortress Site 3, there is another structure/pile of dolomite stones.	
42 7/27/2007 Ghuwayba 738170/3399403 342	Tumulus 33 Ud	Located in a very shallow wadi in close vicinity of fortress Site 3; seems to represent a different period than the fortress and structures.	A grave/tumulus; consists of a pile of massive sandstones. Robbery dig has exposed a rectangular grave chamber well defined by sandstone slabs on at least two sides.	Note the hidden location of the tumulus, uncommon with similar structure in the survey area.

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Table 6.3 FBRS sites summary (more details in the GIS database)* *(continued)*

Site Number Date Visited Wadi Basin Map Reference Elevation	Toponym, if Any Site Type Site area (m^2) Ceramic Age	Location	Description	Comments
43 7/27/2007 Ghuwayba 738174/3399458 343	Structure complex 182 Iron II	On the dolomite plateau (Burj formation), close to the fortress Site 3.	A single structure with a room complex, made mostly of local small dolomite stones. The walls are preserved up to three courses. A few of the dolomite slabs are massive (up to 1 m in length).	
44 7/27/2007 Ghuwayba 737997/3399364 329	Structure complex 647 Iron II	On the Burj dolomite plateau.	A complex of three3 small structures, made mostly of small dolomite stones and small sandstones in some places. The central structure is the largest and is preserved up to 10 courses in some places.	
45 7/27/2007 Ghuwayba 737812/3399431 332	Structure 508 Iron II	Located on the western bank of a small tributary of Wadi al-Ghuwayba and in close vicinity to copper mines (Site 46). Around the site, there are many small archaeological features.	Massive rectangular structure (enclosure) of local large brown sandstone.	From Road Segment 39 to the site and the mines (46, 47), there are many small archaeological features, retaining walls, and stone piles, probably related to the mining activities in this region.
46 7/27/2007 Ghuwayba 737754/3399525 346	Mine 304 Iron II	On the western side of a small tributary of Wadi al-Ghuwayba, a mine dug into the lower part of MBS formation.	This is the most visible mine shaft in the local tributary—blackish tailings visible from a long distance. Other mine shafts probably exist nearby, buried under the sandstone talus. Abundant ceramic.	
47 7/27/2007 Ghuwayba 737781/3399537 347	Mine 121 Iron II	On the eastern side of a small tributary of Wadi al-Ghuwayba, a mine dug into the lower part of MBS formation.	Copper mine shafts, including a possible mine tailing as well as two circular rock constructions (may represent shaft locations).	Around 15 m above the site, there is a small cave where an Edomite painted pottery sherd and a base with wheel markings were found, as well as a large mortar carved into the local sandstone.
48 7/27/2007 Ghuwayba 737952/3399500 359	Archaeological complex/watchtower 443 Iron II	On a hanging shelf overlooking the fortress of Ras al-Miyah East. In the lower parts of the cliffs of the MBS formation.	Massive structure stretching from edge of a cliff to the cliff face, probably rectangular. A few meters of a straight wall (the western side of the "tower") is visible beneath the collapse and is composed of two courses of stones. On an upper rock shelf there are smaller constructions in front of a natural rock shelter/shallow cave. To the east of the massive structure carved into the sandstone cliff face, there is a slightly curved line of seven holes, 10 to 15 cm in diameter (about 3 m above the shelf; "Feature 1" in GPS recording). Below the holes line, a large sandstone block is etched with 22 notches about 2 cm apart (decoration?). This area was the source of the building stones of the unfinished fortress Ras al-Miyah East. There may also be some copper mine shafts buried beneath the collapse, although no clear tailings are visible. The whole area has abundant pottery, especially in the collapse and along the slope below the building and cliff. Many diagnostic, extremely rich.	The holes line feature is similar to the one observed in Site 26. Unique building whose purpose is not clear.
49 7/28/2007 Other 732263/3399266 54	Water source 285 Ud	Spots of high water table north of Wadi al-Ghuwayba and on the margins of Wadi Arabah.	In the three spots, there is evidence of a high water table that may have been a permanent water source in the past. Only 49A has accessible water in the form of a built thmila, 49B is recognized by lush vegetation, and 49C is a modern water drill.	49A is frequented by local Azazme Bedouins and its constructions seem modern.

Table 6.3 FBRS sites summary (more details in the GIS database)* *(continued)*

Site Number Date Visited Wadi Basin Map Reference Elevation	Toponym, if Any Site Type Site area (m^2) Ceramic Age	Location	Description	Comments
50 7/28/2007 Dahal 737178/3406525 146	Inscriptions/petroglyphs 6082 Roman, Byzantine, Ud	On both sides of a sandstone canyon, 50 to 80 m above the first spring of 'Ain ad-Dahal oasis, along the course of Naqb ad-Dahal.	Extensive inscriptions, petroglyphs, and symbols carved on the sandstone walls of Wadi ad-Dahal. In the lower parts, there are modern Arabic inscriptions, but ca. 5 m above the wadi bed there are abundant petroglyphs without any clear Arabic. Most are symbols (lines, triangles, circumscribed star) and depictions of local animals (e.g., ibex), but some may be writings (Thamudic? Safaic?). The high inscriptions suggest that the wadi bed was much higher when they were written (see also Site 12).	First information about the site was received from C. Ben-David. The site is depicted on the 1883 PEF map.
51 7/28/2007 Other 747733/3400701 1278	Structure 391 Ud	On the main saddle between Wadi ad-Dahal and Wadi al-Khanzira, where the principal road between Faynan and Busayra crosses (Road Segments 52 and 53).	Ancient small architectural features and rock lines are disturbed by the asphalt roads and modern fields. Ceramic was sparse.	
52 7/30/2007 Ghuwayba 737895/3398895 328	Pottery scatter 902 EB?	On a prominent rock dome (Salib sandstone) above Wadi al-Ghuwayba, facing both Site 27 and Ras al-Miyah East. The access to the peak (including some rock climbing) is extremely hard and is possible only from the northeast side.	The site is mostly a scatter of pottery sherds in some pockets near the peak itself and to the east and south of it. There are some small cairns on the top of the peak; most of them seem to be recent. Small stone features to the northwest of the center point might be part of the old occupation.	We survey this peak because of a possible relation to the nearby unique Site 27. The peak suffered extensive erosion, and the site may have been more extensive. Body sherds seem to be Early Bronze.
53 'Ain Jlaila 7/15/2007 Dahal 738267/3403567 300	Water source - Ud	On the wadi bed of Wadi Jleila.	A small spring/thmila with some limited water vegetation. It is frequented by local Bedouins and seem to be a permanent water source along Naqb al-Jariya.	UTM location from topo map.
54 7/15/2007 Dahal 740049/3402520 415	Petroglyphs - Ud	In Wadi Jleila, on smooth limestone rock surfaces on both sides of the wadi, where it deepens into a narrow gorge (the rock surfaces were once the wadi bed, before the deepening of the gorge; it is not on the walls of the gorge itself).	Abundant patinated petroglyphs, including local wild animals, human figures, symbols, and so on.	UTM location from topo map.
55 7/15/2007 Dahal 739660/3402507 400	Leopard trap - Ud	Above the wadi bed, near a local trail junction.	A small leopard trap built of local limestone.	UTM location from topo map.
56 7/8/2007 Ghuwayba 739838/3401176 360	Leopard trap - Ud	On the upper slopes of Wadi al-Ghuwayba (here called "Wadi Hamra" in some maps).	A small tumulus and leopard trap.	UTM location from topo map.
57 Kh. al-Hassiya North 7/10/2007 Other 730452/3404730 -10	Watchtower - Iron II?	On the hill above the Nabataean caravanserai (SGNAS Site 229).	A rectangular watchtower. Evidence of robbery excavation is present. Structure is well preserved.	Scarce pottery; seems to be older than the nearby Nabataean caravanserai (Iron Age?).
58 7/9/2007 Ghuwayba 741088/3397149 490	Leopard trap - Ud	On the slopes of the ridges to the east of Wadi al-Ghuwayba.	A small leopard trap built of local stones.	GPS recording—control point 23.
59 7/11/2007 Jariya 736945/3402070 309	Thmilat al-Jariya Water source - Ud	Near the head of Wadi al-Jariya.	A small thmila; does not seem like a significant/permanent water source.	GPS recording—control point 27.
60 7/10/2007 Dahal 734174/3409767 40	Inscriptions/petroglyphs - Modern, Ud	On a sandstone boulder face in the lower part of Wadi ad-Dahal.	Inscriptions, mostly modern (Arabic), but some are patinated and somewhat similar to Site 50.	UTM location from topo map.

*Kh. = Khirbat (in Arabic, "[the] ruins of"); map reference in UTM WGS 1984 36N; elevation in meters above sea level.

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Table 6.4 FBRS recorded road segments.*

N.	Date Visited	Wadi Basin	Road Class	Map Reference Start	Map Reference—End	C	Road Length, m	Direct Length, m	ES	EE	ΔE	S	CF	Comments
1	7/27/07	Ghuwayba	Old dirt road	737652/3398575	738306/3398767	N	636	630	202	241	39	3.5	101	Composed from few segments of road that might represent the course of the old path. In addition, small road segment on the southern slope represents local donkey path used to cross the spur (118–137).
2	7/8/07	Ghuwayba	Old dirt road	738309/3398773	738436/3398864	N	152	148	239	238	1	0.4	102	
3	7/8/07	Ghuwayba	Camel	738436/3398850	738645/3300151	N	414	367	239	234	5	0.7	113	
4	7/8/07	Ghuwayba	Old dirt road	738647/3399156	738768/3399307	N	206	194	233	240	7	1.9	106	
5	7/8/07	Ghuwayba	Old dirt road	738817/3399430	738888/3399629	N	252	216	244	279	35	7.9	117	
6	7/8/07	Ghuwayba	Camel	739102/3399807	739774/3400468	Y	1,074	943	289	322	33	1.8	114	Ceramic—Iron II
7	7/8/07	Ghuwayba	Camel	739774/3400465	739879/3400776	N	386	329	323	358	35	5.2	117	
8	7/8/07	Ghuwayba	Camel	739876/3400779	739710/3401016	N	370	289	357	369	12	1.9	128	
9	7/9/07	Ghuwayba	Donkey	738309/3398394	739015/3398177	N	749	740	213	298	85	6.5	101	
10	7/9/07	Ghuwayba	Donkey	739015/3398177	739260/3398129	N	270	249	299	315	16	3.4	108	
11	7/9/07	Ghuwayba	Donkey	741674/3397789	741617/3397543	Y	349	256	674	604	70	11.4	136	
12	7/9/07	Upper Ghuwayba	Goat	741619/3397536	741241/3397485	Y	529	382	602	578	24	2.6	138	
13	7/9/07	Ghuwayba	Donkey	741088/3397144	740804/3396983	Y	486	326	496	382	114	13.2	149	
14	7/11/07	Jariya	Camel	736986/402015	737297/3402130	N	586	333	312	429	117	11.3	176	
15	7/11/07	Jariya	Donkey	737301/3402126	737338/3400043	N	1,536	1,182	428	446	18	0.7	130	
16	7/13/07	Dahal	Current dirt road	734771/3410782	737714/3410662	N	3,685	2,947	263	455	192	3.0	125	
17	7/13/07	Dahal	Current dirt road	738419/3410179	738790/3410092	N	711	380	437	376	61	4.9	187	
18	7/13/07	Dahal	Current dirt road	740260/3405393	739376/3404929	N	1,788	998	593	430	163	5.2	179	

Table 6.4 FBRS recorded road segments.* *(continued)*

N.	Date Visited	Wadi Basin	Road Class	Map Reference Start	Map Reference—End	C	Road Length, m	Direct Length, m	ES	EE	ΔE	S	CF	Comments
19	7/13/07	Dahal	Current dirt road	739363/3404938	738682/3405251	N	1,167	753	432	228	204	9.9	155	
20	7/15/07	Dahal	Donkey	745486/3403255	745449/3403084	N	258	175	1053	1036	17	3.8	148	
21	7/15/07	Dahal	Camel	744856/3402353	744377/3402120	Y	607	537	922	922	0	0.0	113	Ceramic—Late Islamic?
22	7/15/07	Dahal	Camel	744376/3402118	744232/3402063	N	234	154	920	900	20	4.9	152	
23	7/15/07	Dahal	Camel	744228/3402088	744221/3402097	N	13	12	895	897	2	8.6	108	
24	7/15/07	Dahal	Camel	744116/3402181	743895/3402179	N	322	265	892	868	24	4.3	121	
25	7/15/07	Dahal	Camel	743852/3402178	743394/3402009	Y	562	490	868	852	16	1.6	115	Ceramic—Roman, Iron II, EB
26	7/16/07	Dahal	Camel	737917/3402677	737883/3402588	N	127	95	415	385	30	13.3	133	
27	7/16/07	Ghuwayba	Camel	740377/3401512	740478/3401560	Y	138	112	530	558	28	11.4	123	Ceramic—Iron II
28	7/16/07	Dahal	Camel	740483/3401563	740947/3401730	N	577	494	558	518	40	4.0	117	
29	7/16/07	Dahal	Camel	741138/3401668	742144/3401765	N	1,289	1,014	489	650	161	7.1	127	
30	7/16/07	Dahal	Camel	742143/3401763	743196/3401856	Y	1,323	1,059	651	843	192	8.3	125	Ceramic—Roman
31	7/18/07	Ghuwayba	Donkey	737110/3398348	736844/3398767	N	551	496	192	217	25	2.6	111	
32	7/18/07	Ghuwayba	Donkey	736845/3398768	736262/3399170	N	856	711	220	327	108	7.2	120	
33	7/18/07	Ghuwayba	Old dirt road	736740/3399280	736203/3399177	N	666	549	312	337	24	2.1	121	
34	7/18/07	Jariya	Donkey	736135/3399284	735406/3399369	N	1,001	735	327	267	61	3.5	136	
35	7/18/07	Jariya	Donkey	735402/3399368	735197/3399494	N	314	242	266	207	59	10.6	130	
36	7/18/07	Jariya	Goat	735196/3399493	734925/3399495	N	318	271	207	179	28	5.1	117	Another well-built road segment ascends from KAJ on the other bank of the small tributary that climbs to the main saddle (see in the DVD file name: FBRS_Road_Segment _36_photo_3_ez_7-18-2007_EDM_6272).
37	7/22/07	Ghuwayba	Old dirt road	736791/3399281	737139/3398977	N	973	461	318	348	30	1.8	211	
38	7/22/07	Ghuwayba	Camel	737139/3398977	737730/3399217	N	765	638	348	342	6	0.5	120	

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Table 6.4 FBRS recorded road segments.* *(continued)*

N.	Date Visited	Wadi Basin	Road Class	Map Reference Start	Map Reference—End	C	Road Length, m	Direct Length, m	ES	EE	ΔE	S	CF	Comments
39	7/22/07	Ghuwayba	Camel	737755/3399237	738110/3399521	N	532	456	343	331	12	1.3	117	
40	7/22/07	Ghuwayba	Other	738111/3399526	738902/3399721	N	1,359	811	334	292	42	1.8	168	The main route down from Site 3 most likely follows another path.
41	7/24/07	Dahal	Other	736780/3402793	736604/3402826	N	192	178	451	473	21	6.3	108	A small segment of the trail was taken to mark the beginning of the road.
42	7/24/07	Dahal	Goat	736598/3402828	735883/3403105	N	1,001	768	475	566	92	5.2	130	
43	7/24/07	Dahal	Donkey	735881/3403106	735762/3403155	N	136	129	566	596	30	12.3	106	
44	7/24/07	Other	Donkey	735763/3403153	735699/3403136	N	98	67	593	574	20	11.3	147	
45	7/24/07	Other	Donkey	735669/3403175	735443/3403217	N	323	251	568	507	61	10.7	129	
46	7/24/07	Other	Donkey	735192/3403083	734275/3403007	N	1,172	923	482	417	65	3.2	127	
47	7/24/07	Other	Donkey	734256/3402999	734035/3403142	N	294	265	417	383	33	6.5	111	
48	7/24/07	Other	Goat	734024/3402897	733681/3401989	N	1,454	971	400	176	224	8.8	150	The trail passes some tumuli on the ridge.
49	7/24/07	Other	Goat	733644/3401840	733919/3401054	N	946	843	172	91.2	81	4.9	112	
50	7/24/07	Other	Donkey	733964/3400694	734599/3399759	N	1,313	1,128	86	188	102	4.5	116	The trail passes some small rock piles/graves.
51	7/27/07	Ghuwayba	Donkey	738658/3399300	738212/3399426	N	710	462	251	346	95	7.6	154	First segment of road is well defined with a rock barrier along the outer edge; most of the lower half is not well preserved due to lack of use. The upper part has a few visible switchbacks heading toward the plain in front of the fortress.
52	7/28/07	Dahal	Current dirt road	746338/3401285	747730/3400723	N	1,650	1,503	1108	1284	176	6.1	110	Most probably, this road is on the track of the ancient road to Busayra.
53	7/28/07	Other	Other	747730/3400724	748116/3400908	N	449	427	1282	1206	76	9.6	105	
54	7/28/07	Other	Current dirt road	747224/3401868	748035/3401743	N	259	251	1258	1160	97	20.6	103	
55	7/28/07	Other	Other	749591/3401383	749348/3404190	N	4,183	2,825	1255	1157	99	1.4	148	R_S_55 extends through the modern village of Busayra, where the GPS signal was lost. We continued plotting the road segment, however, to the ancient site of Busayra north of the modern village.
56	7/28/07	Other	Current dirt road	749500/3403199	748444/3403633	N	1,320	1,142	1086	909	177	7.6	116	We did not take the main road from the village of Busayra to the beginning of R_S_56. We took a sideroad shortcut and started the GPS readings there.

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Table 6.4 FBRS recorded road segments.* *(continued)*

N.	Date Visited	Wadi Basin	Road Class	Map Reference Start	Map Reference—End	C	Road Length, m	Direct Length, m	ES	EE	ΔE	S	CF	Comments
57	7/28/07	Other	Current dirt road	748439/3403624	746689/3404527	N	2,522	1,867	911	925	14	0.3	135	There is a large site before the end of the road segment to the north of the road segment that appears to be the ruins of a settlement.
58	7/29/07	Other	Other	748305/3403589	747232/3401777	N	3,620	1,895	930	1253	324	5.1	191	When FBRS 2007 R_S_58 joins R_S_54, the two overlap as they ascend the wadi bank to control_57.
59	7/28/07	Dahal	Other	747225/3401777	743183/3404723	N	6,148	4,993	1235	820	416	3.9	123	Composed from few segments of road that might represent the course of the old path. In addition, small road segment on the southern slope represents a local donkey path used to cross the spur (118–137).

*C = presence of ceramic sherds (yes/no); ES = elevation start (meters above sea level); EE = elevation end (meters above sea level); ΔE = elevation difference (meters); S = slope (angle); CF = road "curvature" percentage of the actual road length from the direct length; high values may represent many curves and switchbacks and thus a well-planned road. However, it can also be a result of topographic obstacles, and low values can simply represent flat areas.

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Table 6.5 Faynan-Busayra principal road: summary of relevant road segments and associated sites, from Faynan to Busayra.

Site/Road Segment	Description
Site_1	Khirbat al-Ghuwayba —an Iron-Age archaeometallurgical complex. Includes some defensive structures.
Road_Segment_1	Old dirt road; in some locations, the ancient road constructions can be seen.
Site_4	Stone enclosure; campsite? Iron Age II pottery.
Site_5	Stone enclosure; campsite? Similar in characteristics to Site_4.
Road_Segment_2	Old dirt road, on the course of the ancient road.
Road_Segment_3	Well-preserved, short segment of the ancient road.
Road_Segment_4	Old dirt road; in some locations, the ancient road constructions can be seen.
Road_Segment_5	Old dirt road; in some locations, the ancient road constructions can be seen.
Road_Segment_6	Long segment of the ancient road along the upper part of WAG (north bank); Iron Age II pottery.
Road_Segment_7	Segment of the ancient road along the upper part of WAG.
Road_Segment_8	Segment of the ancient road along the upper part of WAG.
Road_Segment_27	The upper most part of the ascent out of WAG to the main saddle; switchbacks; not in recent use, thus it is not clearly visible. Iron Age II pottery.
Road_Segment_28	From the saddle with WAG into Wadi Jleila. Some constructions.
Road_Segment_29	Ascending from Wadi Jleila. Well-defined road and interesting stone alignment.
Site_19	Small fortlet. Later than Iron Age pottery.
Road_Segment_30	Ascending to the saddle between Wadi Jleila and Wadi Dahal. Well-defined road constructions.
Site_17	Cemetery in the main saddle. Mostly Bedouin, some might be ancient.
Site_20	Small fortlet on the ridge near to the west of the main saddle. The structure makes use of natural rock outcrop that is visible from a very large distance.
Road_Segment_25	Along the slopes of upper Wadi Dahal. Iron Age II pottery (and later).
Site_16	Massive rock pile; might relate to local fields in the area and not necessarily to the road itself.
Road_Segment_24	Well-defined road segment along the slopes of upper Wadi Dahal.
Site_15	Small fortlet/watchtower/farming structure. Iron Age II pottery (and possibly late).
Road_Segment_23	Short road segment along the slopes of upper Wadi Dahal.
Road_Segment_22	Well-constructed road segment along the slopes of upper Wadi Dahal.
Site_14	Well-preserved retaining wall; where the ancient road crosses small tributary.
Road_Segment_21	Well-constructed road segment along the slopes of upper Wadi Dahal.
Road_Segment_52	Current dirt road that climbs out of Wadi Dahal toward the main saddle on the way to Busayra; probably on the same course of the ancient road.
Site_51	The main saddle between Wadi Dahal and Wadi Umm Za'arura; wide line of stones (wall?) and pottery scatter.
Road_Segment_53	Modern asphalt road, probably on the course of the ancient path.
Road_Segment_55	Modern asphalt road, probably on the course of the ancient path; near Khirbat Umm-Za'arura, a large Iron Age II site and possible watchtower. Some other Iron Age sites along this road (see MacDonald et al. 2004).
Control 58–61	Busayra.

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Appendix
A Desert Kite from the Faynan Area

During the 2006 ELRAP field season, we visited the mines of Jabal Madsus (Hauptmann 2007:130–131) and identified a nearby structure as a desert kite of the type known from the southern Arabah and the Negev (Figure 6.40; Bar-Oz et al. 2009; Holzer et al. 2010; Nadel et al. 2010). The structure dominates the landscape and is clearly seen on satellite images (Google Earth and Ikonos; Figure 6.41). The architectural remains were recorded in 2007 with a differential GPS (see above, in the methodology section), and the data were incorporated into the GIS database of ELRAP (Figure 6.42). The installation takes advantage of the local topography, with its around 120-m stone wall "arms" confining a small wadi and its apex located near the wadi bed itself at the lowest point in the area. Most commonly, desert kites are interpreted as hunting installations, designed to direct herds of gazelles (in the area of the northern Arabah, *Gazella dorcas*) into a killing trap located at the end of the long arms (e.g., Rosen and Perevolotsky 1998). The topography may help to direct the animals (in addition to the low walls), as is clearly the case with the Madsus kite, where the location of the installation was carefully chosen. The small wadi not only is a natural track diverting the animals, but the kite also blocks a saddle that constitutes a major natural pass in the relatively steep ridge of Jabal Madsus (Figure 6.41), and herds from the plains to the south can be easily directed to run through it.

The desert kite of Madsus is the first reported from the eastern margin of the Arabah Valley.[24] Its relatively small size, distinct shape, and intimate link to local topography tie this installation to the desert kites of the southern Negev (Holzer 2003 and comprehensive references therein; Holzer et al. 2010; Nadel et al. 2010). In the southern Negev, about a dozen similar installations were recorded and dated roughly to the Chalcolithic–Early Bronze Age I (fourth to third millennia BCE, based mostly on flints and optical luminescence; there is some evidence of use up to the Middle Bronze Age). The Negev group is distinct from the kites documented in Sinai (e.g., Meshel 1974; Perevolotsky and Baharav 1991), the large-scale installations of the northern Levant (Bar-Oz et al. 2011), and the well-known installations from the eastern desert of Jordan (e.g., Betts 1985; Betts and Yagodin 2000). The latter are much bigger, consisting of walls of thousands of meters in length (in general,



Figure 6.40 An overview of the Madsus desert kite. The small hunting installation takes advantage of the local topography (cf. Figure 6.42).

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they are 1:10–1:20 bigger than the Negev installations) and covering huge areas in the plains of the arid zones of Jordan, especially the Black Desert near the border with Syria. This is where the installations were first identified from the air (Maitland 1927) and got their name following their distinct shape. The east Jordan group is dated by associated datable sites mostly to the Neolithic period (eighth to seventh millennia BCE; this date is still questionable). The younger, smaller Negev installations were interpreted as a final marginal phase of a long-lasting southern Levant phenomenon, although Holzer (2003) contests this assumption and claims that they represent a "renaissance" well adapted to different animal species and different environmental conditions.

The Madsus desert kite is an important addition to our understanding of the regional economy of Faynan. If the Chalcolithic–Early Bronze Age I date for the Negev group is accurate, the hunting installation may be associated with other activities in its immediate environment, such as the copper mines of Madsus and

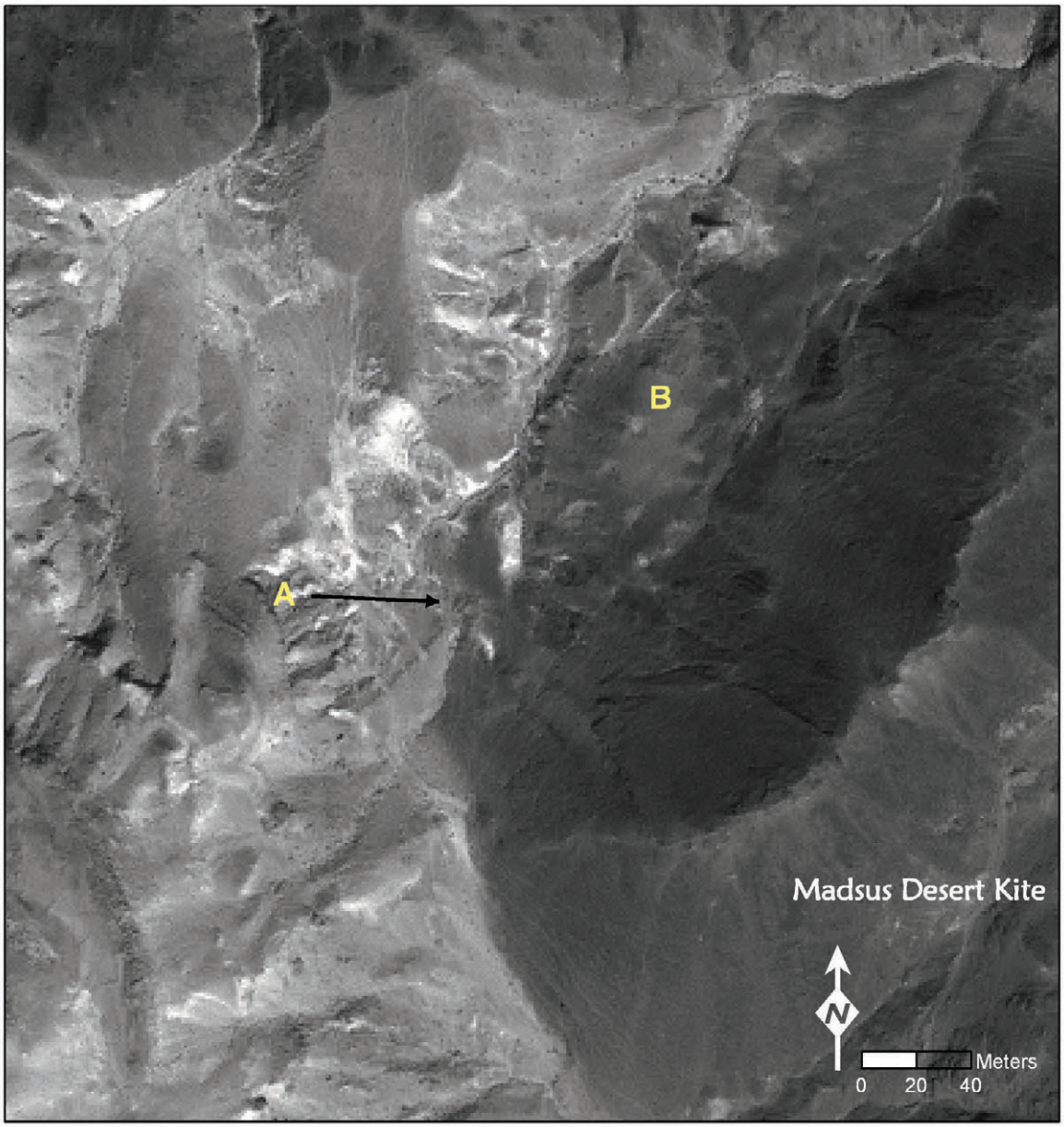

Figure 6.41 High-resolution satellite image (Ikonos, Geoeye) of the Madsus desert kite and its vicinity. (*a*) The desert kite, taking advantage of the local topography; arrow points to the rectangular structure at the head of the hunting installation (cf. Figure 6.42). (*b*) Pit mines field (see Hauptmann, 2007:130–131).

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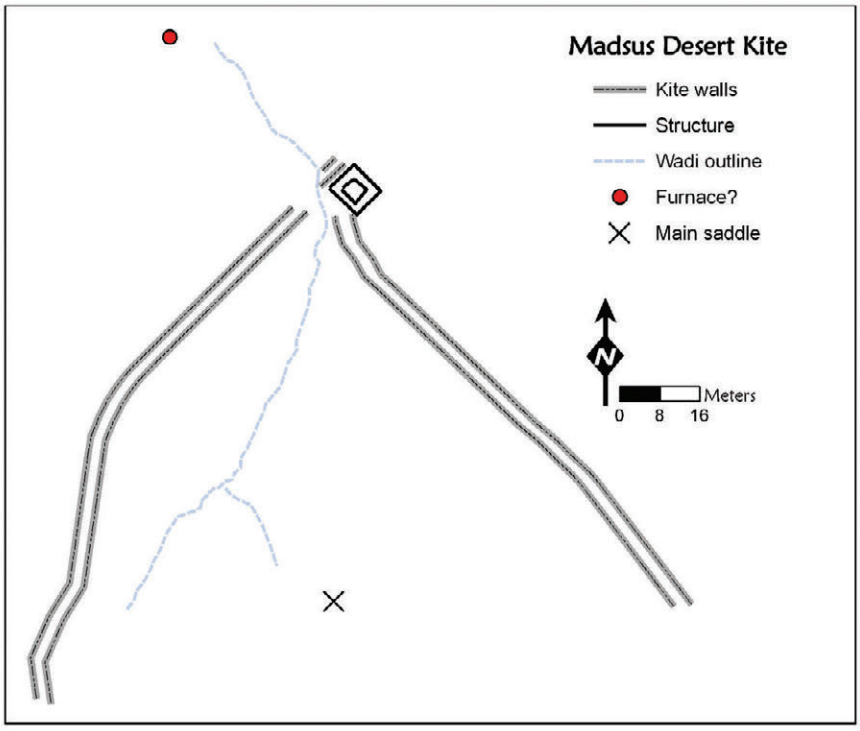

Figure 6.42 Map (GIS) of the desert kite at Jabal Madsus, Faynan, the only installation of its kind known in the eastern side of Wadi Arabah. The location of a possible Chalcolithic copper smelting furnace is also indicated.



Figure 6.43 Early Bronze Age sites in the area of Wadi Fidan. (*a*) The Madsus desert kite (cf. Figure 6.40). (*b*) Madsus copper pit mine field (Hauptmann 2007:130–131). (*c*) ad-Dhuhur copper mine field (Hauptmann 2007). (*d*) Khirbat Hamra Ifdan, a large EBIII to IV copper production center (Levy et al. 2002). (*e*) Wadi Fidan 4, EBI settlement and copper production site (Adams and Genz 1995).

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Figure 6.44 The debated installation near the desert kite and the pit mine field of Jabal Madsus, possibly a Chalcolithic smelting furnace (see text).

Umm ez-Zuhur (tentatively dated to the Early Bronze Age I; see Hauptmann 2007:130–131), the settlement and copper smelting site of Wadi Fidan 4 (Early Bronze Age I; see Genz 1997; Genz and Hauptmann 2002), and perhaps the large Early Bronze Age copper smelting site of Khirbat Hamra Ifdan (Levy et al. 2002) (Figure 6.43). The latter has yielded extensive collection of faunal remains, including several hundreds of gazelle bones that may be directly related to the hunting installation of Madsus (Muniz 2007). The wide dating range for the kite and its unique subsistence-related function in a "metallurgical landscape" do not seem to help solve the interesting debate regarding a small nearby installation that was interpreted as a ("typical") Chalcolithic smelting furnace (Figures 6.42 and 6.44; see Craddock 1995:127–129; contra Hauptmann 2007:131).

Notes

1 According to New Kingdom Egyptian texts, it appears that "Edom" was first a geographic reference that was only later used to designate a people and a polity (see discussion in, e.g., Edelman 1995 and below).

2 The survey took place in July 2007 and included 14 days of intense fieldwork, some of which were backpacking excursions to remote destinations. The field team included E.B.-Y. (supervisor), Joshua J. Van Eee, Eric S. Olson, and Suleiman 'Aid Mana'aje.

3 The Greek (φινω, φαινων) and Latin (Phunon) names of the area also followed the Hebrew Punon and helped preserve this origin in the Arabic name (see Freeman-Grenville et al. 2003).

4 The Papyrus states, "We have just finished letting the Shasu people of Edom pass the fortress of Merneptah-hotphima-'e (life, prosperity, health), which is in Tjeku,

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to the pools of Pi-tum" (*ANET*, 259; see Caminos and Gardiner 1954:293).

5 Perhaps the most notable case regarding ancient route reconstruction and the impassable canyons of Edom is the road to Petra. Wadi Musa, where the ruins of the ancient city lie, has a deep gorge with sheer cliffs blocking the way to the west (toward the Negev and eventually Gaza). Scholars are still debating how the ancient routes bypassed this obstacle and what was the course of the main Roman road (e.g., Ben-David 2007 and references therein). Since important Iron Age (Edomite) sites such as Umm al-Biyara and Tawilan are located in the vicinity of Petra in the Wadi Musa basin, the question of the route to the Arabah also has implications for our understanding of the Iron Age regional road network (and see below).

6 In March 2009, the authors of this chapter visited the al-Buweirdeh springs in search of an Iron Age fortress possibly buried under the dunes. Although no fortress was found in this visit, we recorded several sites, including a Roman/Byzantine small mound with remains of a short aqueduct (maybe the same as observed by Kitchener, UTM coordinates 72370/38545) and a condense scatter of Early Bronze Age slag and furnace fragments (UTM 72415/38650).

7 Musil's description was translated from the German by Sara Baitzel. We thank Chaim Ben-David for pointing out this reference.

8 The GPS antennas were connected to Recons data collectors made by TDS with Interlock 1.0.2 software. Data correction was done using Spectra Precision 1.1.

9 An ongoing study by Ian Jones is focused on documenting the NRA roads based on satellite imagery taken before and after the NRA mineral prospecting in the sensitive region of Faynan. The study is part of the University of California at San Diego (UCSD), Integrative Graduate Education and Research Traineeship (IGERT). The result of this study will help in further understanding the region's ancient road network, as well as in identifying ancient mines that were reworked by the NRA.

10 The stratigraphy of the site was clarified in a sounding made during the 2009 field season of ELRAP (supervised by E.B.-Y. under the direction of T.E.L. and M.N.). Although previous surveys dated the site only to the Iron Age, the preliminary results show a clear distinction between the dwelling and the copper smelting phases of occupation, the former dated to the Roman-Nabataean period (pottery, glass, a stone die) and the latter to the Iron Age I to IIA (pottery, smelting technology, two ^{14}C dates).

11 Weisgerber (2006:15) believes that the Ras al-Miyah mines were "unsuccessful." If this observation is accurate, there is no surprise that there are no corresponding smelting sites in this area of Faynan. Ben-Yosef (2010) suggests to see this situation as reflecting a "conflict zone" in which successful copper production was not possible for political and security reasons.

12 The site was discovered in 2006 by chance. The excavation team of Ras al-Miyah East explored each day a different path to get back to the truck parking near 'Ain al-Ghuwayba, and on one occasion, E.B.-Y. noted the dense pottery in the unique location. In 2007, the site was carefully surveyed as part of the FBRS.

13 If the destination of travelers from Busayra was Khirbat Faynan itself (which has some evidence of occupation throughout the Iron Age; see summary in Ben-Yosef et al. 2010), the preferred road would probably be Naqb Dana and not Naqb al-Ghuwayba.

14 Currently, no settlement on the Edomite plateau can be securely dated to the Iron Age I to IIA; see in particular Bienkowski (2001), who also revised the results of MacDonald's Wadi al-Hasa Survey (MacDonald et al. 1988) and demonstrates clearly the problems of survey dating. Nevertheless, the area was not void of people, as the Egyptian texts (Ward 1992) indicate that the mountains of southern Jordan were populated in the Late Bronze Age and probably later by nomads (the *Shasu*).

15 We thank Chaim Ben-David for bringing this lacuna in survey to our attention. We are grateful to Neil Smith for all the Iron Age pottery identifications in this chapter.

16 See in particular plate with transcriptions on page 215; see also his map from 1883 (Figure 6.5b) that was in turn the source for the indication on Newcombe's map from 1915 (Figure 6.6); the gorge and the oasis of 'Ain ad-Dahal appears as part of Wadi (Wâdy) Ghuweir in these reports. See more details above and in Table 6.1.

17 Fast deepening of wadi channels in the arid regions of the southern Levant is attributed to climatic changes and usually indicates a drier climate (see Introduction, this volume); FBRS Site 50 may contribute to regional climate reconstruction in future studies.

18 The inscriptions of FBRS Site 50 require further investigation by special gear (e.g., LiDAR scanning) and interpretation by relevant experts.

19 The fortress at Khirbat en-Nahas was excavated by the ELRAP team in 2002 and 2006 and was dated by radiocarbon to the tenth century BCE (see Higham et al. 2005; Levy et al. 2005; and Chapter 2, this volume, in particular regarding Areas A and F). As no evidence

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of copper production later than the ninth century BCE was found at the entire site (including more than a hundred ^{14}C measurements), a nonmetallurgical interpretation of the fortress is needed if one insists on dating it to the seventh century BCE. Interpretation of the fortress as part of the main road from Busayra to the Negev is not supported by the geographical and archaeological evidence, as described above; thus, it is hard to find any nonmetallurgical explanation for the location of this massive structure.

20 One of the depressions was excavated as part of the ELRAP 2009 field season, and samples for optical luminescence dating were collected. A full study and report on this will be presented elsewhere.

21 Some reservations regarding the identification of the route and dates of some of the sites have been raised recently (e.g., Hirschfeld 2006), but in general, this route between Judah and Edom is well accepted. The main reference to "The Road to Edom" or "The Way of the Wilderness of Edom" is part of the campaign of Israel and Judah against Moab in the mid-ninth century BCE. As the allies (including the Edomite king, who was a vassal of Judah) decided to invade Moab from the south, they chose this road to reach Edom first. The heat, thirst, and miraculous flash flood in the wadis are part of realistic geographical description.

22 Note, for example, the comment by Rothenberg et al. (1979:220) that "there was never a line of 4th century castella in the 'Arabah, and no traces of any north-south road running all the way from the Dead Sea to the Red Sea have ever been found."

23 According to Snead et al. (2009a:3), examining trails, roads, and paths in this way is part of a "paradigm shift towards the archaeology of landscape." Recent landscape studies, with their emphasis on identifying the cultural context of "systems of movement," have also focused on identifying patterns, and scales of interaction are an extension of the rich tradition of settlement pattern analysis in archaeology articulated long ago by researchers such as K. C. Chang (1968), leading us to question whether a "new paradigm" has been created or, more simply, a broader approach to regional archaeological studies.

24 Recently, U. Avner identified on Google Earth a small desert kite near the village of al-Qatar (29.8223°N, 35.1056°E) in the southern Arabah Valley, which will be the second kite reported from the eastern margins of the valley.

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7 Patterns of Iron Age Mining and Settlement in Jordan's Faynan District

The Wadi al-Jariya Survey in Context

Kyle A. Knabb, Ian W. N. Jones, Mohammad Najjar, and Thomas E. Levy

As a part of the University of California at San Diego (UCSD)–Department of Antiquities of Jordan Edom Lowlands Regional Archaeology Project (ELRAP) in 2007, an intensive pedestrian survey was carried out along a 4-km stretch of the northern aspect of the Wadi al-Jariya. This work completed an earlier ELRAP survey of the southern portion of the Wadi al-Jariya aimed at exploring the Iron Age landscape of ancient mining and metallurgy. A total of 96 new sites were recorded in Wadi al-Jariya. The following is a preliminary analysis of the settlement pattern data collected that season. To better characterize the nature of occupation in the research area, sites of all types from all time periods were recorded, ranging from prehistoric through modern periods. In addition, we present the results of a small systematic survey of Wadi Fidan that was carried out in 2004. This survey completed the survey of a previous Jabal Hamrat Fidan/ELRAP survey of Wadi Fidan. Both surveys documented significant Iron Age settlement devoted to metal extraction and processing. This chapter summarizes the settlement pattern data from two catchment areas (the Wadi al-Jariya/Wadi al-Ghuwayba catchment and the Wadi Fidan catchment) and its relationship to the greater Iron Age settlement in the Faynan district and surrounding regions.

Introduction

This chapter presents the cumulative results of four seasons of archaeological surveys conducted by the Jabal Hamrat Fidan (JHF)/Edom Lowlands Regional Archaeological Project from 1998 to 2007 (Figure 7.1), focusing on the Iron Age material. In addition to the previously published data (Levy et al. 2003; Levy et al. 2001), we describe the unpublished results of two additional seasons of archaeological survey. The first, conducted in 2004, is a small survey of Wadi Fidan that focused on an area southeast of the 1998 survey boundaries. The second, conducted in 2007, is a continuation of the 2002 survey of the Wadi al-Jariya and completed the systematic survey of that wadi system.

Methodological Considerations

Most archaeological survey projects in southern Jordan have had as their main objective to record and describe

Opposite: The Wadi al-Jariya upper basin, looking northwest. The dark outcrops of the Burj formation host extensive Iron Age copper mines. In the background are the 'Araba Valley and Hazeva. *Photo E. Ben-Yosef, UC San Diego Levantine Archaeology Laboratory.*

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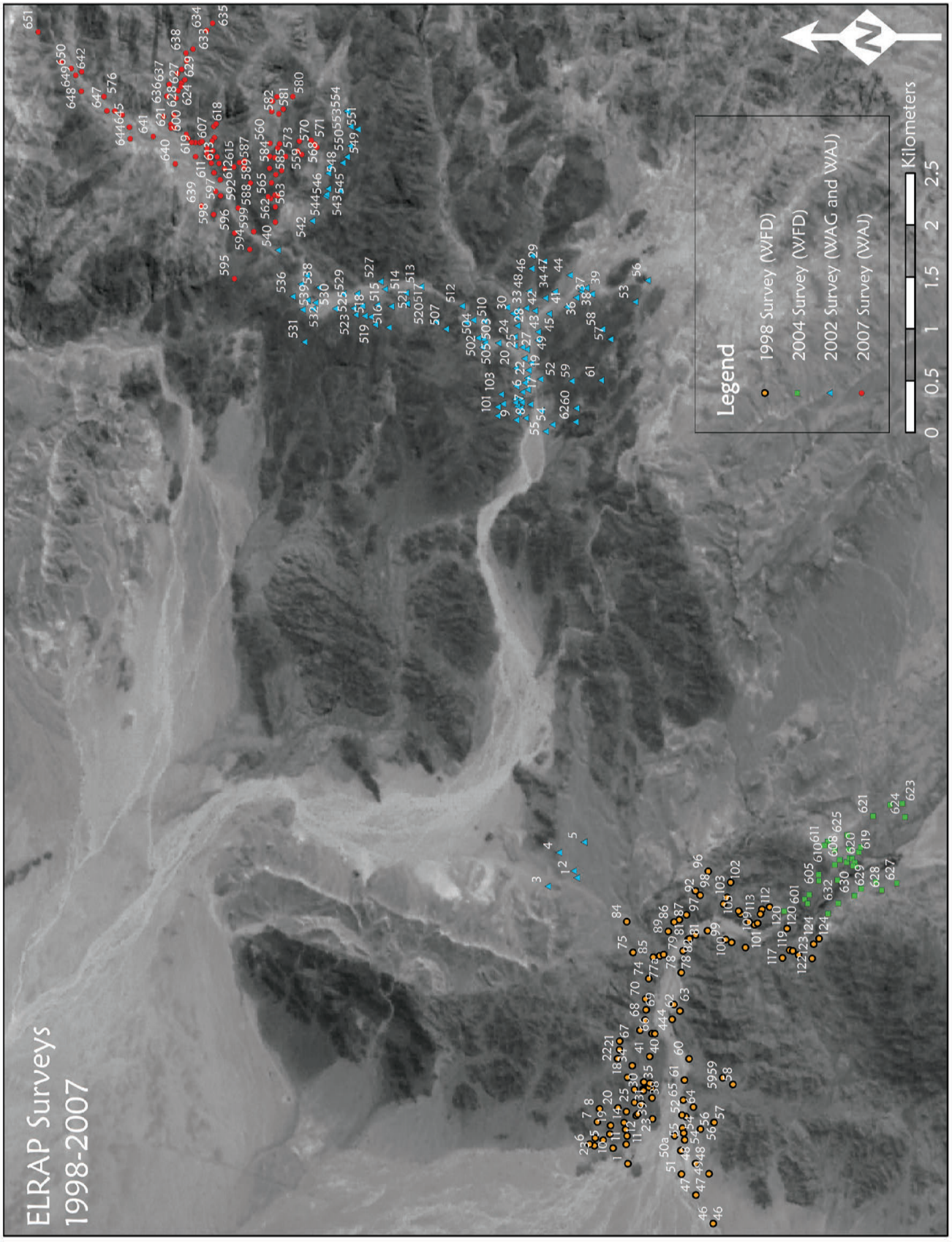

Figure 7.1 Map of all sites recorded during JHF and ELRAP surveys conducted from 1998 to 2007. *Background image: (C) CNES/SPOT Image 1992–1994.*

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settlements in the region (Hart 1986, 1989; Hart and Falkner 1985; Lindner 1992; MacDonald 1988, 1992; MacDonald et al. 2004). Most of the surveys conducted have been purposive or extensive, relating to either one time period or to prominent sites on the landscape. Because the emphasis is on the site itself, rather than the site in its landscape and context, interpretations of the data often devolve into evaluative statements about the relative frequency of sites from a particular occupation period (McQuitty 2005). These surveys are biased toward large, highly visible sites with dense scatters of surface ceramics. They also tend to recover a low density of sites compared to intensive pedestrian surveys. This relationship has been empirically tested by Plog et al. (1978), who showed that there is a strong positive correlation between survey intensity—the degree of detail inspected within the survey boundaries—and the density of sites recorded within a survey area. The current project employs methodologies developed elsewhere in the Mediterranean that deal with these issues (Alcock 1993; Bintliff and Sbonias 1999). The boundaries of the ELRAP surveys are relatively small and focus on natural and cultural boundaries, defined by the catchment areas around the wadis (Figure 7.2). Surveyors were spaced no more than 25 to 50 m apart during the surveys.

There are a number of approaches to defining what constitutes a site in an archaeological survey. A common definition of a site uses artifact density or material remains as the main criterion (Plog and Hill 1971). Variations of this approach are common in surveys in Jordan. Off-site survey, on the other hand, treats the landscape as a continuous artifact of human behavior. Proponents of this approach noted the failure of site-based approaches to recover evidence of nonsedentary peoples who leave behind little material evidence (Dunnell 1992; Thomas 1975). The ELRAP research design attempts to incorporate elements of both approaches to defining a site. Thus, when we speak of a site in this chapter, it refers to a distinct spatial clustering of artifacts, ecofacts, structures, and other human-related features.

Theoretical Considerations

One of the key theoretical issues investigated by ELRAP is the role of technology in social evolution. Ancient copper production entails technologies that have a strong archaeological signature, easily detectable through both survey and excavation. Archaeological data collected in the Faynan region, with its rich copper sources and long history of copper mining and smelting, lends itself to investigation through archaeological production models.

Production is an inherently social activity. Archaeologists have linked craft production to sociopolitical organization through an emphasis on specialization and its connection to the rise of complex societies (Brumfiel 1987, 1998; Costin 2004; Peregrine 1991; Sinopoli 1998). A comprehensive description of the production systems in place during the Iron Age in Faynan, based on the results of archaeological surveys and excavations, is presented in Chapter 11, this volume.

Research Background

As noted above, this chapter focuses on previous surveys conducted by the UCSD ELRAP. The history of archaeological survey and other major archaeological projects conducted in Faynan are detailed in Chapter 5 (this volume).

The UCSD surveys were some of the first full-coverage, systematic surveys conducted in southern Jordan and complement the archaeological surveys carried out in Wadi Faynan (Barker et al. 2007). Three wadi channels have been surveyed since 1998: Wadi Fidan, Wadi al-Ghuwayba, and Wadi al-Jariya. Wadi Fidan and Wadi Faynan are part of the same catchment system, as are Wadi al-Jariya and Wadi al-Ghuwayba. While the recording methods have varied from season to season as we purchased new equipment, the survey methodology and research design have remained consistent.

Description of the Wadis

Wadi Fidan is the lower portion of Wadi Faynan. It begins near the modern Bedouin village of Qurayqira, where the Wadi Faynan cuts through Jabal Hamrat Fidan monzogranite range, forming a narrow gorge. At this narrowing point, there is a perennial spring called ʻAyn Fidan, which gently flows for a few hundred meters along the wadi. From the spring, the wadi continues westward and passes through the Minshar monzogranite for about 2 km until it debouches into the ʻ] Valley (Figure 7.3). Along this segment of the wadi, patches of Pleistocene conglomerates make up terraces where a number of sites were discovered in 1998. Wadi Fidan constitutes a natural pass in the mountainous region of Jabal Hamrat Fidan and a gateway between the Faynan copper ore district and the plains of the ʻAraba to the west.

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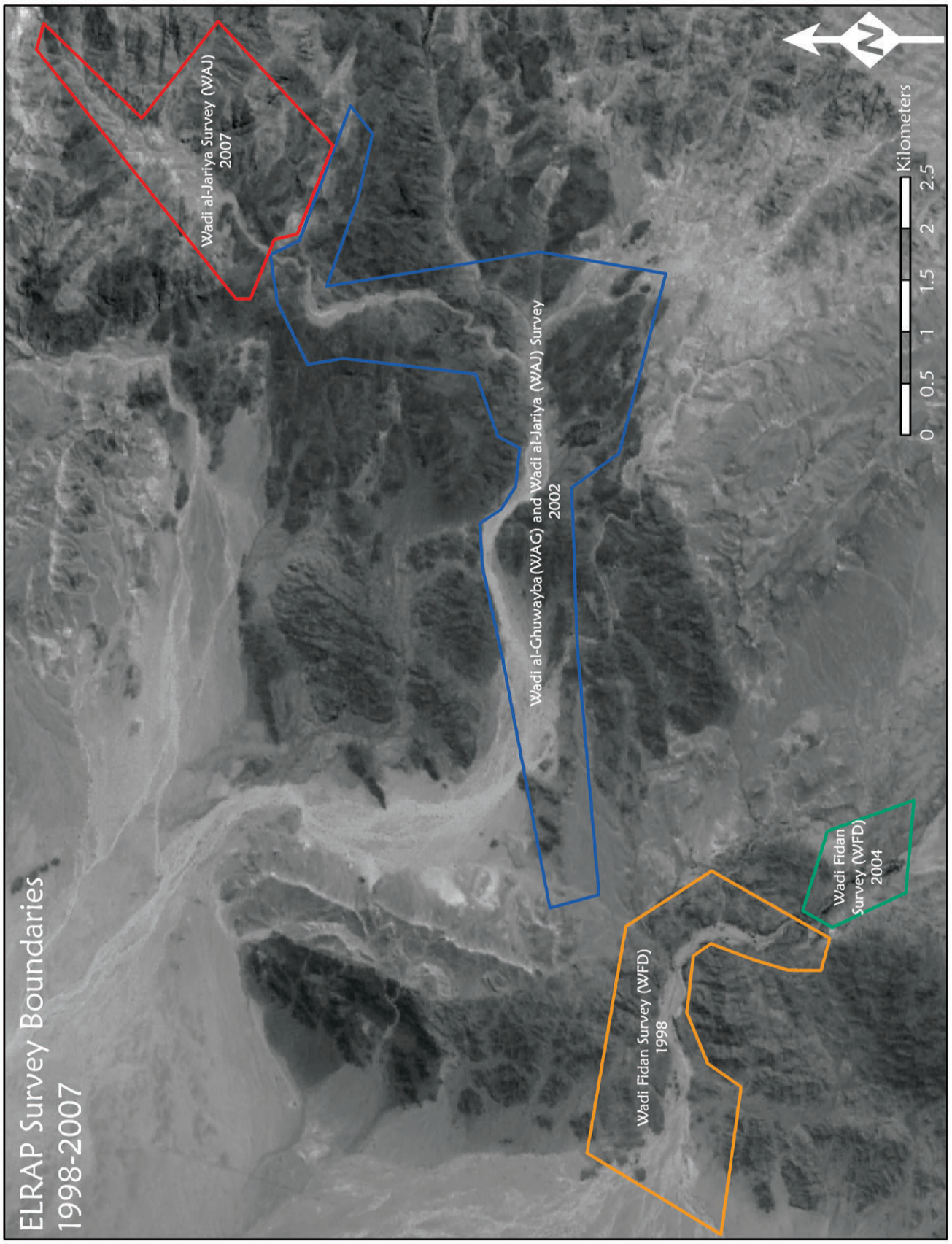

Figure 7.2 Map of the boundaries of all ELRAP surveys conducted from 1998 to 2007. *Background image: (C) CNES/SPOT Image 1992–1994.*

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Figure 7.3 Overview of Wadi Fidan. Wadi 'Araba in the background.



Figure 7.4 Overview of Wadi al-Ghuwayba.

Just a few kilometers northeast of Wadi Fidan, Wadi al-Ghuwayba (also Wadi al-Ghuweiba) was most likely part of the same settlement system during the Iron Age. It flows for 14 km to the west, around the Jabal al-Minshar (the northern extremity of the Jabal Hamrat Fidan), eventually reaching the Wadi 'Araba. To the east, the wadi splits into two smaller drainages, named Wadi Ghuwayba al-Ghani (the wet) and Wadi Ghuwayba al-'Atshana (the thirsty, the dry). The northern drainage cuts through the Hunayk monzogranite mountains on the north bank of the wadi, and Burj dolomite-shale and Salib arkosic sandstone on the south bank of the wadi. The southern drainage cuts through Burj dolomite-shale and fluviatile gravel terraces. To the west, the wadis merge just east of where Wadi al-Jariya debouches into the Wadi al-Ghuwayba. Here, the Wadi al-Ghuwayba passes through the Hunayk monzogranite and Finan granitic formations, Salib arkosic sandstone, Burj dolomite-shale, and occasional terraces of fluviatile gravel. The wadi bed is composed of alluvium and wadi sediments (Figure 7.4). Just before the wadi empties into the Wadi 'Araba, it passes through a formation of Kurnub sandstone and aeolian sand and dunes in the northwestern-most extremities.

Wadi al-Jariya flows south from the Wadi ad-Dahal for 6.5 km until it empties into Wadi al-Ghuwayba approximately 1 km east of Khirbat en-Nahas. In the northernmost sections, the wadi is deeply incised and narrow, and would have served little purpose other than as a road to the plateau, and possibly a local water source (Thmilat al-Jariya, FBRS Site 59; see Chapter 5 [this volume] for description of the site and the ancient road). Here, the wadi flows through the Muwaqqar chalk marl, the Wadi Umm Ghudran



Figure 7.5 Wadi al-Jariya north of Khirbat al-Jariya.

chalk, and other chalky limestone formations (Figure 7.5). Three kilometers northeast of Khirbat al-Jariya, the wadi cuts through the Umm Ishrin sandstone. As the wadi flows south, it continues to pass through Burj dolomite-shale and Salib arkosic sandstone formations that are rich in copper ores, as well as a small area of fluviatile gravel beds. This area is also where the Iron Age copper smelting site Khirbat al-Jariya was established (Ben-Yosef et al. 2010). The southern portion of the wadi passes through the Hunayk monzogranite and some of the Salib arkosic sandstone. Here the wadi is very narrow—only a few meters wide in some places. Approximately 3 km south of Khirbat al-Jariya, the wadi flows into Wadi al-Ghuwayba.

Vegetation in the Wadi al-Jariya is sparse. Because the area receives little water, plant life is restricted to the most arid-adapted plants, such as *Haloxylon* and other small shrubs. The spring at the north end of the wadi produces little more than a trickle, so the wadi

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is usually dry. A few secondary small valleys connect to the Wadi al-Jariya from the east. These were also included in the survey area. Like Wadi al-Jariya, they have steep sandstone walls and cut through ore-bearing deposits. The wadi soils are composed of decomposing sandstone and granite. Rough terrain and high relief also contribute to the lack of suitable agricultural land. In short, the lack of water, good soil, and areas of low relief restricted any type of permanent settlement in the region.

Survey Design, Recording Methodology, and Results from Previous Surveys

The main goal of the 1998 survey (Levy et al. 2001) was to provide a broad settlement context for ongoing and future excavations at five archaeological sites: Wadi Fidan 001 (also known as Tel Tifdan), a Pre-Pottery Neolithic B (PPNB) site (Levy et al. 2001; Twiss 2007, 2008); Wadi Fidan 4, an Early Bronze Age (EBA) I village (Adams and Genz 1995); Khirbat Hamra Ifdan, an EBA III to IV copper smelting site; Wadi Fidan 40 (Levy et al. 1999; Levy, Najjar, Muniz, et al. 2005), an Iron Age cemetery; and Khirbat en-Nahas, an Iron Age copper smelting site (Levy et al. 2004; Levy et al. 2008). The lack of systematic settlement surveys in the region was viewed as a hindrance to the interpretation of these sites when the project began in 1997. Thus, the 1998 survey aimed to clarify the regional dynamics of settlement within the study area, and the study presented here continues this goal by focusing on the Iron Age data.

In 1998, project members surveyed a 4.5-km^2 segment of Wadi Fidan in 10 days. During this time, seven surveyors walked transects at 50-m intervals. The survey boundaries included the area around Khirbat Hamra Ifdan and followed the wadi northwest to where it empties into the Wadi ʻAraba (Figure 7.6). In the small area, the surveyors recorded 125 sites, which were defined as "a distinct spatial clustering of artifacts, features, structures, and ecofact[s]" (Levy et al. 2001:173). Based on the results of the survey data, surveyors suggested that Wadi Fidan was a locus of copper smelting in the Early Bronze Age, while in the Iron Age copper production was carried out on a more limited scale.

In 2004, a 15-day archaeological pedestrian survey was carried out in the south section of the Wadi Fidan (data from this survey first published here). The survey began where the 1998 survey left off, to the southeast of Khirbat Hamra Ifdan, and continued for 250 m south of the ʻAyn Fidan. The objective of this survey was full coverage of 350 m of either side of the Wadi Fidan. Site perimeters were identified first by the most obvious contemporary architectural features, such as the Roman/Byzantine defensive structure at Wadi Fidan District (WFD) 617. If features of multiple periods were present (i.e., an Iron Age structure built over a Paleolithic flint field), then the site perimeter was established based on the largest feature perimeter. If a site contained isolated features (such as single walls or cairns), the site perimeter was established based on geological variables (e.g., a series of decayed limestone mounds). Environmental variables were also noted for each site. Digital photographs were taken of site overviews and important architectural features. Surface finds were sampled for each general site area and specific feature. Site perimeters and feature perimeters were mapped using a total station. Each site was given a general feature number and each feature given a separate feature number. These numbers were attached to each spatial data polygon and to the surface finds. A total of 33 sites were recorded in a 0.13-km^2 surveyed area (Figure 7.7). These ranged in type from Middle Paleolithic flint fields to modern Bedouin camp sites, with the majority being cairn fields and small clusters. Similar to the other surveys, many sites had multiperiod use.

The 2002 survey of Wadi al-Ghuwayba and Wadi al-Jariya (Levy et al. 2003) covered 12 km^2 in three weeks and was primarily aimed at contextualizing the Iron Age landscape around Khirbat en-Nahas prior to the first large-scale excavation (see Chapter 2, this volume). The survey team walked transects spaced up to 50 m apart. The survey boundaries included all areas within 250 m of the wadi channels. In total, the surveyors recorded 118 sites: 64 in Wadi al-Ghuwayba and 54 in Wadi al-Jariya (Figure 7.8).

It is important to note that this survey did not cover the upper reaches of both tributaries of Wadi al-Ghuwayba (al-ʻAtshana and al-Ghani, see above). These areas, particularly the region around the oasis of ʻAin al-Ghuwayba (Ghuweiba), are rich in archaeological sites, many of which were recorded by the Faynan-Busayra Regional Survey (Chapter 6, this volume, The Ras al-Miyah Archaeology Complex). However, significant portions of the region still await a detailed pedestrian survey, the data of which are necessary for comprehensive analysis of the water catchment as a whole.

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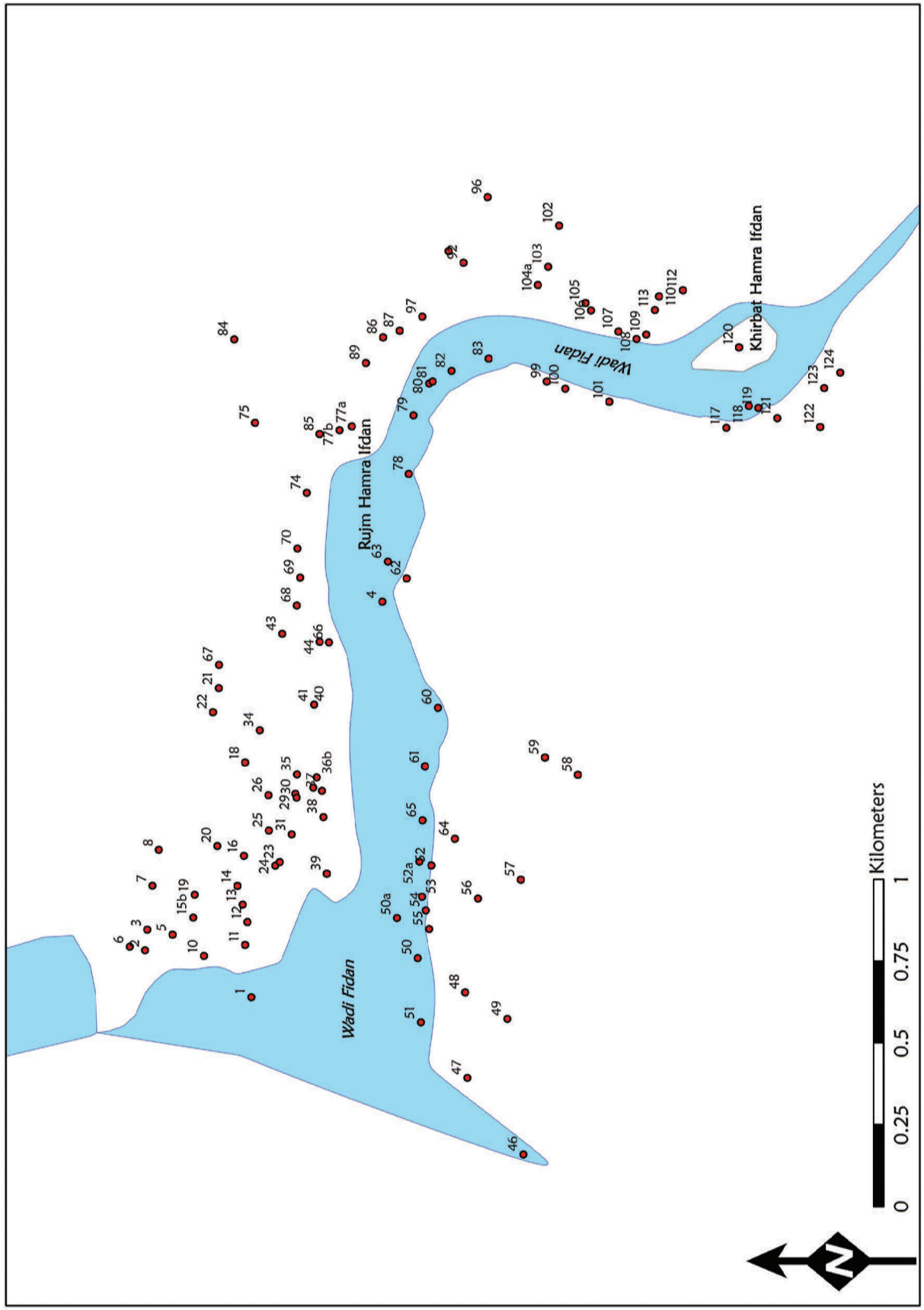

Figure 7.6 Map of all sites recorded during the 1998 Wadi Fidan survey.

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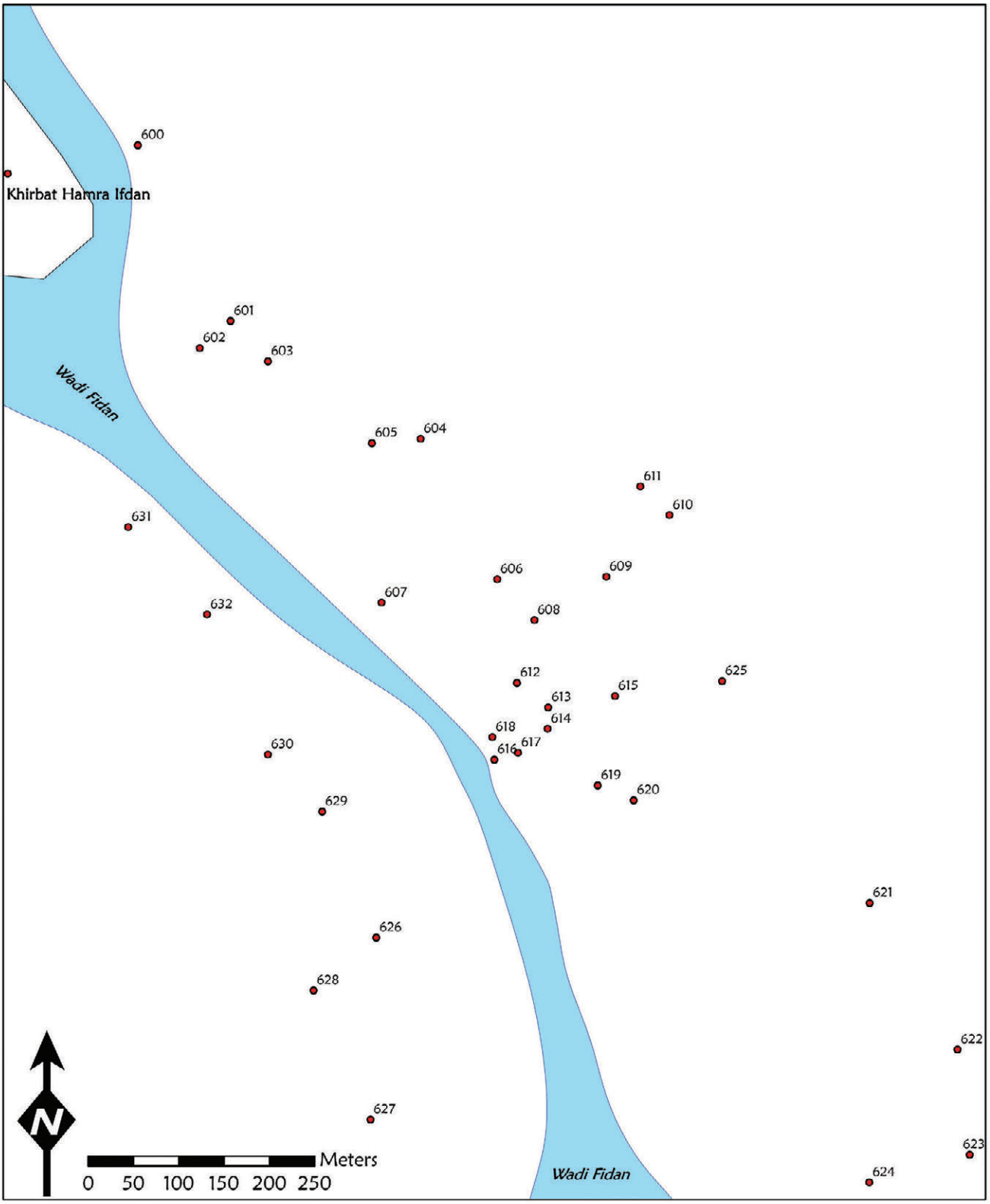

Figure 7.7 Map of all sites recorded during the 2004 Wadi Fidan survey. The 2004 survey area is located to the southeast of Khirbat Hamra Ifdan.

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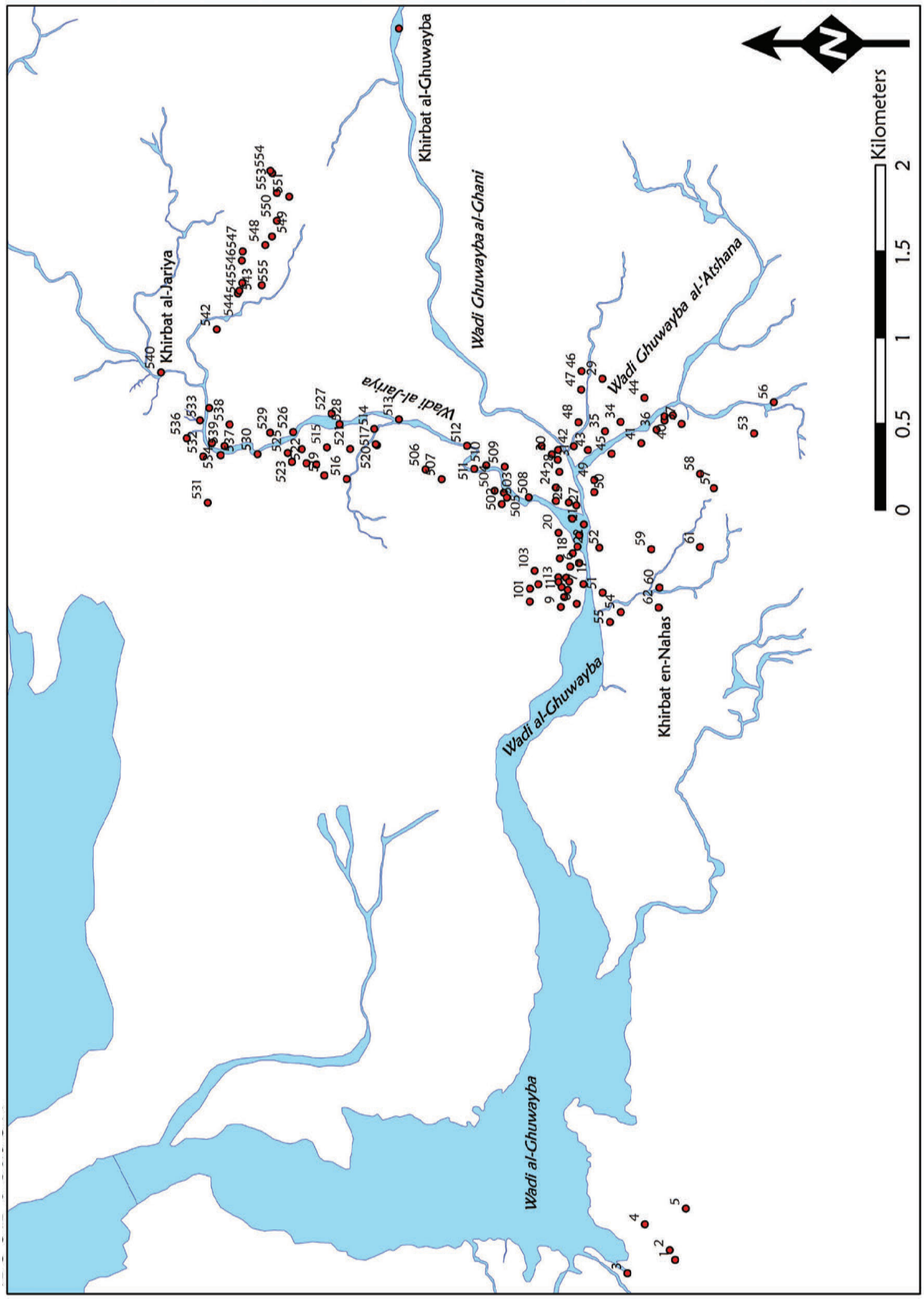

Figure 7.8 Map of all sites recorded during the 2002 Wadi al-Ghuwayba and Wadi al-Jariya survey.

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The most prominent of the sites in the Wadi al-Ghuwayba/Wadi al-Jariya survey are Khirbat en-Nahas, Khirbat al-Jariya, and Khirbat Nuqayb al-Asaymir. The smelting site of Khirbat en-Nahas forms the centerpiece of the Iron Age study presented in this volume. In addition, Khirbat al-Jariya is a key component of the earliest Iron Age copper production in Faynan (Ben-Yosef et al. 2010). Khirbat Nuqayb al-Asaymir is a Middle Islamic copper smelting site. A wide range of cultural and environmental variables were recorded for each site. Digital photographs were taken at each site and prominent architectural features were recorded using a Total Station. Topographic and architectural maps were made at each of the three major copper smelting sites. These data were then imported into ArcGIS for analysis and storage.

The 2007 survey of the Wadi al-Jariya was conducted over five weeks (data first published here). The total area surveyed was approximately 10 km^2. A total of 96 new sites were recorded in Wadi al-Jariya and two secondary drainages (Figure 7.9). Surface architecture and artifacts were used to identify sites. Diagnostic artifacts (lithics, pottery, glass) were collected to assign a relative date to the site. We used an Epoch 10 Differential GPS unit to record site locations with an accuracy of several centimeters. The GPS units were also used to map architectural and other features visible on the surface (see, e.g., Figure 7.93b). Digital photographs were taken of each site and of architectural features visible on the surface. Environmental data, the geological setting, and other natural and cultural variables were recorded on a standard form. All these data are linked in a geographic information system (GIS) that was used to create maps of the survey and will be used for further spatial analysis.

Iron Age Metallurgical Sites from Other Surveys

To contextualize the Iron Age finds of the ELRAP surveys, we provide here a short description of major Iron Age copper production sites in the Faynan region. More detailed description and discussion of the Iron Age settlement pattern appears in Chapter 12, this volume.

Umm ez-Zuhur Mines. Umm ez-Zuhur is a mining area located between Wadi Fidan and Wadi al-Ghuwayba (Figure 7.10). This complex was first reported by the Deutsches Bergbau-Museum (DBM) team. The mining area consists of 24 tailings containing Burj dolomite-shale (BDS) mining waste, several galleries that were exposed through erosion and are now visible in the wadis, and one mine entrance, also exposed by erosion (Hauptmann 2007:130–131; Weisgerber 2006:14). Hauptmann (2007:131) dates the tailings to the Iron Age II. No mines or tailings were recorded during the 1998 and 2004 surveys of Wadi Fidan, and as such, Umm ez-Zuhur probably represents the ore source for the minor Iron Age smelting sites in Wadi Fidan, including Khirbat Hamra Ifdan (WFD 120) and Rujm Hamra Ifdan (WFD 77a). These mines likely supplied ore to Khirbat Hamra Ifdan during the Early Bronze Age.

Barqa al-Hatiya. Barqa al-Hatiya is a small Early Bronze Age and Iron Age smelting site located approximately 5 km south of Wadi Fidan. Of the four houses at the site, three date to the Early Bronze Age, while the last has been dated as Iron Age I (Adams 2003; Fritz 1994; Hauptmann 2007:142). A radiocarbon date for this building, however, places the occupation in the ninth century BCE (Ben-Yosef 2010; Levy et al. 1999). It is possible that the mines in Umm ez-Zuhur also provided the ore for Barqa el-Hetiye, in addition to the smelting sites in Wadi Fidan (Hauptmann 2007:142).

Jabal al-Jariya Pit Mines, Khirbat al-Ghuwayba, and Ras al-Miyah Mines. These sites, visited during the 2007 Faynan-Busayra Regional Survey (FBRS), are presented in detail in the chapter by Ben-Yosef et al. (this volume; see also Chapter 11). Of particular interest for the current discussion is the Jabal al-Jariya pit mine field, which was dated to the Iron Age primarily based on its location near the smelting centers of Khirbat en-Nahas and Khirbat al-Jariya; it is likely that these mines represent one of the most important Iron Age ore sources in Faynan (Ben-Yosef et al. 2009). Preliminary optically stimulated luminescence (OSL) dating of one of the pit mines sampled in 2009 confirms an Iron Age date (Ben-Yosef 2010).

Ras an-Naqb. Ras an-Naqb is a primarily Early Bronze Age II/III site approximately 4 km southeast of Khirbat en-Nahas. One slag mound at the site, containing around 100 tons of smelting debris, has been dated to the Iron Age II based on associated pottery and the slag itself. Hauptmann (2007:123) suggests that this slag mound was probably the result of Iron Age recycling of Early Bronze Age II/III slag to extract the remaining metal.

Khirbat Faynan. Although the surface of Khirbat Faynan is dominated by Byzantine period architectural

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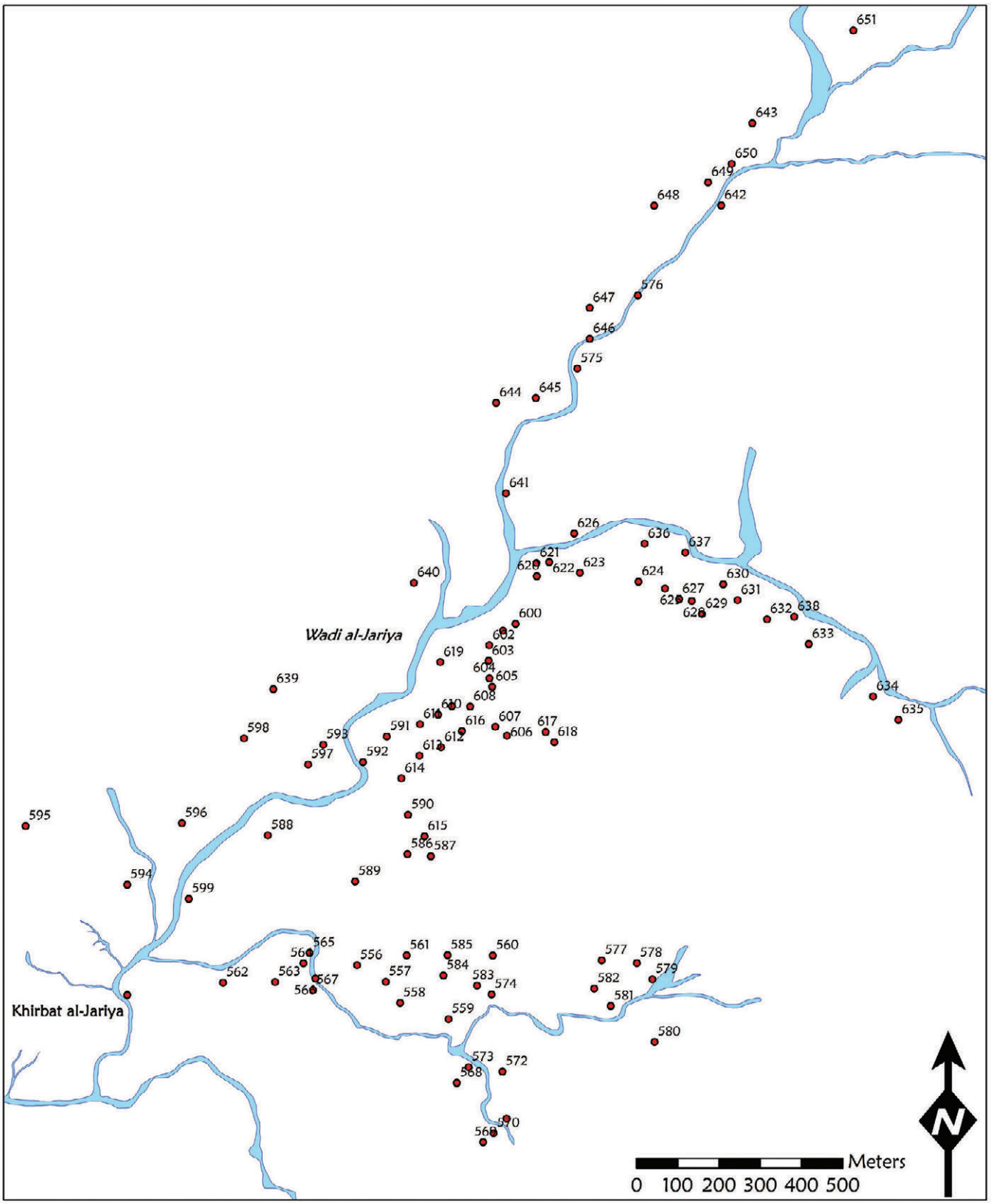

Figure 7.9 Map of all sites recorded during the 2007 Wadi al-Jariya survey.

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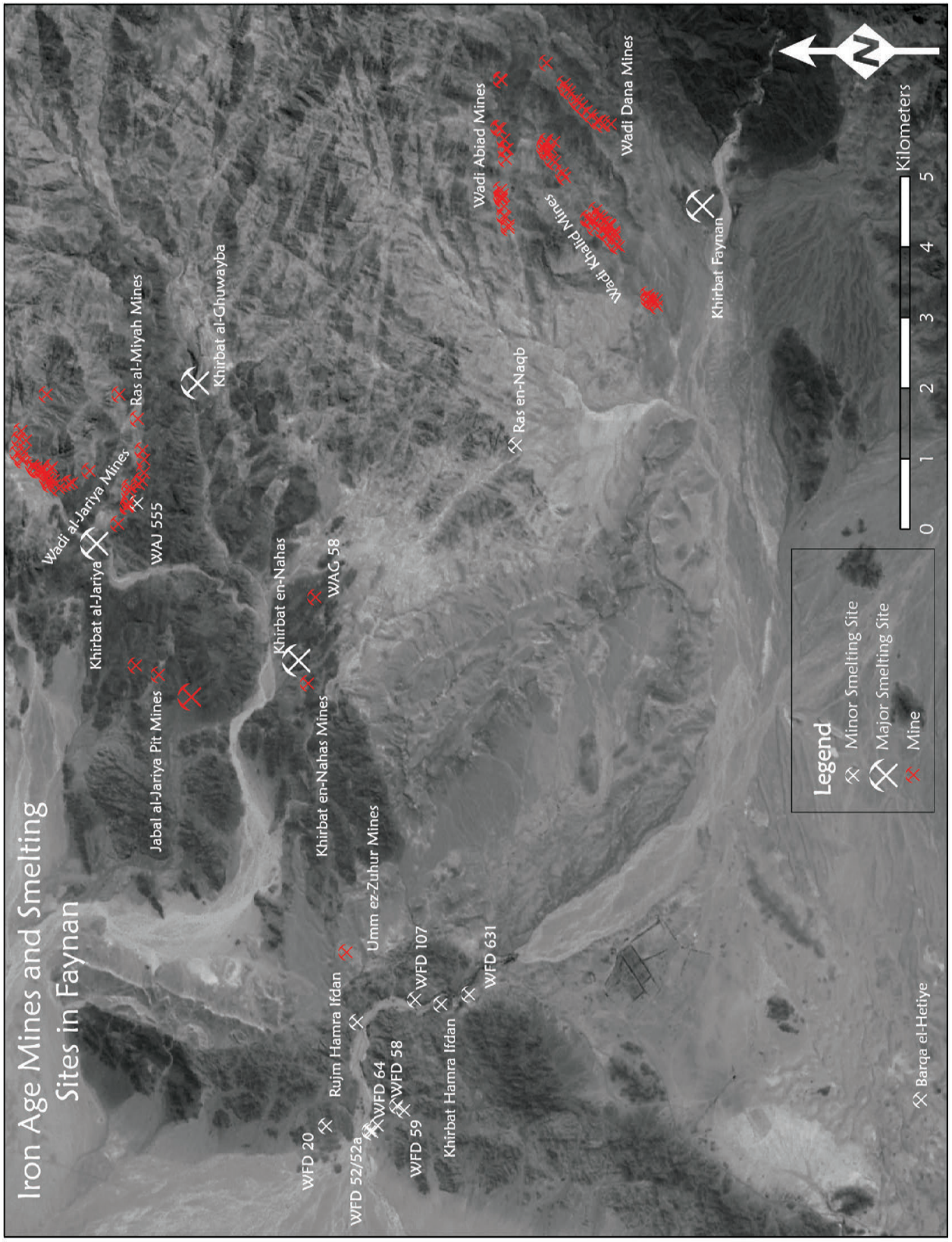

Figure 7.10 Map of all major Iron Age mining and smelting sites located in the Faynan district. *Background image: (C) CNES/SPOT Image 1992–1994.*

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remains, there are many Iron Age slag mounds around the site in addition to smelting debris from other periods (Hauptmann 2007:94–109; Musil 1907). Previous surveys by the DBM (Hauptmann 2007) and Council for British Research in the Levant (CBRL) (Barker et al. 2007), which have focused on Khirbat Faynan and the area surrounding it, have generally broken it up into many "sites," with each slag mound and many other features being assigned individual site numbers. Hauptmann (2007:97) notes, however, that the Iron Age slag mounds surrounding the site are probably connected to one another, although it is not possible to prove this without excavation. North of the tell itself, there is also a "field system," called WF424 by the CBRL team, containing nonagricultural buildings and evidence of smelting activities, which dates to the Iron Age (Mattingly et al. 2007:278–279). Several agricultural field systems also yielded Iron Age sherds in the area around Khirbat Faynan, although much of the evidence for Iron Age farming has been obscured or destroyed by later activity (Mattingly et al. 2007:282–285). All of this suggests that Khirbat Faynan was a center of both settlement and copper production in the Iron Age.

Beyond this, however, the Iron Age occupation of Khirbat Faynan is not well understood. Ben-Yosef et al. (Chapter 12, this volume) discuss the possible political and economic significance of the site in the early history of Edom, but little can be said for certain. Likewise, the connection between the copper production activities at Khirbat Faynan and the smelting sites in Wadi Fidan, Wadi al-Ghuwayba, and Wadi al-Jariya is not clear.

Wadi Abyad. The Wadi Abyad mining district contains two sets of mines. There are 10 Roman mines dug into previous Chalcolithic mines exploiting the Umm 'Ishrin sandstone, as well as 14 tailing piles from the BDS in the bottom of the wadi, which were dated as Iron Age II based on associated ceramics (Hauptmann 2007:115–116). Based on their location, the mines in Wadi Abiad were most likely associated with smelting activities at Khirbat Faynan (see Chapter 12 and Figure 12.5, this volume).

Wadi Khalid Mines. The mining district in Wadi Khalid consists of 56 mines, all exploiting deposits in the BDS. The mines were exploited for a long period, and evidence for mining activity in the Early Bronze Age, Late Bronze Age, Iron Age, and Roman period has been found (Hauptmann 2007:116–121). Like the mines in Wadi Abiad, it is likely that mining activities here were devoted to obtaining ore to be smelted at Khirbat Faynan (see Chapter 12 and Figure 12.6, this volume).

Wadi Dana Mines. Wadi Dana contains 14 mines that date to the Early Bronze Age and Iron Age (Hauptmann 2007:122). These mines are even closer to Khirbat Faynan than the mines in Wadi Abiad or Wadi Khalid, and like both of those mining districts, the mines in Wadi Dana are probably related to copper production activities at Khirbat Faynan (see Chapter 12 and Figure 12.7, this volume). The following section presents descriptions of the Iron Age sites recorded during the four surveys under discussion, organized by site type.

Results of the Surveys

The classification of archaeological sites into categories is a necessary but somewhat arbitrary process. There is little consistency regarding site type classifications in the Mediterranean, which is why explicitly stating the criteria used to determine site categories, whether descriptive or functional, is so important. The types described below apply to only those sites that have an Iron Age occupation.

Agricultural Sites

Only two Iron Age agricultural sites were recorded by ELRAP team members, both in Wadi Fidan. The category is defined as sites that exhibit evidence only of agricultural features and do not have evidence of a settlement nearby. Sites that were interpreted as serving an agricultural function were usually made up of a terrace or field system and often had irrigation channels.

WFD 007 is composed of two small dams in the wadi separating clusters of possible structures or field walls. The measured size of this site is 1,700 m^2. Two circular features were also recorded close to the site. Eleven of the 13 ceramic sherds collected from the site date to the Iron Age.

WFD 019 is located in a small wadi that branches off of Wadi Fidan, about 70 m south of WFD 007. The site consists of several walls varying from one to three preserved courses, which extend over an area of 1,700 m^2. Most of the wall lines follow natural contours and appear to cut across a drainage channel, although the walls in the channel are quite eroded. These walls stretch for over 50 m, forming a rectangle in the valley. The walls may have been used as part of an ancient terrace system. Thirty-one sherds were collected at the site, all of which date to the Iron Age.

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Architecture Fragment Sites

Architecture fragments are defined as sites containing surface remains that were most likely part of a building, but their function is unclear and the density of architectural remains is lower than at a settlement site. The definition is intentionally vague due to the prevalence of poorly preserved and ephemeral sites encountered during the survey. One architecture fragment from the Iron Age was recorded during the ELRAP surveys.

WAJ 640, a site that spans approximately 600 m on the west side of Wadi al-Jariya, was the only architecture fragment site from which we collected Iron Age ceramics. Each feature, located on a low, sandy plateau above the wadi, is separated by small drainages that run perpendicular to Wadi Jariya. The site is composed of poorly preserved architecture fragments (Figures 7.11 and 7.12) that may have been part of a campsite. A number of cairns and circular features (Figures 7.13 and 7.14) were also recorded. The features at this site are spread sporadically across the wadi terrace.

Cairns

We define *cairns* as large rock piles lacking surface evidence that the feature or features were used as graves or as structures. This category is another intentionally neutral term that results from the uncertainty of interpretable materials found at the site.

WFD 010 is a group of five cairns spread over several hilltops north of Wadi Fidan. The cairns and associated artifacts were recorded within an area of 200 m^2. Four Iron Age body sherds were collected from this site.



Figure 7.11 View south at several eroded architecture fragments built of stone against a hillside at WAJ 640.



Figure 7.12 Another view of WAJ 640, with an eroded architecture fragment visible in the foreground. The feature has been constructed on a low, flat terrace above the wadi channel.



Figure 7.13 A circular depression at WAJ 640, now overgrown with *Anabasis* shrubs.



Figure 7.14 A circular feature incorporating a larger standing stone at WAJ 640.

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WFD 014 is a single small cairn, roughly 400 m southeast of WFD 010, surrounded by many lithic flakes and debitage. A single Iron Age sherd was collected near the cairn.

WFD 015 is a small site consisting of two cairns (015a and 015b) on a hilltop, one with standing stones. Each cairn is 4 m in diameter. Although no ceramics were collected at WFD 015, the site was dated to the Iron Age based on its proximity to WFD 007, an Iron Age agricultural site (Figures 7.15 and 7.16). Located near the mouth of the Wadi Fidan overlooking the Wadi 'Araba, these standing stone features may have been territorial markers near one of the main western entrances to Faynan.

WFD 067 consists of three cairns on the northern slope of the drainage, constructed within an area of 1,000 m^2. The cairns are composed of diorite and sandstone, which stand out against the surrounding peaks of granite. Thus, these features may have marked a pathway or trail. In addition to the cairns, the surveyors observed a small scatter of slag.

WFD 089 is a group of four cairns associated with a relatively dense Iron Age pottery scatter within an area of 25 m^2. Thirty-three Iron Age sherds, including a painted rim, were collected from the site.

WFD 602 is located on a flat ridge on the northern side of Wadi Fidan, near Khirbat Hamra Ifdan. There is a circular feature, most likely an eroded cairn, near the center of the site, around which was found a concentration of Iron Age pottery (Figure 7.17). The site also contains eight stone circles running in a northwest–southeast line, as well as three very short single-course wall lines and a cairn. Three small rectangular features were also observed, possibly related to recent use of the site as a campsite. In addition to these architectural features, a substantial lithic scatter dating to the Paleolithic was also found. These features are spread over an area of 6,800 m^2.

WFD 630, a cluster of four oval-shaped cairns that range in size from 2 to 4 m, is oriented roughly from east to west along the top of a high hill between two small wadis. The site was measured to make up an area of 150 m^2 within which four sherds of Negebite ware were collected.

WFD 631 is a group of cairns and stone circles located approximately 600 m south of Khirbat Hamra Ifdan. Between the concentration of cairns and the concentration of stone circles is a scatter of slag. Iron Age and Roman/Byzantine pottery was collected at the site, as well as numerous lithic flakes within an area of 200 m^2.

WAG 059 is situated on the eastern end of the plateau bounding Wadi Nuqayb al-Asaymir to the north. Clear views of Khirbat en-Nahas and Wadi al-Ghuwayba are afforded from all features at this site (4,300 m^2), which consists of one cairn approximately 1.5 m in diameter, along with six fragmentary cairns in the form of concentrations of eroded shale slabs. A large sample of Iron Age pottery, along with slag, was recovered from the surface immediately surrounding the six cairn fragments.

WAJ 515 includes an area of 5,900 m^2 to the west of Wadi al-Jariya. A number of cairns are present throughout the site (Figures 7.18 and 7.19), mainly in the west. Two circular features, one in the eastern part of the site and one near the center, are also present. Two short wall lines were found in the western part of the site. Iron Age pottery was collected at the central circular feature and the surrounding area.



Figure 7.15 Feature A at WFD 15, a small cairn incorporating a standing stone.



Figure 7.16 Looking north from feature B at WFD 15, a small cairn.

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Figure 7.17 The prominent circular feature at the center of WFD 602. A dense concentration of Iron Age pottery was found around this feature.



Figure 7.18 One of several cairns concentrated in the western portion of WAJ 515.



Figure 7.19 One of two short wall lines present in the western part of WAJ 515.



Figure 7.20 A cairn built in a relatively cleared area at WAJ 523.

WAJ 522 is a cluster of seven badly preserved cairns, mostly concentrated along the south edge of a narrow strip of sediment bounded by gullies to the east, north, and south and by a cliff to the west. Ten sherds of Iron Age pottery were collected at the site. The total measured site size is 300 m^2.

WAJ 523 consists of nine cairns of varying sizes, most of which are concentrated at the central part of the site. The site measures 1,500 m^2 (Figures 7.20 and 7.21).

WAJ 527 is situated on an extensive field on the lower slopes of the granite range to the east of Wadi al-Jariya. The site extends over an area of 5,500 m^2 and consists of several cairns and crude stone circles found in a sparse scatter throughout the site (Figures 7.22 and 7.23).

WAJ 590 is a small site that consists of three small cairns on a rocky plateau 70 m east of Wadi al-Jariya. Although a small amount of Iron Age ceramics were collected from the site, which covers an area of 2,600 m^2, the features there were badly preserved.

WAJ 596 sits on a rocky plateau above Wadi al-Jariya. The site contains a variety of features, and it is difficult to define according to one site type. The primary features are four large cairns, one of which has a rock line that extends away from it about 2 m to the north. Within an area of 12,700 m^2, surveyors also recorded a tent clearance and a large rock circle, 5 m in diameter, constructed of large rocks placed on their side. Iron Age, Roman/Byzantine, and Islamic period pottery was collected at the site (Figures 7.24–7.27).

WAJ 641 (4,700 m^2) consists of three robbed cairns and a hearth on a sandy plateau above the junction of Wadi al-Jariya and a smaller wadi system. Robber trenches around the cairns were still visible during the 2007 season. Pottery collected at the site dated to the Iron Age and Roman/Byzantine periods (Figure 7.28).

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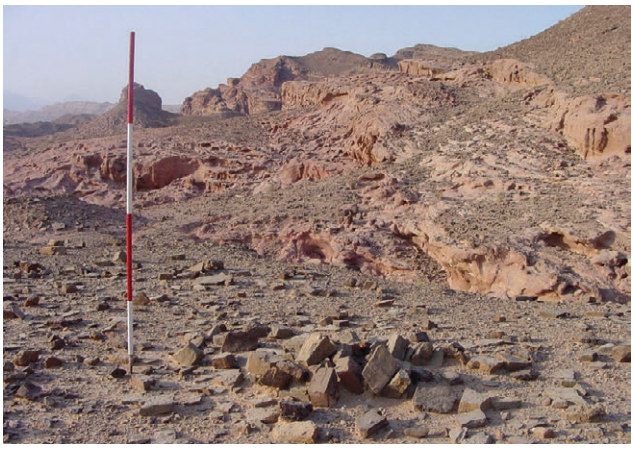

Figure 7.21 One of the small cairns recorded at WAJ 523.



Figure 7.22 One of the small stone circles found at WAJ 527.



Figure 7.23 A view south from a small cairn at WAJ 527, showing patches of *Haloxylon* and other scrub plants growing along the edges of Wadi al-Jariya.



Figure 7.24 Two of the cairns at WAJ 596, which sits atop a rocky plateau above Wadi al-Jariya.

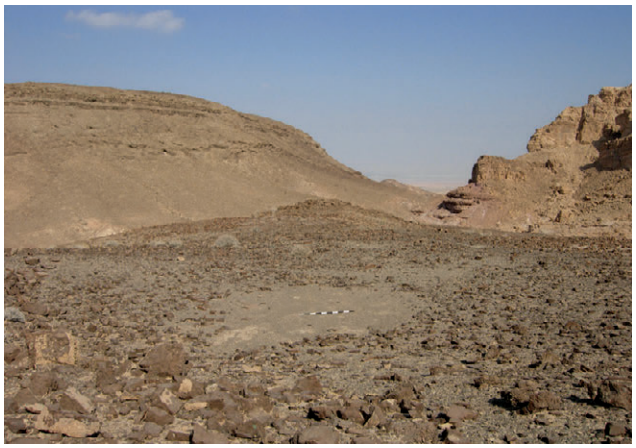

Figure 7.25 The tent clearing recorded in a field of stones at WAJ 596.



Figure 7.26 The largest of the four cairns found at WAJ 596.

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Figure 7.27 The large (ca. 5 m in diameter) circular feature at WAJ 596, constructed primarily of standing stones.



Figure 7.28 The robbed cairns that were found at WAJ 641.

Campsites

Sites identified as campsites consist of low-density and ephemeral habitation areas, often with at least one of the following characteristics: tent clearings, hearths, and animal pens. These site types are surprisingly absent from the Wadi Fidan and Wadi al-Ghuwayba surveys; Iron Age campsites were recorded only in Wadi al-Jariya.

WAJ 516 is an ancient campsite located approximately 250 m west of Wadi al-Jariya on small and relatively flat terrain, which is covered with eroded shale. The site encompasses an area of 3,000 m^2. A large rectangular feature, which probably represents a tent clearing, was found at the center of the site, and this feature has been divided into two uneven spaces. The largest of these spaces measures 14 x 10 m, and the small space measures 7 x 5 m. The feature is surrounded by 12 cairns. Considerable amounts of ceramics and some flint artifacts were found in and around the rectangular feature (Figures 7.29–7.30).

WAJ 521 is located on a topographic saddle around 250 m to the west of Wadi al-Jariya. The large rectilinear structure (Figure 7.31) is similar to other campsites recorded in Wadi al-Jariya and by the FBRS (see Chapter 5, this volume). In addition, there are more than 10 cairns at this site (3,200 m^2). At the highest point of the saddle, there is a stone circle measuring 4.5 m in diameter (Figure 7.32). A large amount of Iron Age pottery was collected



Figure 7.29 The large rectangular feature at the center of WAJ 516, probably a tent clearing.



Figure 7.30 One of the 12 cairns surrounding the large rectangular feature at WAJ 516.

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Figure 7.31 The large rectangular feature located at the high point of the topographic saddle at WAJ 521. This feature is most likely a tent clearing.



Figure 7.32 A view of the topography of WAJ 521, also showing one of the eroded cairns found at the site.



Figure 7.33 A view looking south across WAJ 530, highlighting the heavily eroded and ephemeral nature of most features at the site. Acacia trees, such as the one visible at the site in this photo, are more common in the southern portion of Wadi al-Jariya.



Figure 7.34 A heavily eroded tent clearing found at WAJ 562.

between the cairns and in the surrounding area. Some of the cairns appear to be relatively recent, but most seem to be much earlier.

WAJ 530 consists of a large number of various stone-built installations, most of which are poorly preserved and of unknown purpose. Several hearths and cairns are scattered throughout the site across an area of 14,000 m^2. None of the features at the site are more than 80 cm in diameter. Iron Age pottery and some slag were collected at the site, as well as some lithic artifacts (Figure 7.33).

WAJ 562 (1,900 m^2) is located on a low terrace below a sandstone outcrop to the south of a small wadi branching east off of Wadi al-Jariya. A small channel running north–south bisects the site. A number of tent clearings and other architecture fragments were observed, most of them in the western portion of the site: seven rectangular, two circular, and five highly fragmentary. Ceramics dating to the Iron Age and Late Islamic period were collected from the western part of the site (Figure 7.34).

WAJ 565 (200 m^2) is located on a low sandstone terrace above a small wadi. It is sheltered to the west by sandstone cliffs. The surveyors recorded a rectangular structure measuring 5 x 4 m and a stone circle approximately 2 m in diameter. These features probably represent the remains of a campsite. A groundstone mortar was also recorded in close proximity to the site (Figure 7.35).

WAJ 586 (1,100 m^2) is located on a hill 50 m east of Wadi al-Jariya. The main feature at the site is rectangular and consists of two rock walls preserved to two to three courses, with much rock collapse and a possible doorway in the east wall. The northwest side of the feature takes advantage of a low sandstone outcrop to form the north and west walls. To the north of this feature is a rectangular depression that possibly served as a tent clearing. On the

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northern side of the hill is a tall cairn. A road built in the mid-twentieth century by the Jordan Natural Resources Authority (NRA) bisects the site in the northeast, and on the north side of this road are two small cairns. Ceramics dating to the Iron Age and Roman/Byzantine period were collected at the site (Figure 7.36).

WAJ 588 is located on a rocky hill and plateau above Wadi al-Jariya. The site (21,800 m^2) extends to both sides of the wadi, although most is on the east side. On the eastern side of the wadi, two large tumuli, one of which has been looted, were observed at the bottom of the hill, and much pottery was collected near this feature, especially near the looted tumulus. On top of this same hill are two hearths. Two rectangular terraces, one with clearly visible wall lines and one with wall lines that were less visible on the surface, were also noted. Two other terraces, one at the southern margins of the site, contained numerous rock circles identified by the survey team as graves. On the western side of the wadi is a small, sheltered terrace with the remains of a recent campsite, and to the north of this feature are five rock circles, also identified as graves (Figures 7.37 and 7.38).

WAJ 591 (1,000 m^2) consists of a small hearth, a tent clearance, and three cairns on a plateau above Wadi al-Jariya. Iron Age and Roman/Byzantine ceramics were collected at the site.

WAJ 593 (2,000 m^2) is located on a plateau on the western side of Wadi al-Jariya and consists of several square rooms, approximately 5 x 5 m, arranged around a central courtyard. A modern-looking wall faces the wadi and an NRA road goes up to the site from the wadi. At the south end of the site there is a small platform built of rock and cement. Iron Age, Roman/Byzantine, and modern ceramics were collected at the site (Figures 7.39 and 7.40).

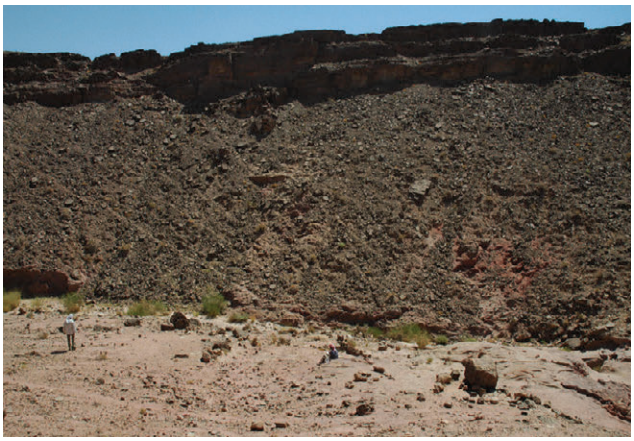

Figure 7.35 A view of WAJ 565, looking west toward the sandstone cliffs that shelter the site. In the left of the photo, two wall lines of a rectangular feature, probably the remnants of a tent clearing, can be seen.



Figure 7.36 The rectangular depression, probably a tent clearing, at WAJ 586. In the top left of the image, a road constructed by the NRA in the mid-twentieth century is visible.



Figure 7.37 One of two tent clearings (rectangular) identified at WAJ 588, with its accompanying hearth clearing (circular). At the top of the image, Wadi al-Jariya to the southeast is visible.



Figure 7.38 Two small cairns recorded at WAJ 588.

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WAJ 595 sits on a high plateau to the northwest of Khirbat al-Jariya. The site (8,800 m^2) provides spectacular views of Wadi al-Jariya, Wadi al-Ghuwayba, Khirbat al-Jariya, and even as far as the Wadi 'Araba. Features include a small tent clearance with a rock wall on the southeastern side of the site and a tumulus near the center of the site, which appears to be robbed. Some of the collapsed stones on this feature could be capstones. There are also small circular features in the eastern and southeastern parts of the site. Ceramics collected from the site date to the Iron Age, Roman period, and possibly the Early Bronze Age (Figures 7.41–7.45).



Figure 7.39 One of the rectangular features at WAJ 593, which was identified as a tent clearing.



Figure 7.40 Several wall lines at WAJ 593, arranged around the central cleared area.



Figure 7.41 Four circular features found at WAJ 595.



Figure 7.42 The tent clearing found in the southeastern part of WAJ 595.



Figure 7.43 The large robbed tumulus near the center of WAJ 595.



Figure 7.44 Looking west over the Wadi 'Araba from WAJ 595. The site commands views of Wadi al-Ghuwayba, Wadi al-Jariya, and west as far as the 'Araba.

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Figure 7.45 Looking southeast over Wadi al-Jariya from WAJ 595. Khirbat al-Jariya is visible in the center of the photo.



Figure 7.46 WFD 604—small circular fragment recorded during the 2004 survey of the Wadi Fidan, on the northeast bank above the wadi channel.

Cemeteries

Cemetery refers to an area with multiple features that mark graves, such as rock piles, stone circles, or groups of tumuli. The most prominent, and only securely dated, example of an Iron Age cemetery is WFD 040 (see Chapter 8, this volume). WFD 040, a large Iron Age cemetery located to the north of Wadi Fidan, was excavated as part of the JHF and ELRAP projects during the 1997, 2003, 2004, and 2009 field seasons. See Chapter 9 (this volume) for a detailed presentation of this site.



Figure 7.47 A larger circular feature, pictured here, was also recorded at WFD 604, on a flat, rock terrace above Wadi Fidan. View is to the east.

Circular Features

This is another category that is intentionally vague. A circular feature is defined by rounded walls that cannot be definitively identified as part of a building and may vary greatly in size.

WFD 013 (70 m^2) consists of two small circular features located next to a cluster of standing stones. One of the circular features showed signs of paving on the surface. The standing stones are oriented on an east–west axis, and stand up to 1 m in height.

WFD 604 (5,200 m^2) consists of two circular features (Figures 7.46 and 7.47), between 1 and 3 m in diameter, on the northeast bank of the Wadi Fidan. In addition, surveyors recorded a large wall fragment (Figure 7.48) that is 6 m long and two courses wide, as well as an architectural fragment that may be rectangular in shape but no more than a few meters wide.

WAG 024 is situated on a terrace north of Wadi al-Ghuwayba, near the junction of Wadi Ghuwayba al-Ghani and Wadi Ghuwayba al-'Atshana. The site (4,500 m^2) is bounded in the north by a smaller drainage, which runs east–west. Numerous extensively



Figure 7.48 A single-course, partially buried wall line makes up one of the features at WFD 604. Wadi Fidan can be seen in the background, below the Jabal Hamrat Fidan mountains.

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Figure 7.49 One of the circular features recorded at WAG 24, on a terrace above the Wadi al-Ghuwayba, which is visible in the background. Orientation to the north.



Figure 7.50 Another circular feature at WAG 24, in Wadi al-Ghuwayba. Like the previous feature, this one was constructed on a terrace just above the wadi.

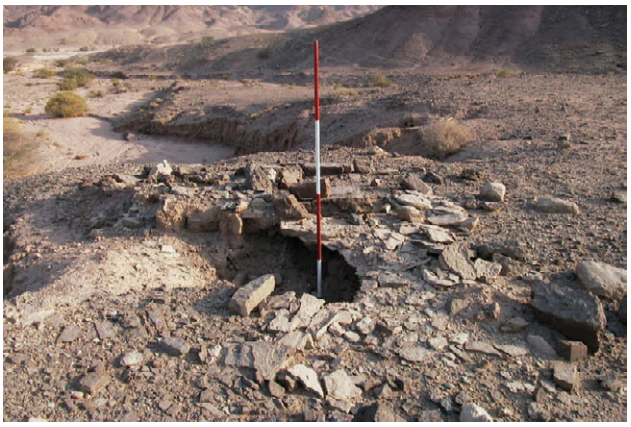

Figure 7.51 This circular feature at WAG 60 has been heavily disturbed by looters. Similar to WAG 24, this feature was constructed on the bank above Wadi al-Ghuwayba.



Figure 7.52 WAJ 61, a series of circular features and cairns on a hill above Khirbat en-Nahas. From the terrace, the site commands an excellent view of Wadi al-Ghuwayba, Wadi Nuqayb al-Asaymir, and Khirbat en-Nahas.

eroded circular features (Figures 7.49 and 7.50) are scattered over the surface of the site, although four more well-preserved examples were recorded in the southern part of the site. Three fragmentary stone circles were also found. Many lithic artifacts were collected, as well as six Iron Age sherds. A small amount of copper ore was also collected.

WAG 060 (150 m^2) is located on a hillock surrounded by drainages at the mouth of Wadi Nuqayb al-Asaymir. To the west of the site, a small wadi running north–south separates WAG 60 from Khirbat en-Nahas. In the western part of the site is a large, circular feature (Figure 7.51), which has been robbed. In addition to this feature, a cairn was recorded at the eastern part of the site.

WAG 61 (2,700 m^2) is located on the western end of the plateau bounding Wadi Nuqayb al-Asaymir to the south. The site follows the cliff line and has a clear view of Khirbat en-Nahas and Wadi al-Ghuwayba to the northwest. Eleven circular features were identified (Figure 7.52), along with 31 irregular-shaped cairns.

Located along the western bank of Wadi al-Jariya, WAJ 514 is 1,200 m^2 in area. The site is situated on an elongated strip of an alluvial fan cut by gullies, which bound the site on all sides with the exception of the east, where it is bounded by the wadi. Despite the relatively large size of the site, very few structures were recorded. These include two circular features, a cairn, and various poorly preserved installations, which measure no more than 1.5 m in diameter (Figure 7.53).

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Figure 7.53 Stone circle at WAJ 514. In the background, there is a possible circular feature.



Figure 7.54 One of the circular features recorded at WAJ 537. Wadi al-Jariya can be seen in the background.

WAJ 520 is an impressive site that may be a cemetery. The site (33,600 m^2) is located on a plateau 50 m west of Wadi al-Jariya. Dozens of cairns are scattered on the surface, with varying degrees of preservation. The survey team made a conservative estimate of between 40 and 50 cairns at the site. On the northeastern edge of the site, there is an isolated, rectangular accumulation of rocks that may represent a demolished structure containing several rooms. The surveyors noted an unusual density of ceramics throughout the site compared to other nearby sites, although the density of pottery was noticeably lower near the tumuli. The majority of ceramics collected at the site are Iron Age, with others dating to the Roman/Byzantine periods and possibly the Early Bronze Age.

WAJ 535 is situated on a small plateau between a narrow wadi gorge and granite hillocks. The site is found on the western part of the plateau, where two small (less than 1 m in diameter) circular features were found a meter apart. There is a fragmentary wall adjacent to these features.

WAJ 537 (4,300 m^2) sits on a flat, sandy plateau above and to the southwest of Wadi al-Jariya. It consists of several circular features (Figures 7.54 and 7.55), cairns, and wall lines. The site covers a large area, but the density of archaeological remains is low. Some lithic artifacts, copper ore, slag, and a copper object were found, as well as a small quantity of pottery that dates to the Iron Age and possibly the Early Bronze Age.

WAJ 561 (60 m^2) consists of a small half-circle of rocks stacked against a rock outcrop. A bedrock mortar was recorded on top of the outcrop. The half-circle of rocks may have been used as a hearth or storage area.



Figure 7.55 Another well-preserved stone circular feature recorded at WAJ 537.

WAJ 564 sits on a low sandstone shelf above a small wadi, sheltered to the west by sandstone cliffs. Approximately eight circular features were recorded, varying from 1 to 3 m in diameter. The site extends over an area of 150 m^2.

WAJ 574 (700 m^2) is located on a rocky plateau south of WAJ 560, a mine. This site takes advantage of a natural rock outcrop to form one side of a wall. Two rock walls are roughly perpendicular to the outcrop and the south side is open (Figure 7.56). The surveyors recorded a stone circle at the southern end of the structure, and nearby are a hearth and two cairns. This site probably functioned as a temporary camp for the people working in the mines nearby.

WAJ 575 was recorded on a low step above the wadi, on a sandy and rocky surface. It consists of a poorly preserved circular feature approximately 2.5 x 4 m. We observed two additional small circular features (Figure

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Figure 7.56 WAJ 574, a circular feature built against a natural stone outcrop. The person in the photo stands on the outcrop, which forms a shelf and was used as a wall. The other two walls extend for approximately 3 m perpendicular to the wall, forming a horseshoe-shaped feature.



Figure 7.57 A small rock circle feature with a standing stone that is part of WAJ 575.

7.57) near the rock circle and a single post hole near the wadi channel. The site, which may have functioned as a campsite, comprises an area of 250 m^2.

WAJ 582 (20 m^2) is situated on a low sandy hill at the end of a small wadi surrounded by sandstone cliffs, near ancient mines and a possible ancient road to the Ras al-Miyah fortresses (see Chapter 11, this volume). Two circular features, one partial and one complete, were identified. Each one measures about 2 x 1 m. The features may have been used as a road marker of some kind. The area has been damaged by heavy bulldozing and erosion (Figure 7.58).



Figure 7.58 Overview of WAJ 582, which is composed of circular features that have been disturbed by bulldozing and erosion.

Metallurgical Sites

This category refers to smelting sites and ore-processing sites. Metallurgical sites include anything from a small scatter of slag to a large smelting site, such as Khirbat en-Nahas or Khirbat al-Jariya.

WFD 020 is one of the smallest metallurgical sites (1 m^2) found in the Wadi Fidan and consists of a scatter of copper ore on a hilltop not associated with other artifacts. Ore does not occur here naturally.

WFD 052 (6,500 m^2) is a complex site, composed of numerous walls (Figure 7.59) in association with a small drainage (Figure 6.60) alongside a Pleistocene conglomerate outcropping. The site extends westward, where the surveyors recorded three large rectilinear structures. The dimensions of the structures are approximately 10x20 m. Pieces of slag are scattered uniformly across the site. Five cairns mark the southern extent of the recorded site boundaries. Another set of features, called WFD 52a, consists of three semicircular stone structures on a slope of a conglomerate outcrop. The survey team collected crucible fragments, indicating the use of this feature as a copper production area. Ceramics collected from WFD 52 and 52a date to the Early Bronze Age, Iron Age, and Roman/Byzantine periods. The four Iron Age sherds make up about one-third of the ceramics collected from the site.

WFD 058 is a relatively large (4,700 m^2) area littered with large quantities of slag, also discussed in Chapter 11, this volume. Fifteen rock piles were observed on the surface, which may represent small smelting installations. The site is also located near a small spring. Thirty Iron Age sherds and a crucible fragment were collected at the site.

WFD 077a, known as Rujm Hamra Ifdan (RHI), was excavated as part of ELRAP during the 2004 field season. Dates from the site have been published previously (Levy et al. 2008), and analysis of the site formed part of Smith's (2009) doctoral dissertation. The excavations at RHI are discussed in Chapters 10 and 12 (this volume).

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Figure 7.59 One of the walls recorded at WFD 52. Due to the presence of crucible fragments at the site, a metallurgical function is suggested. Wadi Fidan is visible in the background.



Figure 7.60 Overview of WFD 52 and the small drainage, where the team also recorded circular features. These can be seen to the left of the tree in the center of the picture.



Figure 7.61 One of the installations recorded at WAJ 511. Because of the high amount of copper slag found at the site, it has been classified as serving a metallurgical function.

WFD 120 refers to Khirbat Hamra Ifdan, a large copper production and settlement site that dates primarily to the Early Bronze Age III to IV but also has important Iron Age smelting evidence (see Chapter 12, this volume). The site was excavated as part of the JHF and ELRAP projects during the 1999, 2000, and 2007 field seasons. Preliminary results relating to the Early Bronze Age have been published by Levy et al. (2002), and the Early Bronze Age faunal assemblage was analyzed by Muniz (2007) as part of his doctoral dissertation. Metallurgical activity at KHI in the Iron Age has been shown through the use of both radiocarbon and archaeomagnetic dating, and these results, as well as a discussion of the 2007 excavation of an Iron Age slag mound at the site, are presented in Ben-Yosef's (2010) doctoral dissertation.

WAG 062 is the survey number given to Khirbat en-Nahas. The site (ca. 10 ha) was excavated during three seasons (2002, 2006, and 2009). Numerous aspects of the site have been published previously, including the pottery from the site (Smith 2009; Smith and Levy 2008), the metallurgical remains (Ben-Yosef 2010), and the site's impact on Iron Age chronology (Higham et al. 2005; Levy et al. 2004; Levy, Najjar, van der Plicht, et al. 2005; Levy et al. 2008). Detailed discussion of various aspects of the JHF and ELRAP excavations at KEN can be found in Chapters 2, 5, 8, and 13 (this volume).

WAJ 511 (1,100 m^2) is situated on a flat terrace to the east of Wadi al-Jariya. Its boundaries are naturally marked by small tributary wadis to the north and south, and a range of granite hills to the east. Three structures were observed at the site, of which only the corners can be seen above ground. These are built of stone to a maximum height of 1.5 m. The remains of several badly preserved walls or installations (Figure 7.61) were recorded at the northern end of the site. A limited amount of pottery dating to the Early Bronze Age, Iron Age II, and Roman/Byzantine period was collected, as were several flint artifacts. A relatively large quantity of copper slag was observed throughout the site.

WAJ 540 is the site number assigned to the Iron Age site of Khirbat al-Jariya, which was excavated during the 2006 field season (Ben-Yosef et al. 2010). The results of this small excavation, which focused mostly

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on Iron Age metallurgy, have been published previously (Ben-Yosef 2010; Ben-Yosef et al. 2010). For further discussion, see Chapter 12 (this volume).

WAJ 555 was identified as an ore-processing site. It is located in the valley bottom below the Iron Age mines at WAJ 546 and WAJ 547. Several cairns and stone circles were found here extending over an area of 700 m^2.

Mining Sites

This refers to a site where mine shafts, adits, or tailing piles were found. The majority of the mines that were found in the ELRAP surveys were associated with the Wadi al-Jariya. The locations of these mining areas have been noted by previous researchers (Hauptmann 2007; Rabb'a 1994), but the ELRAP surveys reported here were the first to systematically record the mining features in high detail. Site size is not presented here because it was impossible to accurately estimate the extent of each mine. However, in some cases, the surveyors measured the sizes of tailing piles (see Table 7.3). In these cases, the range of sizes is presented. Although the surveyors did not record evidence of Iron Age occupation at each mine, we believe a majority of the mines were used primarily during the Iron Age based on their proximity to the Iron Age smelting sites at Khirbat al-Jariya and Khirbat en-Nahas. In addition, Early Bronze Age materials are scarce, as are classical period finds. The nearest classical period site is the caravanserai excavated at Khirbat al-Ghuwayba. Mining sites were found in clusters during the 2002 and 2007 survey seasons. As such, clusters of mines and prominent features found there are presented, rather than descriptions of each mining site. In total, five clusters of mines were recorded and are presented below.

The first cluster of mines, recorded in 2002, was given the site number WAG 58. This group of mine shafts is located on a plateau to the north of Wadi Nuqayb al-Asaymir. Three mine shafts are visible on the surface, and these are surrounded by tailing piles (Figure 7.62). This mine extracted ore from the same mountain as the larger and primarily Middle Islamic mine site WAG 57, located just down the slope to the south. The mining at WAG 58 is of a smaller scale than WAG 57. Two sherds of Iron Age pottery were collected, as well as some slag. Based on location, it seems likely that the mines at WAG 58, like WAG 57, were reused as part of the Middle Islamic copper production at nearby Wadi Nuqayb al-Asaymir, in addition to their use during the Iron Age.

The second cluster of mines (WAJ 542–554) was recorded during the 2002 survey season. The mines are all clustered in a tributary wadi that lets out near Khirbat al-Jariya. While Iron Age ceramics were collected at only one of the sites, 548, they have all been treated as Iron Age mines due to their close proximity to the large Iron Age smelting site, Khirbat al-Jariya. Surface artifacts were scarce at these mines, and only at one other site were the surveyors able to collect ceramics: at WAJ 551, where they collected Roman/Byzantine ceramics. In addition, one quartzite hammer stone of unknown date was collected from WAJ 544, and four mining hammers, similar in style to those collected from Wadi Fidan 4, were collected from WAJ 548.

The third cluster of mines (WAJ 560, 572, 577, and 578; Figures 7.63–7.69) was recorded during the 2007 season in a tributary wadi connected to Wadi al-Jariya, just 100 m north of Khirbat al-Jariya. The tributary is



Figure 7.62 A possible infilled mineshaft at WAG 58. The site is composed of three infilled mineshafts that are surrounded by tailing piles.



Figure 7.63 WAJ 560, a large mine tailing pile that is part of the first cluster of mines recorded during the 2007 Wadi al-Jariya survey. The site has been heavily bulldozed by the Jordan Natural Resources Authority. For scale, note person standing above the tailing.

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Figure 7.64 A close-up of a section of the tailing pile at WAJ 560 that was exposed during bulldozing by the NRA.

bounded by sandstone cliffs and ascends gradually in elevation. There is an NRA road, and past the road, a path can be followed to the Ras al-Miyah fortresses. The surveyors recorded three mines in this area. WAJ 560 is a mineshaft and mine tailings covering an area of about 3,130 m^2 (Figures 7.63–7.65). The mine begins between two distinct sandstone formations on a steep hill. The site has been bulldozed by the NRA. One large swale goes up the mountain and cuts into the mine tailings. Other smaller tracks have moved the mine tailings and sandstone rocks in random directions. A large pile of sediment and mine tailings has been piled in the center of the site. The surveyors found a few pieces of pottery that date to the Iron Age.

WAJ 572 is a mineshaft that has been filled in with sediment and collapse (Figures 7.66–7.67). The shaft



Figure 7.65 A wall at the top of the tailing pile, which may have surrounded a shaft entrance that is now covered with collapse.



Figure 7.66 WAJ 572—a light scatter of copper ore and Iron Age ceramics below a collapsed mineshaft opening (see below).

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Figure 7.67 Collapsed mineshaft opening at WAJ 572.



Figure 7.68 WAJ 577—a possible mineshaft opening (above the north arrow) that has been filled with rock collapse and sediment.



Figure 7.69 A mine opening at WAJ 578. The opening has been enlarged by a bulldozer. The modern digging stops after about 10 m, after which the mine may open into a gallery or a shaft.

is about 1.5 m in diameter. Very few tailings were observed, suggesting that the mine might not have been used extensively.

North of the NRA road is another mine, labeled WAJ 577. The sandstone cliffs have been excavated and a possible shaft has been filled in with sediment (Figure 7.68). No finds were collected from this site.

The mine entrance at WAJ 578 was bulldozed by the NRA. A possible shaft or gallery may have been exposed by the NRA activity (Figure 7.69).

At the fourth cluster of mines, surveyed during the 2007 season, 19 distinct mining sites were recorded (WAJ 587, 600–615, and 617–618; Figures 7.70–7.83). These mines are located along the eastern side of the Wadi al-Jariya channel at the base of the sandstone cliffs that border the wadi. The cluster begins about 1.5 km north of Khirbat al-Jariya, extending north for about a kilometer. Most of these sites consist of mine tailing piles; the mineshafts have probably been filled in with sediments. The largest tailing pile covers an area of 15,580 m^2, and the smallest is a little more than 200 m^2. Iron Age ceramics were collected from the surface of 14 sites, while ceramics from other periods were collected from 9 sites. Early Bronze Age style mining hammers were collected from five of the tailing piles. Only one mine shaft (Figure 7.81) was recorded at the second cluster of mines, at WAJ 614. The shaft appeared to be approximately 7 to 10 m deep and was surrounded by tailings.

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Figure 7.70 WAJ 587—a large tailing pile that is part of the first cluster of mines recorded during the 2007 survey. The tailings are located in a small tributary wadi that connects to Wadi al-Jariya.



Figure 7.71 A small circular feature in the tailings of WAJ 587.



Figure 7.72 Four tailing piles on the east side of Wadi al-Jariya, which can be seen in the upper left part of the frame. The central tailing pile is WAJ 602. Tailing piles were recorded individually to measure their size and have better control over the surface artifacts collected during the survey.



Figure 7.73 Typical tailing piles at the second cluster in Wadi al-Jariya. In the foreground, WAJ 605 can be seen. The tailing piles are located on the east side of the wadi at the base of the sandstone cliffs. The view is approximately to the north.



Figure 7.74 A typical tailing pile at WAJ 607, in a small tributary on the east side of Wadi al-Jariya. The view is to the west.



Figure 7.75 Small, approximately 1 m in diameter, circular features found adjacent to the tailing pile at WAJ 607.

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Figure 7.76 WAJ 608—a large scatter of mine tailings on the east side of Wadi al-Jariya. The wadi is bounded here by high sandstone cliffs. Site 608 has been subject to substantial erosion, which has created a drainage channel that runs toward the bottom right of the image.

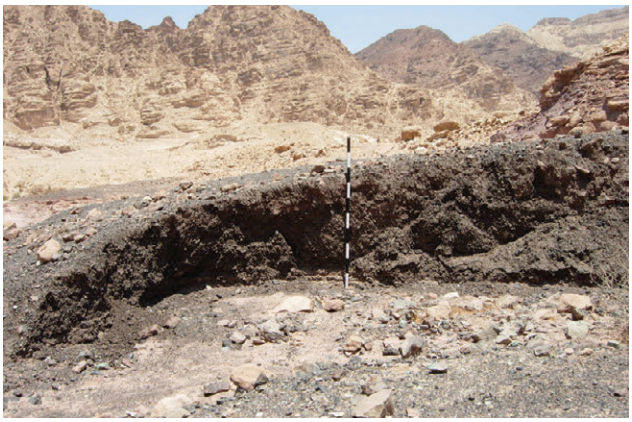

Figure 7.77 A cross section of the mine tailings at WAJ 608. The cut (perhaps by the NRA) shows that the tailings are over a meter deep in some areas.



Figure 7.78 A possible mine adit at WAJ 608. The small feature was eroded from weathering. Note the pencil placed for scale.



Figure 7.79 A small scatter of mine tailings (WAJ 612) at the base of a low cliff on the east side of the Wadi al-Jariya. The photo is oriented to the northwest. Wadi al-Jariya and Jabal al-Jariya are visible in the background. The Jabal al-Jariya mines are located to the west of the mountain (see Chapter 12, this volume).

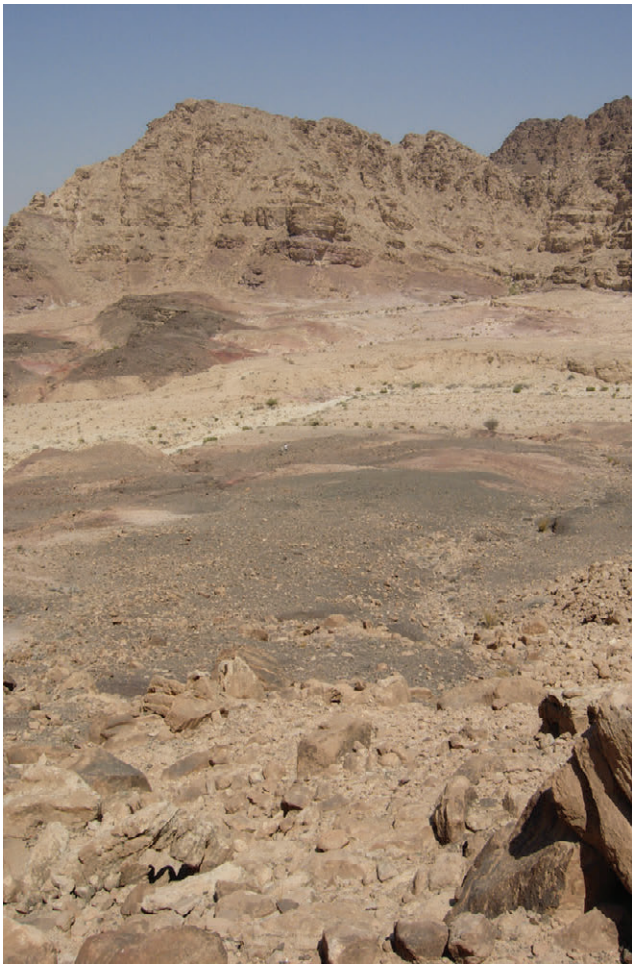

Figure 7.80 A large scatter of copper ore at WAJ 614, where surveyors also found a mineshaft (see next image). The view is to the west. Wadi al-Jariya is visible in the background.

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Figure 7.81 An open mineshaft at WAJ 614. The shaft measured about 1.5 m in diameter and extended to a depth of 10 m.



Figure 7.83 Copper ore mineralizations at WAJ 615. The ore was easily accessible near the surface of the site and along the floor of the channel (see previous image).



Figure 7.82 WAJ 615 was unlike any other mining feature the surveyors recorded. No mineshaft or gallery was visible, but the copper ore mineralization appeared to have been reached along the bottom of the channel. Toward the back, the ore could be extracted by digging into the small cliff. A few small mine tailing piles were recorded around the site.



Figure 7.84 WAJ 621: the entrance to a mineshaft or gallery, which opens toward Wadi al-Jariya, to the west. It has been filled in with sediment and collapse. The surrounding area contained few tailings. The tributary wadi where the third cluster of mines was found extends into the background (upper right).

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Sixteen mine sites were recorded in the fifth cluster (Figures 7.84–7.92): WAJ 620–629, WAJ 631–634, WAJ 636, and WAJ 637. These mines are north of the second cluster in a tributary wadi that connects to Wadi al-Jariya. These mines are all within 2 km of Khirbat al-Jariya. The tributary wadi is bounded by sandstone cliffs that cover the dolomite shale that contains copper mineralizations. The area has also been exploited by the NRA, who have constructed roads and cut into many existing mine tailing piles. Most of the sites recorded during the survey consist of mine tailing piles. These piles range in size from 200 to 7,750 m^2. Iron Age ceramics were collected from six of the recorded sites, while ceramics from other periods were collected from only four sites. Three mineshafts were recorded in association with mine tailing piles.



Figure 7.85 The entrance to WAJ 621. The opening would have been quite large before it was in filled with collapse and sediment.



Figure 7.86 WAJ 622 is a large pile of tailings eroding down a hill slope. There has been a great deal of NRA construction around this site, which has disturbed the archaeological remains. The site is located adjacent to Wadi al-Jariya, at the mouth of a tributary wadi.



Figure 7.87 One of the features at WAJ 623, the mouth of a possible mineshaft or mine gallery that has been filled with sediment. There are two smaller holes that have been dug into the sandstone to the right of the opening. The mine opens to the east, away from Wadi al-Jariya.



Figure 7.88 This tailing pile at WAJ 623 has had a trench dug through it, most likely by the NRA. View is oriented to the north. The small channel of the tributary wadi is visible in the background.

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Figure 7.89 A small tailing pile at WAJ 626. The tailings are located just above the modern wadi channel. A wall line is visible in the background (top center). The architecture most likely dates to the Late Islamic period, based on ceramics collected around those features.



Figure 7.90 A small architecture fragment at WAJ 626. Late Islamic (i.e., Ottoman period) ceramics were collected from the ephemeral architectural features at the site. Their relation to the mine tailings could not be established but most likely postdated the mining since no Late Islamic mining or smelting is known from Faynan.



Figure 7.91 WAJ 628—a large tailing pile is visible in the background, across the wadi. Construction and bulldozing by the NRA are visible in the foreground, and a modern road runs from the left to the right of the frame.



Figure 7.92 WAJ 629—a large pile of tailings covers the surface of the hill slope. A large, approximately 1-m-wide trench has been dug through the tailings. The modern wadi channel of the tributary wadi is visible in the background.

Rectangular Features

Rectangular features are another category that is intentionally vague. They are defined by features with rectilinear walls that cannot be definitively identified as part of a building.

WFD 062 contains a rectilinear structure, measuring 20 m^2 on a hilltop above WFD 4. One Iron Age pot sherd was collected from this site, which can only tentatively be dated to the Iron Age.

WFD 112 consists of a rectangular building measuring 22 x 8 m. It is a wide building with an entrance to the south. It is constructed of stone that is preserved to one course high. The east side is much better preserved; the surveyors recorded a plaster floor and two circular installations in center of building. Each installation is approximately 1 m in diameter. The building is on the edge of a plateau above the wadi and is surrounded on three directions by fields of cairns. There is a line of cairns, wall-like, stretching east to west for approximately 10 m to the south of the rectangular feature. The features were recorded within an area of 1,800 m^2. Seven Iron Age ceramic sherds were collected from the site, along with four Roman/Byzantine sherds.

Located on a plateau above Wadi al-Jariya, WAJ 643 (1,700 m^2) is approximately 1 km south of the

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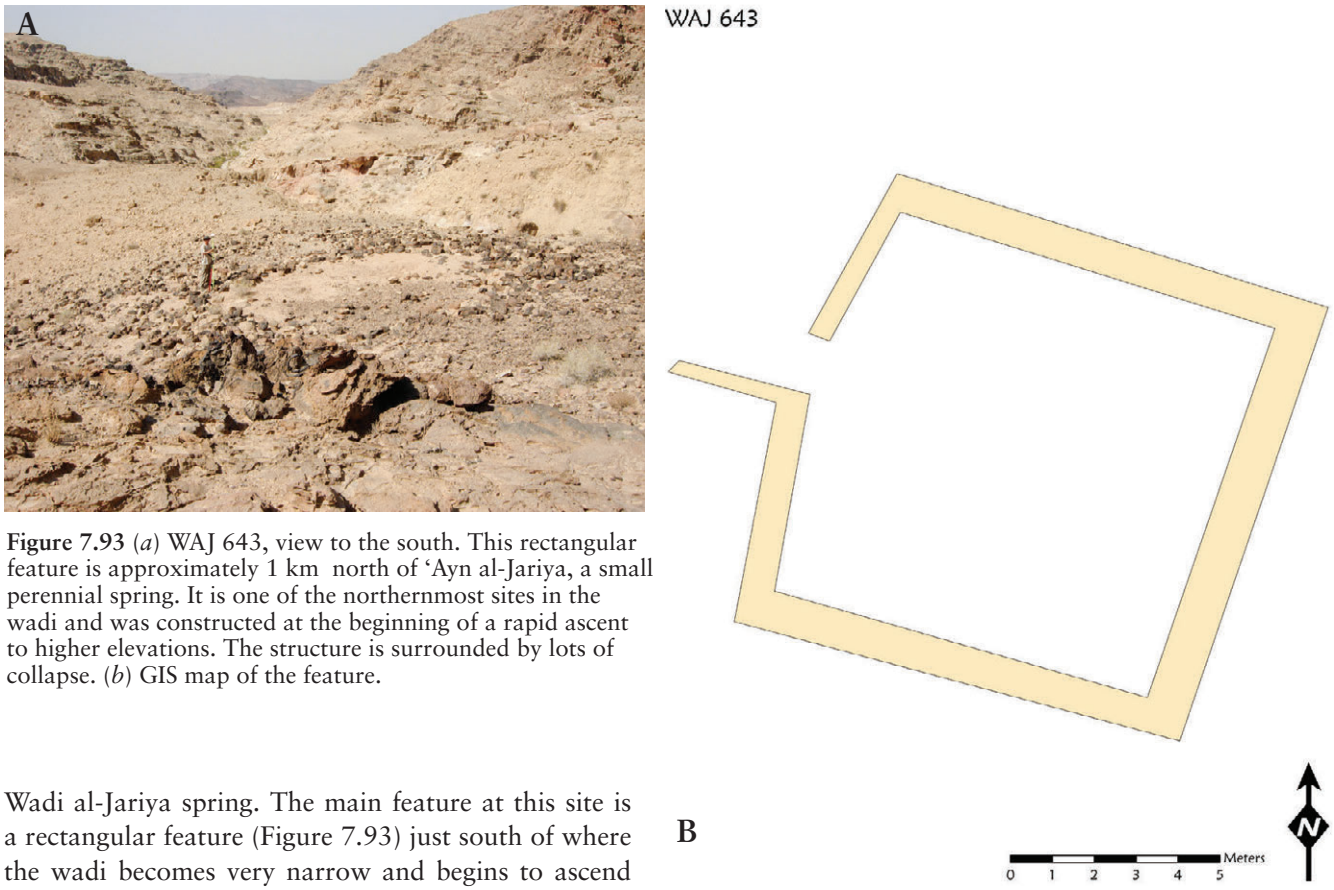

Figure 7.93 (*a*) WAJ 643, view to the south. This rectangular feature is approximately 1 km north of 'Ayn al-Jariya, a small perennial spring. It is one of the northernmost sites in the wadi and was constructed at the beginning of a rapid ascent to higher elevations. The structure is surrounded by lots of collapse. (*b*) GIS map of the feature.

Wadi al-Jariya spring. The main feature at this site is a rectangular feature (Figure 7.93) just south of where the wadi becomes very narrow and begins to ascend rapidly to higher elevations. The structure, which has collapsed, is oriented on a northeast to southwest axis, and there appears to be a doorway on the west side of the building near the northwest corner. This site may be related to the Iron Age road system that connected the Faynan district to the highlands (Chapter 6, this volume).

Rock Shelter

This category represents small, cave-like openings at the base of a cliff that contain evidence for human occupation or features that use an overhanging cliff as partial shelter. In general, rock shelters contain only ephemeral architecture, if there is any at all.

WAJ 518 (4,400 m^2) is located 250 m to the west of Wadi al-Jariya at the base of a small cliff. The site's boundaries are marked by gullies to the north and south, a small cairn field to the east, and a cliff face to the west. The site consists of five rock shelter complexes (Figure 7.94) with various stone built features and two semi-circular ruins at the eastern rock shelter. Some walls are preserved up to five courses of stone. A number of small structures, possibly storage facilities, were built throughout the site.



Figure 7.94 These small, circular wall features were constructed at the base of an overhanging cliff, forming a natural rock shelter. The site is located some distance from the Wadi al-Jariya—over 250 ms. They may be related to the campsites the survey team found in the same wadi system.

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Sherd Scatters

A sherd scatter is defined by a concentration of pottery found in an area with no visible architectural remains. This category may include pot drops or other, more dense and widespread assemblages of pottery.

Just a thin scattering of pottery, WFD 081 is a very small scatter of pottery sherds (1 m^2). Nine sherds were collected: five date to the Iron Age, two date to the Early Bronze Age, and two date to the Roman/Byzantine period.

WFD 087 is a dense scatter of Iron Age pottery, located near possible grave features on the eastern edge of the feature. The sherd scatter covers an area of 90 m^2.

WFD 096 is a small scatter of four Iron Age ceramic sherds. No other features were recoded in association with this feature.

WFD 628 is located on the western bank of ʻAyn Fidan. No architectural features were observed. The main feature at this site was a large lithic scatter (3,900 m^2), but there was also a smaller pottery scatter. The pottery dated to the Early Bronze Age, Iron Age, and Roman/Byzantine periods.

WAG 026 is located on a low terrace east of Wadi al-Jariya and north of Wadi al-Ghuwayba. Wadi al-Jariya forms the western boundary of the terrace. The find spot (350 m^2) is cleared of the cobbles that would seem to be normally covering the surface. Finds included many Iron Age sherds, lithics, and copper ore.

WAJ 635 is another scatter in the Wadi al-Jariya, consisting of about 15 Iron Age sherds found at the base of a sandstone cliff along a box canyon. WAJ 635 is located at the eastern end of the tributary wadi containing the third cluster of mines identified during the 2007 survey.

Tumuli

Tumuli are cairns or rock piles that mark graves. They are often indicated by a visible, robbed burial chamber.

WFD 123 is composed of two robbed tumuli built out of local rocks, probably collected from the wadi. At both tumuli, human remains are scattered throughout the pile of fill and boulders left by the looters. A single Iron Age sherd was collected at the site, which covers an area of 70 m^2.

The tumuli at WAJ 639 are located on a sandy steppe above Wadi al-Jariya in a box canyon. There are three robbed tumuli (Figure 7.95) in the eastern portion of the site (covering an area of ca. 3,300 m^2). In addition to these, there are numerous rock circles in a shallow channel leading into the small box canyon. To the east there is a sandstone outcrop that forms a natural rock shelter. Below it is a line of rocks, underneath which the survey team noted fabric from a goat hair tent. Iron Age pottery was collected near the robbed tumuli, but no artifacts were found around the rock circles or tent.



Figure 7.95 WAJ 639—these tumuli have been robbed. They were built on a terrace on the eastern side of the Wadi al-Jariya. A group of mines can be seeing in the background, below the cliffs that bound the eastern side of the Wadi al-Jariya.

Discussion of the Results

The intensive pedestrian surveys carried out by the ELRAP team along the Wadi Fidan, Wadi al-Ghuwayba, and Wadi al-Jariya provide important Iron Age data concerning a landscape of copper extraction and production during the Iron Age. While absolute dating of the mines identified in these surveys is not possible at present, given the overwhelming evidence for early Iron Age copper production at the two main sites—Khirbat en-Nahas and Khirbat al-Jariya—it seems most likely that the mines described above are contemporary. The three wadis discussed were part of a settlement system that was mainly focused on the extraction, processing, and distribution of copper. A comparison of the results for each wadi catchment is discussed below and presented in Table 7.1.

Wadi Fidan

As seen in the distribution of Iron Age sites along the Wadi Fidan (Figure 7.96; Table 7.1), Iron Age settlement function varied significantly compared to the WAJ/WAG catchment. A total of 26 Iron Age sites were recorded in Wadi Fidan (Table 7.2). As one of the main western gateways to the Faynan district was the Wadi Fidan, it is interesting that Iron Age settlement in

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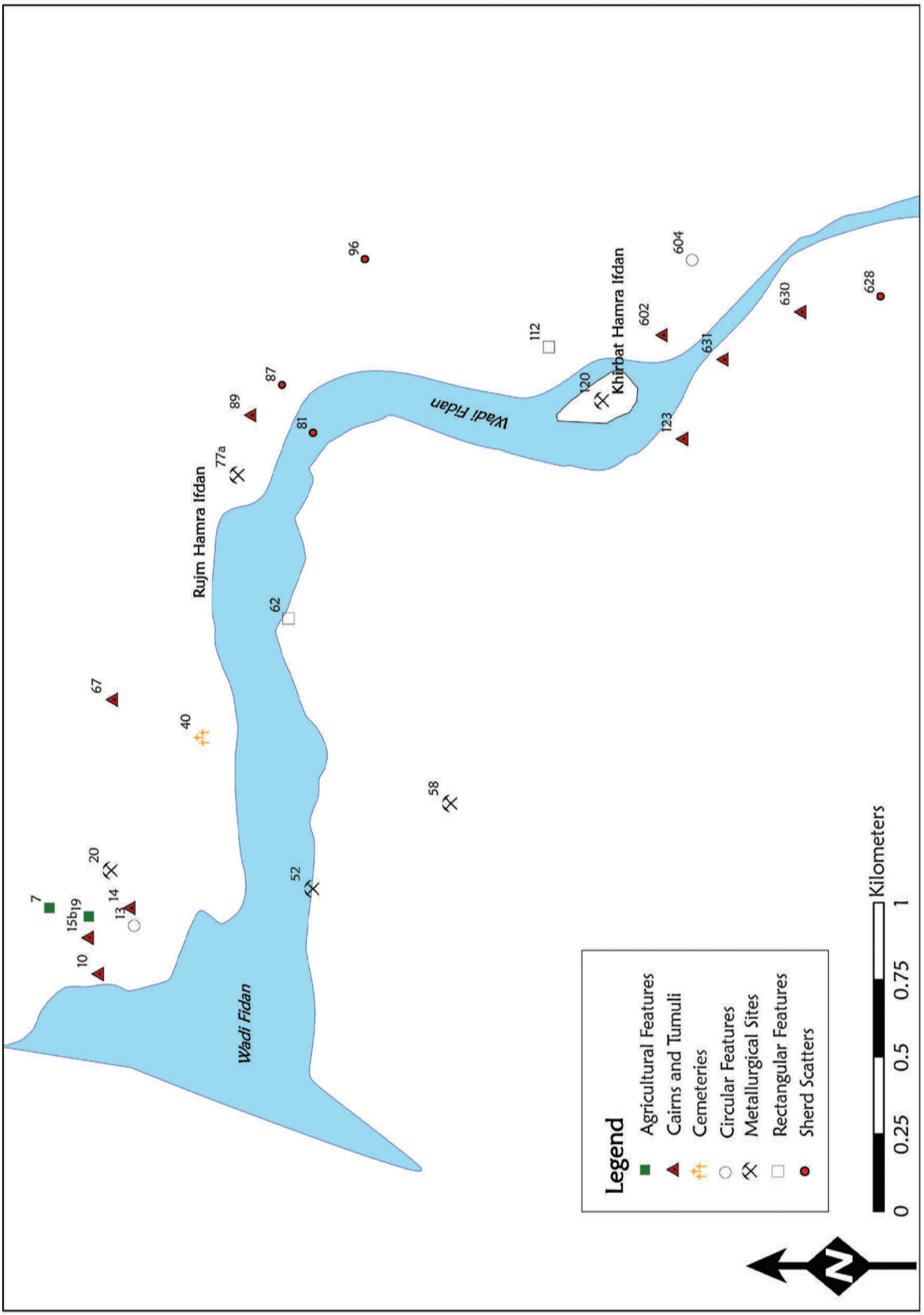

Figure 7.96 Map of Iron Age sites recorded in Wadi Fidan during the 1998 and 2004 surveys.

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Table 7.1 Frequency of sites by type in Wadi Fidan and Wadi al-Jariya/Wadi al-Ghuwayba catchment. The number of sites in WAJ/WAG is significantly higher than in Wadi Fidan, in part because of the ore distribution and the importance of the area for copper extraction.

Site Type/Wadi System	WFD	WAJ/WAG
Agricultural	3	-
Architecture Fragment	-	1
Cairns	8	8
Campsite	-	10
Cemetery	1	-
Circular Features	2	12
Metallurgical	5	4
Mines	-	54
Rectangular Features	2	1
Rock Shelters	-	1
Sherd Scatter	4	2
Tumuli	1	1
Total	**26**	**94**

this area was not as intense as it was in early periods. Nevertheless, many of the sites were dated using small samples of Iron Age sherds, and the overall quantity of Iron Age materials suggests that Wadi Fidan was an important locus of activity during this period.

The evidence for sedentary occupation is scant, especially compared to other areas, such as the Wadi Faynan valley. Wadi Fidan was an important gateway to these areas and seems to have been a well-traveled route, based on the presence of eight large cairn sites and five pottery sherd scatters. The large cairns recorded by ELRAP, many of which were built on high ground, would have been visible to travelers walking along the wadi channel below the Holocene and Pleistocene terraces. These cairns may have marked the route to some of the major Iron Age sites in the region.

In addition to the smaller, ephemeral sites, surveyors recorded two small Iron Age agricultural sites in Wadi Fidan. Archaeologists have suggested that Iron Age groups subsided on a mostly pastoralist economy (LaBianca and Younker 1998; Chapter 8, this volume). With the exception of the immediate area around Khirbat Faynan (Barker et al. 2007), the lack of permanent agricultural settlements throughout Faynan seems to corroborate this hypothesis. However, the ELRAP surveys recorded two Iron Age agricultural sites with either agricultural terraces or field systems, similar to those at Wadi Faynan, but much smaller. It is important to note that the presence of Iron Age sherds in agricultural features is not enough to exclusively date them to a particular time period. However, the presence of Iron Age ceramics at these sites suggests that small-scale agriculture may have been used to supplement a mostly pastoralist lifestyle. Compared to Wadi al-Jariya and Wadi al-Ghuwayba, the soils of the wadi beds in Wadi Fidan and Wadi Faynan are more conducive to agricultural production. In addition, the perennial spring at ʻAyn Fidan would have aided seasonal crop production.

Iron Age copper smelting in Wadi Fidan was carried out on a very small-scale basis. Unlike the larger smelting sites, Khirbat Faynan, Khirbat an-Nahas, and Khirbat al-Jariya, there are no large Iron Age slag piles or deep deposits of smelting waste in Wadi Fidan. However, the sites of Rujm Hamra Ifdan and Khirbat Hamra Ifdan, where ELRAP excavations revealed Iron Age copper production, are important exceptions (see Chapter 10 and 12, this volume).

Summary of Wadi al-Jariya and Wadi al-Ghuwayba

Seventy-five Iron Age sites were recorded in Wadi al-Jariya and Wadi al-Ghuwayba (Figure 7.97; Table 7.3). Unlike the wadis to the south and southeast, there was no agricultural production in Wadi al-Jariya or Wadi al-Ghuwayba; the wadis would not have been conducive to agriculture, because there is very little arable land and water. Instead, these areas were dedicated to the mining and production of copper and were an important route connecting the highlands and the lowlands (Chapter 6, this volume). There is little evidence of permanent Iron Age settlement in Wadi al-Ghuwayba and Wadi al-Jariya, although the large sites of Khirbat en-Nahas and Khirbat al-Jariya served as major centers of mining, smelting, and production.

Although Early Bronze Age mining hammers were found at some of the mines in Wadi al-Jariya, the majority of the mines should be dated to the Iron Age. This is, in part, based on proximity—there are no Early Bronze Age smelting sites within 5 km of the mines. The nearest Early Bronze site, Ras en-Naqb, is much closer to the mines at Faynan, and the Early Bronze sites in Wadi Fidan are more than 7 km from the Wadi al-Jariya mines. It would have been more efficient to exploit ore from local sources, such as at Umm ez-Zuhur. Similarly, the workers at Khirbat al-Jariya most likely exploited the closest sources of ore in the wadis just north of the

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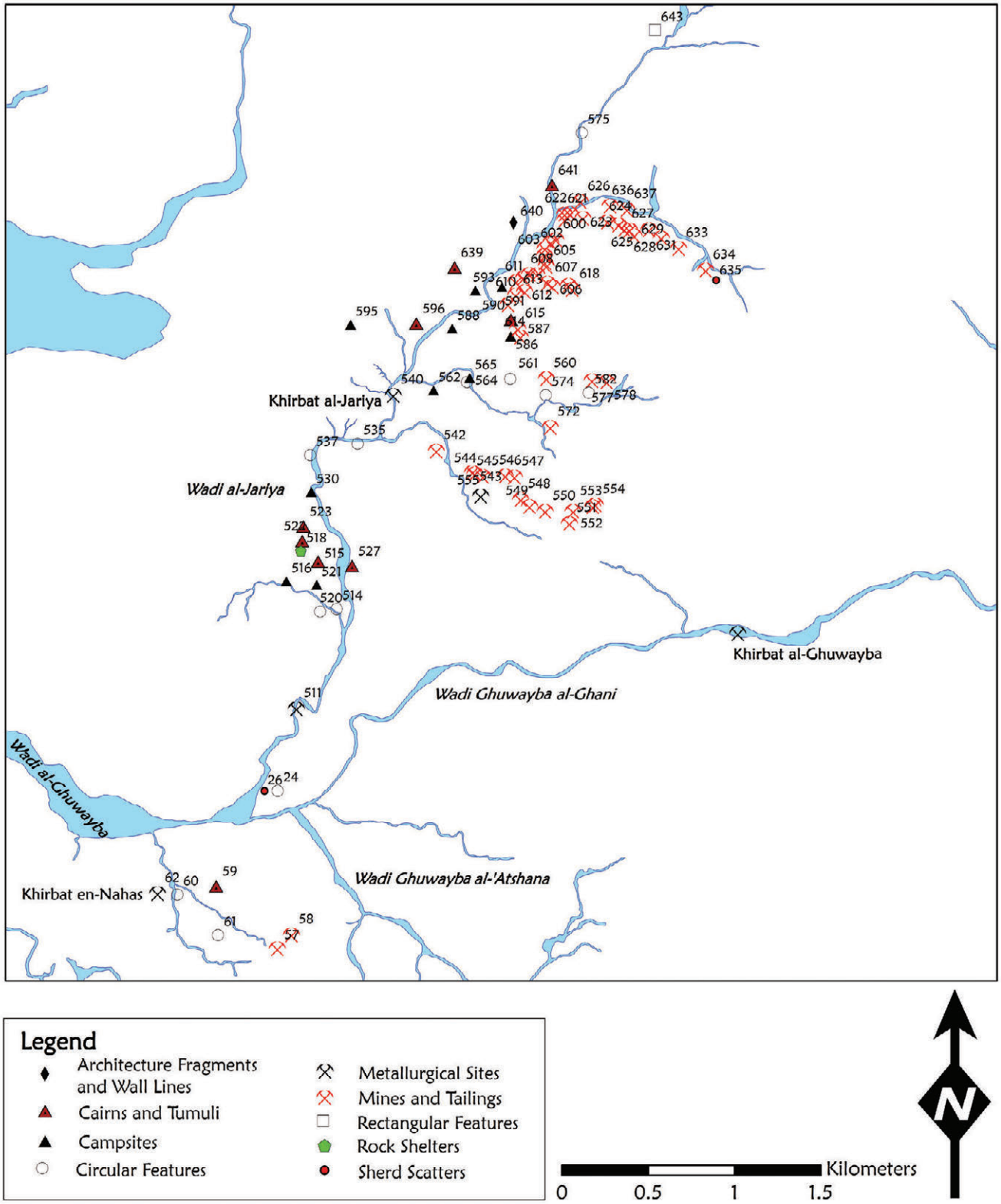

Figure 7.97 Map of Iron Age sites recorded in Wadi al-Ghuwayba and Wadi al-Jariya during the 2002 and 2007 surveys.

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site. The presence of mining hammers at some of these sites may indicate limited exploitation during the Early Bronze Age, or it may be the result of reuse of the hammers. That said, mining hammers like those found at the Early Bronze Age site of Wadi Fidan 4 are not a well-established indicator of cultural chronology. Most of the Early Bronze Age mining hammers found at Wadi Fidan 004 were recovered from the surface; few of them have been recovered from stratified contexts. Since the raw materials to make the hammers are not readily available in Wadi al-Jariya or Wadi al-Ghuwayba, miners would have made them near the source of the stone so as to minimize the amount they had to carry.

A total of 36 mining sites with evidence of Iron Age exploitation were recorded in the WAG/WAJ catchment, although the total number of such sites is more than double that. As we describe above, most of the mining sites were probably exploited during the Iron Age as a part of the copper production system centered at Khirbat en-Nahas and Khirbat al-Jariya. The ELRAP excavations at these sites, combined with intensive archaeological surveys, provide a clear and detailed picture of copper production systems that operated in Faynan (see Chapter 12, this volume; Ben-Yosef 2010).

Another interesting discovery from the Wadi al-Jariya surveys was the presence of eight Iron Age campsites. These sites are some of the few campsites from the Iron Age recorded in Edom. In addition, numerous architectural features and rock shelters provide evidence for an ephemeral, transient occupation of the wadi. Many of these sites are located close to the mining site clusters recorded by ELRAP. The temporary nature of these sites and their proximity to mining sites suggest these may have been temporary encampments used by Iron Age miners who extracted and transported the copper ore to Khirbat al-Jariya.

In summary, the frequency of metallurgical and mining sites in Wadi al-Jariya/Wadi al-Ghuwayba highlights its characterization as a copper production landscape. Unlike the wadis to the south and southwest, where Iron Age settlement was geared toward copper production and agricultural production, there is an absence of any permanent settlement sites in the Wadi al-Jariya/Wadi al-Ghuwayba catchment. This pattern of land use must be viewed as a part of the regional exploitation of copper resources in Faynan during the Iron Age.

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Table 7.2 Iron Age sites from Wadi Fidan surveys.

Site Number	Northing	Easting	Elevation	Site Name	Site Size (m^2)	Major Periods	Other Periods	Site Type	Site Type 2
WFD 007	396571	727472	–38		1,700	IA		Agricultural	
WFD 010	396355	727411	–18		200	IA		Cairns	
WFD 013	396238	727571	–19		70	EB, IA		Circular features	
WFD 014	396256	727628	–12			IA	Paleo	Cairn	Lithic scatter (50 m^2)
WFD 015	396353	727547	1			IA		Cairns	
WFD 019	396378	727595	–29		1,700	IA		Agricultural	
WFD 020	396320	727748	–3		1	IA		Metallurgical	
WFD 040	396075	728144	13			IA		Cemetery	
WFD 052	395667	727709	–18		6,500	EB, IA, Roman		Metallurgical	Rectangular features, circular features
WFD 058	395228	727998	14		4,700	IA		Metallurgical	
WFD 062	395768	728580	29		20	IA		Rectangular feature	
WFD 067	396322	728303	8		1,000	IA		Cairns	Metallurgical
WFD 077a	395950	729021	18	Rujm Hamra Ifdan		IA		Metallurgical	
WFD 081	395708	729186	10		1	EB, IA, R/B		Sherd scatter	
WFD 087	395807	729330	41		90	IA		Sherd scatter	
WFD 089	395914	729238	36		25	IA		Cairns	
WFD 096	395556	729754	53			IA		Sherd scatter	
WFD 112	394939	729486	60		1,800	IA	Roman	Rectangular feature	Cairns
WFD 120	394776	729319	53	Khirbat Hamra Ifdan		EB, IA	R/B, Early Islamic	Metallurgical	Settlement
WFD 123	394508	729203	57		70	IA		Tumuli	

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Table 7.2 Iron Age sites from Wadi Fidan surveys. *(continued)*

Site Number	Northing	Easting	Elevation	Site Name	Site Size (m^2)	Major Periods	Other Periods	Site Type	Site Type 2
WFD 125	395381	729400	17			IA		Agricultural	
WFD 602	3394646	729542	58		6,800	Paleo, IA		Cairn	Circular features
WFD 604	3394548	729786	68		5,200	Paleo, IA		Circular Features	Rectangular features
WFD 628	3393939	729673	67		3,900	Paleo, EB, IA, R/B		Sherd Scatter	Lithic scatter
WFD 630	3394199	729621	63		150	IA		Cairns	
WFD 631	3394448	729465	55		200	IA, R/B		Cairns	Metallurgical

Paleo = Paleolithic; EB = Early Bronze; IA = Iron Age; Nab = Nabatean; Nab/Roman = Nabatean/Roman; R/B = Roman/Byzantine; MI = Middle Islamic

Table 7.3 Iron Age sites from Wadi al-Jariya/Wadi al-Ghuwayba surveys.

Site Number	Northing	Easting	Elevation	Site Name	Site Size (m^2)	Major Periods	Other Periods	Site Type	Site Type 2
WAG 024	3397582	734173	94		4,500	IA	EB	Circular features	Cairns
WAG 026	3397583	734096	87		350	IA	EB	Sherd scatter	Lithic scatter, metallurgical
WAG 057	3396659	734158	106			MI II		Mines	
WAG 058	3396737	734242	135			IA	MI	Mines	
WAG 059	3397030	733805	136		4,300	IA		Cairns	Metallurgical
WAG 060	3396984	733579	86		150	IA		Circular feature	Cairn
WAG 061	3396743	733813	153		2700	IA		Circular features	Cairns
WAG 062	3396991	733464	83	Khirbat en-Nahas	100,000	IA		Metallurgical	
WAJ 511	3398059	734289	100		1,100	EB, IA, R/B		Metallurgical	
WAJ 514	3398640	734532	136		1,200	IA	EB	Circular features	Cairn
WAJ 515	3398919	734427	125		5,900	IA	EB	Cairns	Circular features, wall lines
WAJ 516	3398807	734240	132		3,000	IA		Campsite	Cairns
WAJ 518	3398982	734328	134		4,400	IA	EB	Rock shelters	Architecture fragment

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Table 7.3 Iron Age sites from Wadi al-Jariya/Wadi al-Ghuwayba surveys. *(continued)*

Site Number	Northing	Easting	Elevation	Site Name	Site Size (m^2)	Major Periods	Other Periods	Site Type	Site Type 2
WAJ 520	3398627	734436	120		33,600	IA	EB	Circular features	Cairns
WAJ 521	3398783	734417	125		3,200	IA		Campsite	Cairns
WAJ 522	3399040	734335	138		300	IA		Cairns	
WAJ 523	3399126	734345	137		1,500	IA		Cairns	
WAJ 527	3398890	734625	127		5,500	IA		Cairns	Circular features
WAJ 530	3399326	734394	131		14,000	IA	EB	Campsite	
WAJ 535	3399606	734668	143		10	IA	EB	Circular features	Wall line
WAJ 537	3399542	734390	133		4,300	EB, IA		Circular features	Cairns, wall lines
WAJ 540	3399885	734880	154	Khirbat al-Jariya		IA		Metallurgical	
WAJ 542	3399555	735126	163			IA		Mine	
WAJ 543	3399428	735336	194			IA		Mine	
WAJ 544	3399419	735351	196			IA		Mine	
WAJ 545	3399402	735396	206			IA		Mine	
WAJ 546	3399403	735527	224			IA		Mine	
WAJ 547	3399397	735581	223			IA		Mine	
WAJ 548	3399264	735616	236			EB II, EB III, IA	Byzantine	Mine	
WAJ 549	3399223	735666	238			IA		Mine	
WAJ 550	3399194	735758	247			IA		Mine	
WAJ 551	3399121	735898	263			R/B		Mine	Metallurgical
WAJ 552	3399191	735921	271			Modern	IA	Mine	
WAJ 553	3399217	736036	289			IA		Mine	
WAJ 554	3399228	736051	293			Unknown		Mine	
WAJ 555	3399287	735382	187		700	IA	Modern	Metallurgical	Cairns, circular features

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Table 7.3 Iron Age sites from Wadi al-Jariya/Wadi al-Ghuwayba surveys. *(continued)*

Site Number	Northing	Easting	Elevation	Site Name	Site Size (m^2)	Major Periods	Other Periods	Site Type	Site Type 2
WAJ 560	3399672	735661	0			IA		Mine	
WAJ 561	3399672	735453	244		60	IA	Paleo	Circular feature	
WAJ 562	3399606	735008	184		1,900	IA	Islamic	Campsite	Architecture fragment
WAJ 564	3399653	735203	193		150	IA, R/B		Circular features	
WAJ 565	3399678	735218	194		200	IA		Campsite	
WAJ 572	3399390	735685	257			Unknown		Mine	
WAJ 574	3399577	735658	254		700	IA		Circular features	Cairns
WAJ 575	3401097	735867	221		250	IA	EB	Circular features	Campsite
WAJ 577	3399660	735926	278			EB		Mine	
WAJ 578	3399654	736011	277			R/B		Mine	
WAJ 582	3399592	735908	273		20	IA		Circular features	
WAJ 586	3399918	735455	227		1,100	IA, R/B		Campsite	
WAJ 587	3399913	735511	227			IA		Mine	
WAJ 588	3399964	735116	182		21,800	IA		Campsite	Tumuli
WAJ 590	3400014	735456	205		2,600	IA	Paleo	Cairns	
WAJ 591	3400204	735405	192		1,000	IA, R/B		Campsite	
WAJ 593	3400184	735251	191		2,000	IA	Paleo, R/B	Campsite	
WAJ 595	3399986	734529	252		8,800	IA, R/B	EB	Campsite	Tumulus, circular features
WAJ 596	3399993	734908	209		12,700	IA, N/R, Islamic		Cairns	Circular feature
WAJ 600	3400477	735717	201			IA		Mine	
WAJ 601	3400461	735686	201			IA, Nab		Mine	
WAJ 602	3400425	735653	199			IA	EB	Mine	
WAJ 603	3400388	735652	201			EB, IA		Mine	

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Table 7.3 Iron Age sites from Wadi al-Jariya/Wadi al-Ghuwayba surveys. *(continued)*

Site Number	Northing	Easting	Elevation	Site Name	Site Size (m^2)	Major Periods	Other Periods	Site Type	Site Type 2
WAJ 604	3400345	735653	201			IA		Mine	
WAJ 605	3400324	735660	201			IA	Paleo, EB	Mine	
WAJ 606	3400206	735696	210			IA, N/R	Paleo	Mine	
WAJ 607	3400227	735668	207			EB, IA		Mine	
WAJ 608	3400276	735607	197			IA		Mine	
WAJ 609	3400277	735562	194			IA	EB, Late Islamic	Mine	
WAJ 610	3400257	735529	195			IA	R/B	Mine	
WAJ 611	3400233	735485	189			IA, Roman	Paleo	Mine	
WAJ 612	3400178	735536	199			IA		Mine	
WAJ 613	3400157	735484	198			IA	Late Islamic	Mine	
WAJ 614	3400102	735440	199			IA	Paleo	Mine	
WAJ 615	3399962	735496	206			EB, IA		Mine	
WAJ 617	3400214	735790	225					Mine	
WAJ 618	3400190	735811	227			Unknown		Mine	
WAJ 620	3400593	735768	200			EB		Mine	
WAJ 621	3400625	735767	198			IA	Paleo	Mine	
WAJ 622	3400627	735798	201			EB, IA, R/B		Mine	
WAJ 623	3400601	735873	210			IA		Mine	
WAJ 624	3400580	736015	220			EB, IA		Mine	
WAJ 625	3400563	736079	229			Unknown		Mine	
WAJ 626	3400697	735859	206			Late Islamic	IA	Mine	Campsite
WAJ 627	3400537	736113	226			EB		Mine	

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Table 7.3 Iron Age sites from Wadi al-Jariya/Wadi al-Ghuwayba surveys. (*continued)*

Site Number	Northing	Easting	Elevation	Site Name	Site Size (m^2)	Major Periods	Other Periods	Site Type	Site Type 2
WAJ 628	3400533	736144	229			Unknown		Mine	
WAJ 629	3400501	736169	235			Unknown		Mine	
WAJ 631	3400535	736255	224			Unknown		Mine	
WAJ 632	3400488	736326	227			Unknown	Modern	Mine	Campsite
WAJ 633	3400428	736427	232			Unknown		Mine	
WAJ 634	3400301	736583	242			IA, Nab		Mine	
WAJ 635	3400244	736645	248			IA		Sherd scatter	
WAJ 636	3400672	736030	213			IA		Mine	
WAJ 637	3400651	736128	218			IA		Mine	
WAJ 639	3400319	735130	194		3,300	IA		Tumuli	
WAJ 640	3400577	735470	217		36,200	IA	Paleo, PPN, EB, Nab	Architecture fragment	
WAJ 641	3400795	735693	216		4,700	IA	R/B	Cairns	
WAJ 643	3401693	736291	263		1,700	IA	Paleo	Rectangular feature	

Paleo = Paleolithic; EB = Early Bronze; IA = Iron Age; Nab = Nabatean; Nab/Roman = Nabatean/Roman; R/B =Roman/Byzantine; MI = Middle Islamic

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8 Feeding the Iron Age Metalworkers at Khirbat en-Nahas
Zooarchaeological Data

Adolfo Muniz and Thomas E. Levy

The chapter presents a zooarchaeological investigation of the faunal remains recovered during the three excavation seasons at the Iron Age copper production center at Khirbat en-Nahas. A total of 31,868 specimens were recovered and processed, of which the identified specimens total 3,860. These data allow us to gain insights about provisioners and consumers of meat products that played an important role in the Iron Age food supply at this ancient production center. While sheep and goats were the dominate meat source, some cattle contributed to the diet as well as supplements from hunted wild taxa such as gazelle, fish, and hare. In general, the population at Khirbat en-Nahas had equal access to meat that was brought to the site. This highlights the decision to ensure adequate food supplies for the both the administrators and workers at this site throughout the Iron Age sequence to facilitate maximum levels of copper production.

Introduction

Animals and their products played an important role in provisioning the mining community (both elites and workers) with the needed protein to facilitate their work in the harsh desert in the environs of Khirbat en-Nahas (KEN). The deep-time University of California, San Diego (UCSD) Edom Lowlands Regional Archaeology Project (ELRAP) in Faynan has paid particular attention to the study of zooarchaeological remains found at the various copper ore processing, smelting, and manufactory sites excavated from the prehistoric periods (PPNB) (Twiss 2007) through the complete Early Bronze Age sequence represented in the region—EB I through EB IV (Muniz 2007). In the study here, the first published summary of Iron Age zooarchaeological research on faunal assemblages recovered from the site of Khirbat en-Nahas in southern Jordan is presented. This study is also the first published summary of a zooarchaeological investigation of an Iron Age metal production site in the southern Levant. The recent large-scale archaeological excavations at this site provide a unique opportunity to use faunal remains to study different dimensions of the lifeways of the inhabitants of this large industrial copper production site. As described in Chapter 2, this site served as one of the most important southern Levantine centers for the production of copper during the Iron Age period,

Opposite: The late Abu Fawwaz al-Rashida and donkey traverse the Faynan region. Human–animal relationships have been a key variable for successful adaptation to the Saharo-Arabian desert zone where Khirbat en-Nahas and the other Iron Age copper production sites are located. *Photo: Thomas E. Levy.*

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particularly the tenth to ninth centuries BCE. The systematic excavations that began in 2002 have shown that activities at Khirbat en-Nahas can be dated as far back as the twelfth-century BCE. Seven areas at this site were excavated during three major campaigns in 2002, 2006, and 2009 (Figure 8.1). These include Areas A, F, M, R, S, T, and W. To date, all of the recovered assemblage with the exception of Area F has been processed. Although much information is presented here, it is by no means the final analysis as different aspects of the research are currently under way.

To understand the role of animals in what was the first industrial-scale metal production system in the southern Levant, this study acknowledges the importance of subsistence studies, including provisioning of animals at this important site and corresponding changes in animal production in the surrounding area. Central questions surrounding the consumption of meat are explored and focus on two main issues alongside basic questions of the types of animals exploited, and these include consumption and the distribution of food resources in social arenas to define status within the social and economic hierarchies (Goody 1982; Grant 2002; Gunnerman 1997; Harris 1987; Hodder 1991; Kirch and O'Day 2003; Marom et al. 2009; Miracle and Milner 2002). A meal, regardless of its size or formality, is an event that develops and maintains affiliations among people—whether a participant or not—who partake in it, as well as the preparers and consumers involved in the process. Foodways also change through time, and the changes may vary among individuals of differing status, occupation, gender, and age. Randi Haaland has explored this in depth in ancient and contemporary worlds of both the Near East and Africa (Haaland 2007). This is most evident in complex societies where subsistence decisions also are based on status and political concerns. For example, elites may consume expensive resources because they can "afford" them and because the foods—and their consumption—symbolize their wealth and power (Ervynck et al. 2003). As Ervynck et al. (2003:431) remind us, "Imported goods can be luxuries in that, even when they are abundant in their place of origin, they are rare at the place of consumption. The costs of transport, together with their limited availability on the market, make these goods especially expensive." Food, then, incorporates numerous aspects of culture—ranging from technology to nutrition and the symbolic—and the Iron Age copper production factory at KEN is an excellent locale to explore these issues.

Another significant aspect of subsistence practices and strategies lies in the manipulation and distribution of resources in social arenas. This is carried out through sharing, cooking, and communal consumption. Resources, through their preparation and consumption, are transformed into food, which like any



Figure 8.1 Khirbat en-Nahas excavation areas during the 2002, 2006, and 2009 seasons.

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item of material culture serves a variety of nutritional and economic functions while carrying multiple symbolic meanings that may be purposively created, manipulated, and deployed by agents (Milner and Miracle 2002:1) for their personal gain. The study here will explore how food, in particular meat and the secondary products of animals, was used in an ancient industrial context—one that predates the Classical periods when there is a wealth of historical sources concerning these issues (Maltby 1990, 2006; for the Roman world, see especially Choyke 2004; Forstenpointner et al. 2002; Maltby 2005).

The Faunal Assemblage from KEN

The faunal remains investigated at Khirbat en-Nahas were excavated over a period of three seasons as part of ELRAP. The faunal assemblage was recovered from loci belonging to Strata I–VI dating to the ninth to the thirteenth centuries BCE (Higham et al. 2005; Levy 2009; Levy et al. 2004; Levy et al. 2005; Levy, Higham, et al. 2008). However, the majority of specimens were recovered from strata dating to the ninth and tenth centuries BCE.

Faunal specimens were collected by hand and from the sieve (1/4 inch or 6.35 mm) from deposits found with cultural material within structures. Thus, all taxa from these loci had an equal chance of being counted. Systematic random sieving was carried out on some loci associated with the exterior of some structures. Here, the recovery of bones by hand may have introduced a bias in favor of the larger taxa. However, given the sample of numerous small fish and bird bones recovered, the bias may not be severe. Overall, the condition of the faunal assemblage was poor. This is because most fauna specimens were highly fragmented, extremely brittle, and coated with mineral salts and sometimes fragments of slag. Three main approaches were used for recording: (1) number of identified specimens (NISP) was used to determine relative taxonomic abundance, (2) minimum number of elements (MNE) was calculated by totaling the percentage of completeness for each bone, and (3) minimum number of individuals (MNI) was calculated based on laterality. Where possible, information was recorded for each bone fragment, including species identification, anatomical element, handedness (laterality), portion and degree of fusion, fragmentation, and condition. Miscellaneous information, including the evidence of butchery, burning, and bone working, was recorded when present and currently is being analyzed. For all excavated areas, estimated ages at death are based on epiphyseal fusion of the long bones (Silver 1969). Data on dental eruption and wear are currently outstanding. Thus, two critical areas are currently lacking: the results for tooth wear analysis and bone measurements. Figure 8.2 presents the general stratigraphy for the different excavation areas at KEN that are used in the fauna analysis presented here.

Overview of the Faunal Assemblage from Khirbat en-Nahas

The overall composition of the faunal assemblage for the excavation areas of Khirbat en-Nahas is shown in Table 8.1 and Figure 8.3. A total of 31,868 specimens were recovered and processed. The identified specimens total 3,860. As Table 8.1 and Figure 8.1 indicate, the remains of the large domestic mammals dominate all assemblages and include cattle, sheep/goat, and donkeys. Most specimens or 3,148 (81.6 percent) are classified as sheep/goat. Out of this group, 290 or 7.5 percent of identified specimens are goat, while 83 specimens or 2.2 percent represent sheep. The difficulties in distinguishing between the morphological remains of sheep and goat species have been documented in research methods (Boessneck 1969; Clutton-Brock 1979; Payne 1985). The focus on nonmorphological approaches (e.g., Balasse and Ambrose 2005; Bar-Gal et al. 2003; Buckley et al. 2010) to distinguish sheep from goat remains is becoming prevalent and is key to future research, particularly at this site. The distinction between sheep and goat was made using criteria combined from Boessneck (1969), Kratochvil (1969), and Prummel and Frisch (1986). Bone specimens were compared with faunal collections from CBRL-Amman, San Diego Museum of Natural History, and Wadi Faynan Southern Jordan. Based on morphological attributes, including horn and horn cores, all specimens belonging to sheep/goat appear to be domestic. Cattle are the second most abundant taxa at Khirbat en-Nahas. A total of 152 (3.9 percent) specimens have been identified from across the seven areas. Also identified were 64 (1.7 percent) specimens belonging to donkey, 7 (<1 percent) to camel, and 34 (<1 percent) to dog (Table 8.1; Figure 8.3).

Select mammals, birds, mollusks, reptiles, and fish account for the wild species identified at the site. Mammalian species are represented by gazelle species (NISP = 29 or <1 percent), hare (NISP = 42 or 1.1 percent), rodents (NISP = 43 or 1.2 percent), and bat (NISP = 4 or <1 percent) (Table 8.1 and Figure 8.3). The most

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Figure 8.2 Correlation of Strata from all Excavation Areas (A, M, F, S, T, R and W) at Khirbat en-Nahas. The Roman numerals in the first column (St. = Stratum) represent the general strata that are used to compare these different areas at the site. The main tool for correlating cross-cutting contexts was the high resolution radiocarbon dating. Color key: white = unoccupied / post-abandonment context; orange = mainly smelting and other pyrotechnological activities; green = mainly architectural remains (buildings); blue = unexcavated contexts; pink = virgin soil

St.	^{14}C	KEN-A	KEN-A description (2002, 2006)	KEN-M	KEN-M description (2002, 2006)	KEN-F	KEN-F description (2006)	KEN-S	KEN-S description (2002)	KEN-T	KEN-T description (2006)	KEN-R	KEN-R description (2006, 2009)	KEN-W	KEN-W Description (2009)
I		A1a A1b	Post-abandonment	-	Post-abandonment	F1a F1b	Post-abandonment (Unoccupied)	S1a S1b	Post-abandonment	T1a	Post-abandonment (Unoccupied)	R1a R1b Post-abandonment	Post-abandonment	W1A	Collapse
II	9th	A2a	Ephemeral metal production outside gate	M1 ; 1a	Smelting; (1a after building abandonment?)			S1	Abandoned possible corral				R3 courtyard copper production complex	W1B	Post-abandonment (Unoccupied)
	9th	A2b	Intensive metal production	M2a	Intensive smelting; late phases in building	F2a	Addition of small architectural units	S2a	Minor extensions of main building					W2	Structure complex; storage areas; cultic? Undated
III	Late 10th - early 9th	A3a	Decommissioning Residential?	M2b	First phase of building; intensive smelting	F2b	Main building w/ basins, recycling	S2b	Main building – casting/ slag processing	T1bT 2a	2nd occupation phase floor	R2a	Some additions to structure		
IV	10th	A3b	Building of gatehouse	M3 [IV-V]	Industrial horizon; intense copper production	F2c	Crushed slag below building	-	Unoccupied	T2b	Main building phase, residential	R2b	Main building phase, residential		
V	Early 10th	A4a	Crushed slag/ below gate					S3	Sparse crushed slag	T3	Pre-building smelting	R3a R3b	Crushed slag below building	W3	Metallurgical debris
VI	Late 12-11th	-	Unoccupied	M4	Copper production	-	Unoccupied	S4	Small scale metal production and domestic activities	-	Not excavated	-	Not excavated		
VII	13-12th			M5a M5b	Installations; small scale production			S5	Unoccupied						Not excavated
-	-	A4b	Virgin sediment	-	Virgin sediment	F3	Virgin sediment	S5	Virgin sediment						

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Table 8.1 Comparison of faunal assemblage from Khirbat en-Nahas.

	Areas													
	A		M		R		S		T		W		All Areas	
Domestic Species														
Cattle *(Bos taurus)*	72	6.7%	34	4.1%	13	4.9%	2	0.2%	30	7.2%	1	0.4%	152	3.9%
Camel *(Camelius dromedarius)*	1	0.1%	3	0.4%	0	0.0%	3	0.3%	0	0.0%	0	0.0%	7	0.2%
Dog *(Canis* sp.*)*	13	1.2%	7	0.8%	0	0.0%	11	1.1%	2	0.5%	1	0.4%	34	0.9%
Donkey (*Equus asinus*)	38	3.5%	17	2.1%	7	2.6%	0	0.0%	1	0.2%	1	0.4%	64	1.7%
Goat *(Capra hircus)*	81	7.5%	69	8.4%	31	11.6%	94	9.0%	8	1.9%	7	3.1%	290	7.5%
Sheep *(Ovis aries)*	20	1.9%	15	1.8%	1	0.4%	46	4.4%	0	0.0%	1	0.4%	83	2.2%
Sheep/Goat *(Ovis/Capra)*	753	69.7%	579	70.2%	207	77.2%	715	68.5%	319	76.3%	202	90.2%	2775	71.9%
Wild Species														
Bat *(Chiroptera)*	3	0.3%	0	0.0%	0	0.0%	0	0.0%	1	0.2%	0	0.0%	4	0.1%
Birds *(Aves* sp.*)*	42	3.9%	7	0.8%	4	1.5%	15	1.4%	13	3.1%	2	0.9%	83	2.2%
Fish *(Ostychtes* sp.*)*	12	1.1%	78	9.5%	0	0.0%	109	10.4%	14	3.3%	2	0.9%	215	5.6%
Gazelle *(Gazella dama)*	2	0.2%	0	0.0%	4	1.5%	15	1.4%	8	1.9%	0	0.0%	29	0.8%
Hare *(Lepus capensis)*	7	0.6%	11	1.3%	0	0.0%	11	1.1%	10	2.4%	3	1.3%	42	1.1%
Rodents (*Rodentia* sp.)	32	3.0%	1	0.1%	1	0.4%	7	0.7%	2	0.5%	0	0.0%	43	1.1%
Shell *(Mollusc* sp.*)*	5	0.5%	1	0.1%	0	0.0%	16	1.5%	10	2.4%	4	1.8%	36	0.9%
Snake *(Viper* sp.*)*	0	0.0%	3	0.4%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	3	0.1%
Total Identified	1081	20.2%	825	10.8%	268	6.1%	1044	13.6%	418	7.0%	224	26.1%	3860	12.1%
Unidentified														
Large	8	0.1%	365	4.8%	341	7.8%	45	0.6%	243	4.1%	9	1.0%	1011	3.6%
Medium	4257	79.4%	6423	84.3%	3772	86.1%	6563	99.3%	5315	88.7%	624	72.7%	26954	96.2%
Small	14	0.3%	8	0.1%	1	0.0%	0	0.0%	19	0.3%	1	0.1%	43	0.2%
Total Unidentified	4279	79.8%	6796	89.2%	4114	93.9%	6608	86.4%	5577	93%	634	74%	28008	87.9%
Total Specimens	5360	100.0%	7621	100.0%	4382	100.0%	7652	100.0%	5995	100.0%	858	100.0%	31868	100.0%

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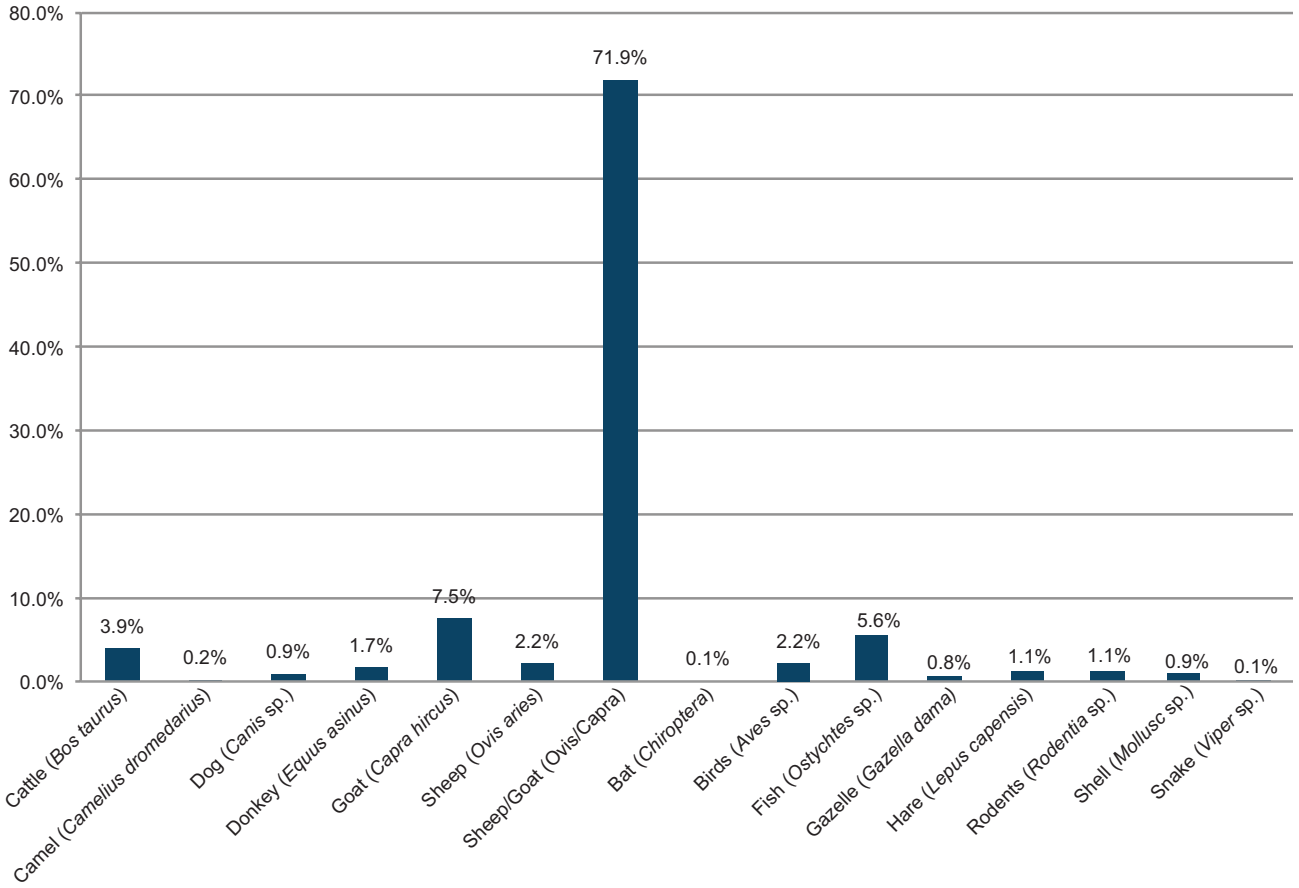

Figure 8.3 Khirbat en-Nahas taxa (NISP = 3,860).

abundant wild taxa recovered was fish vertebrae (NISP = 215 or 5.6 percent) and bird remains (NISP = 83 or 2.2 percent). Although further analysis is necessary on both of these taxa, preliminary analysis on the fish specimen indicates the remains may be represented by a variety of specimens, including parrotfish and Nile perch. The shell specimens (NISP = 36 or <1 percent) found throughout the different excavation areas further support the notion there was movement of exotic species to Khirbat en-Nahas from the Mediterranean or Red Sea coast.

Area A

The gatehouse excavation in the fortress at KEN was carried out over two seasons (2002 and 2006). Labeled Area A, the gatehouse provides an important dichotomy between its military function in the tenth century BCE and the decommissioned phase in the ninth century BCE, when it became a large building where a variety of smelting activities took place. A total of 5,360 specimens were processed from Area A (Figure 8.4). Of these, 1,081 specimens were collected from loci found within and around the exterior of the gate structure (see Chapter 1). The remains of both domestic and wild animals were recovered here. The identified domestic animal species include cattle (6.7 percent), donkey (3.5 percent), dog (1.2 percent), and sheep/goat (79.1 percent). One tibia fragment belonging to a camel (<1 percent) was recovered from L92, an industrial ashy fill with slag concentration located in the northwestern chamber of the gate. Wild species include birds (3.9 percent) and fish (1.1 percent), as well as gazelle (<1 percent), hare (<1 percent), rodents (3 percent), and shell (<1 percent).

Caprovines represent the most abundant taxa in Area A. Of the identifiable material, 854 specimens or 79 percent were categorized as belonging to domestic sheep and goat. When possible, the distinction between sheep and goat was made on the basis of the morphological criteria described by Boessneck (1969). Table 8.2 presents the results of the Area A specimen count. Most identified specimens appear to be from goat. The ratio for every goat to sheep is 1:2.5. Given the Saharo-Arabian

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Table 8.2 Area A bone counts for the main ungulates (NISP = 1,081).

	Capra hircus		*Ovis aries*		*Ovis/Capra*		*Bos taurus*	
	NISP	*MNE*	*NISP*	*MNE*	*NISP*	*MNE*	*NISP*	*MNE*
Head								
Occipital condyle					1	1		
Horn					9	3		
Mandibular condyle	1	1			61	10		
Teeth					11	11		
Axial								
Atlas	1	1			2	2		
Axis					4	4		
Caudal							1	1
Forelimb								
Scapula glenoid	2	2			17	17	2	2
Humerus complete	1	1						
Humerus proximal					7	4		
Humerus distal	2	2	1	1	19	10		
Radius complete	3	3						
Radius proximal	2	2	3	3	6	6		
Radius distal	1	1			5	5		
Ulna complete								
Ulna proximal	1	1	1	1	7	6		
Ulna distal					2	2		
Metacarpus complete								
Metacarpus proximal					2	2		
Metacarpus distal					1	1		
Hindlimb								
Acetabulum			1	1	18	9	1	1
Femur complete								
Femur proximal					17	7		
Femur distal					4	4	1	1
Tibia complete								
Tibia proximal				1	8	8		
Tibia distal	2	2		1	17	8		
Fibula							1	1
Astragalus	5	5	1	1	22	18	1	1
Calcaneus					11	8		
Tarsal					4	4		
Metarsus complete								
Metarsus proximal	1	1			4	4		
Metarsus distal	1	1			3	3		
Lower Limbs								
Phalanx 1	25	18	2	2	34	22		
Phalanx 2	8	5	3	3	23	19		
Phalanx 3	1	1			13	11		
Metapodial complete								
Metapodial proximal			1	1	16	6	2	2
Metapodial distal	6	4			23	11	1	1
NISP	63		13		371		10	
%NISP	5.83%		1.20%		34.32%		0.93%	
MNI	5		2		9		1	

desert climate of the region, the ratio is hardly surprising as goats are better adapted to heat and dryness and are more resilient to disease.

Table 8.3a–c presents the epiphyseal fusion data on the sheep/goats identified from two main strata at KEN when industrial-scale copper production took place dating to the ninth and tenth century BCE. The data reveal that a fairly high proportion of immature sheep/goat specimens were present for both the ninth and tenth centuries BCE. This becomes more apparent with

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animals dying between 1.5 and 3.5 years of age. In middle to late fusing specimens from the ninth century BCE, 52.94 percent and 53.06 percent were unfused specimens. A similar pattern can be found in specimens from the tenth-century BCE strata. The sample indicates 80 percent and 100 percent of middle and late fusing specimens are unfused. These results could indicate that individuals taking their meals in the vicinity of the gate structure might have had a preference for young animals. The access to high market cuisine could be related to the status of these individuals.

The fusion data have been plotted into survivorship curves and are presented in Figure 8.5. During the tenth century BCE, the data indicate that the highest mortality rate for sheep/goat was for animals between 12 and 18 months. Given that sheep and goat long bones fuse by approximately 3.5 years (Silver 1969), it could be argued that this group of animals were culled. In the tenth century BCE, the data indicate that animals had a better chance of survival to maturity and were being culled beginning at age 12 or 18 months. This could be attributed to the small sample (NISP = 9) of specimens recovered for these loci. However, the data analyzed here suggest animals were exploited for meat and for their secondary products. This may reflect the provisioning of meat for both industrial phases of copper production in the gatehouse area.

In Area A, there is no evidence for particular body part selection (Table 8.2). Forelimbs and hindlimbs were found in equal proportion. In addition, significant numbers of other bone elements were found in Area A, including cranial fragments, neck, body, and specimens from the lower extremities, indicating all portions were consumed and that animals were most likely butchered at the site.

A total of 10 (<1 percent) cattle specimens (MNI = 1) were recovered from Area A. The unidentified specimens belonging to a large animal are more than likely cattle, but donkey remains (3.5 percent) were also identified. The presence of cattle in this desert site is intriguing. As Caroline Grigson has shown, while cattle bones may be small in number in a fauna assemblage, they represent a much larger "live weight" of meat than a sheep or goat (Grigson 2006). Thus, the presence of cattle at KEN, in particular the gatehouse where it functioned as a nondomestic building in both the ninth and tenth centuries BCE, may reflect the intention to bring bovines to the copper factory to provision relatively large numbers of individuals.

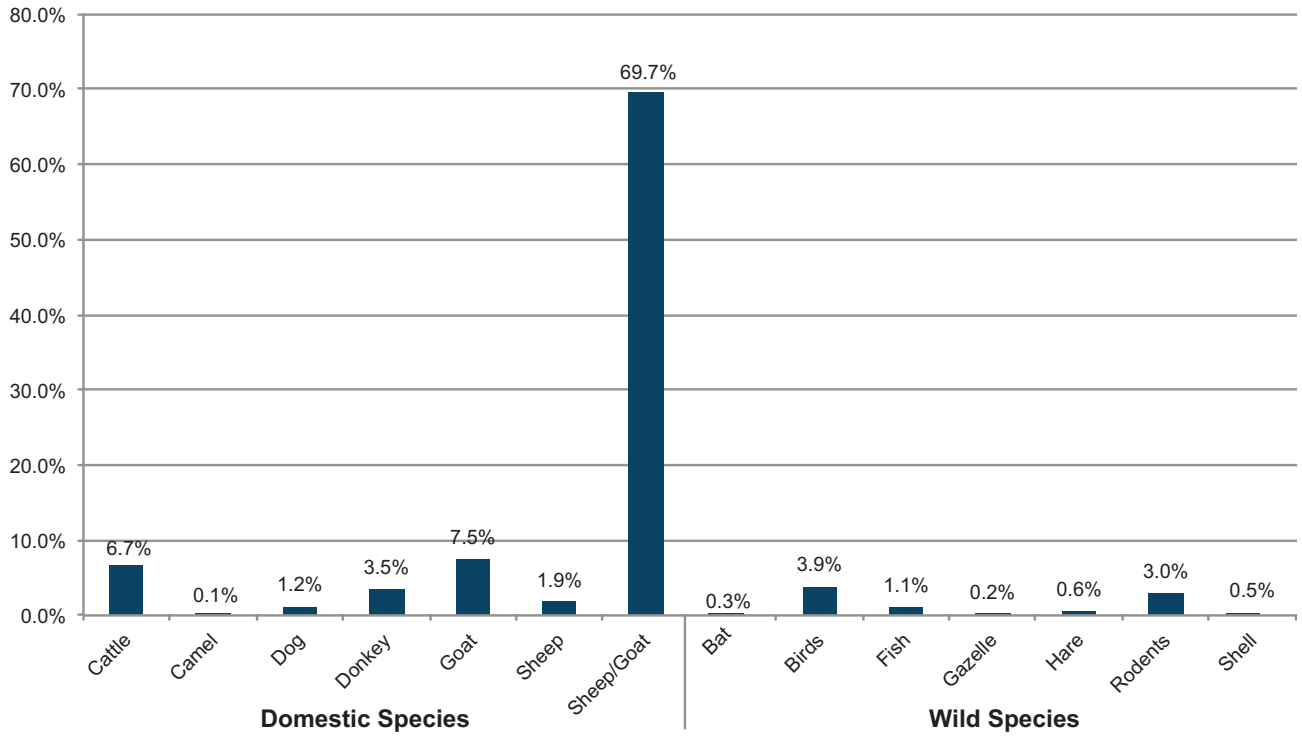

Figure 8.4 Area A taxa.

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Table 8.3a–c Area A sheep/goat fusion data for ninth (NISP = 227) and tenth (NISP = 23) centuries BCE.

			9th Century BCE		10th Century BCE	
Group	*Element*		*Fused*	*Unfused*	*Fused*	*Unfused*
Group A						
Fusing 0-6	Prox Radius		2	9	0	0
	Prox Metapodial		3	14	1	0
		Subtotal	**5**	**23**	**1**	**0**
Group B						
Fusing 6-12	Dist Scapula		1	18	0	0
	Dist Humerus		4	12	0	3
		Subtotal	**5**	**30**	**0**	**3**
Group C						
Fusing 12-18	Prox 1st/2nd Phalanx		20	44	6	5
		Subtotal	**20**	**44**	**6**	**5**
Group D						
Fusing 18-30	Dist Tibia		3	9	0	0
	Dist Metapodial		20	13	1	1
		Subtotal	**23**	**22**	**1**	**1**
Group E						
Fusing 30-48	Prox Humerus		2	3	0	0
	Dist Radius		5	8	0	0
	Prox Ulna		2	1	1	0
	Dist Ulna		1	0	0	0
	Prox Femur		8	4	2	0
	Dist Femur		2	3	0	0
	Prox Tibia		6	4	0	0
	Prox Calcaneus		4	2	3	0
		Subtotal	**30**	**25**	**6**	**0**
		Total	**83**	**144**	**14**	**9**
			227		**23**	

	Group A			Group B			Group C			Group D			Group E		
	F	U	%	F	U	%	F	U	%	F	U	%	F	U	%
9th Century BCE	5	23	2.2%	5	30	2.2%	20	44	8.8%	23	22	10.1%	30	25	13.2%
10th Century BCE	1	0	4.3%	0	3	0.0%	6	5	26.1%	1	1	4.3%	6	0	26.1%

9th Century BCE

Age Interval (mos)	Dying Interval (fused)	Dying Age Interval	Surviving Interval
x	*Nx*	*dx*	*lx*
0-6	5	2	100
6-12	5	2	98
12-18	20	9	96
18-30	23	10	87
30-48	30	13	77
48+			63
NISP	227		

10th Century BCE

Age Interval (mos)	Dying Interval (fused)	Dying Age Interval	Surviving Interval
x	*Nx*	*dx*	*lx*
0-6	1	4	100
6-12	0	0	96
12-18	6	26	96
18-30	1	4	70
30-48	6	26	65
48+			39
NISP	23		

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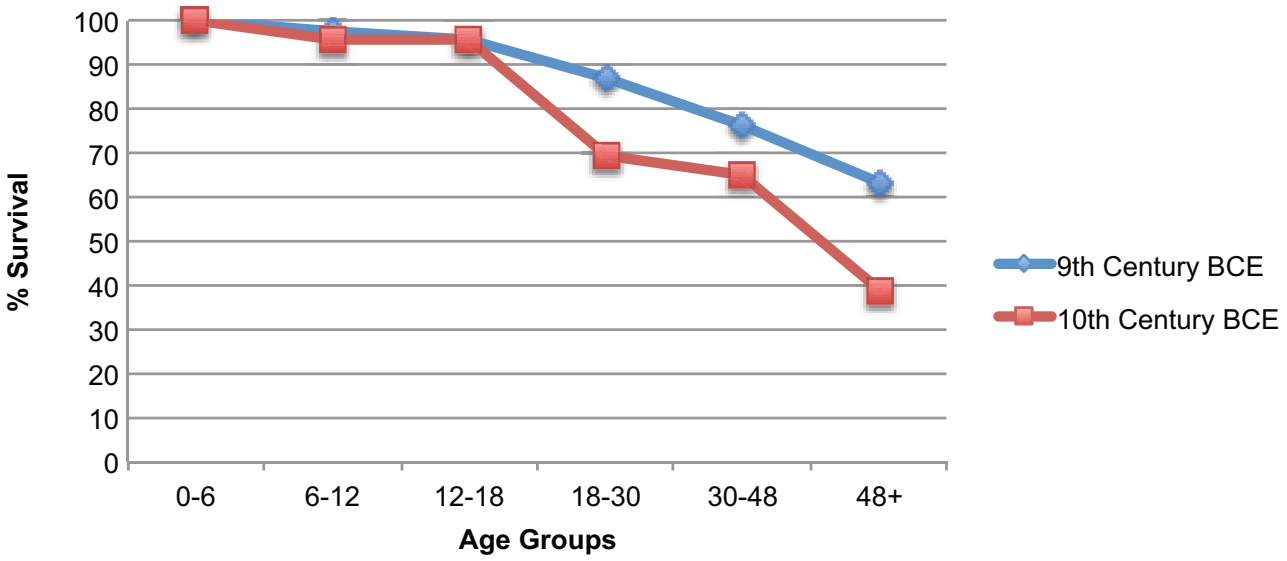

Figure 8.5 Survivorship curve for Area A sheep/goat during the ninth to tenth centuries BCE.

Area M

The chronological anchor for Khirbat en-Nahas is the deep excavation made to virgin soil through one of the site's many slag mounds. The excavation included exposure of a building complex dating to the ninth century BCE near the site surface and an approximately 5 x 5–m probe that extended around 6.5 m through the "slag mound" located along the eastern site of the ancient copper factory (see Chapter 2, this volume). This was an area of intense industrial activity in both the ninth and tenth centuries BCE where furnaces were broken open, slag was crushed, and very few complete objects were found. Area M yielded a total of 7,621 identified and nonidentified specimens. Most of these specimens were heavily fragmented and difficult to identify beyond taxonomic classification family. Only 825 have been identified from the slag mound and its associated structures. The remains of both domestic and wild animals have been identified (Figure 8.6). Domestic animals include cattle (4.1 percent), camel (<1 percent), donkey (2.1 percent), dog (<1 percent), and sheep/goat (80.4 percent). Wild species identified in Area M include birds (<1 percent), fish (9.5 percent), and hare (<1.3 percent). Other species, including rodents, shell, and snakes, account for <1 percent of the faunal assemblage (Figure 8.6).

Caprovines represent the most abundant taxa in Area M. Of the specimens identified, 663 or 80.4 percent were categorized as belonging to domestic sheep (NISP = 15 or 1.8 percent) and goat (NISP = 69 or 8.4 percent). The remainder of specimens (NISP = 579 or 70.2 percent) is too fragmented for taxa identification and has been categorized as sheep/goat. Specimens were recovered from all levels of Area M, ranging from deposits associated with periods ranging from the thirteenth through ninth centuries BCE, thereby providing an insight into herd management practices by the inhabitants at the site. Table 8.4 presents the results of the Area M identified bone counts by NISP, MNE, and MNI. As expected, most identified specimens are from goat. This is not surprising as goats are more resilient in this arid environment. The ratio for every sheep to goat is 1:4.3. Specimens belonging to cattle have been recovered at this area, indicating that the availability of this species was not restricted but was being consumed by individuals carrying out smelting activities throughout the site.

Table 8.5a–c presents the epiphyseal fusion data on the sheep/goats identified from Area M strata dating to the ninth through thirteenth centuries BCE. The data reveal that a fairly high proportion of immature sheep/goat specimens was present for both the ninth and tenth centuries BCE. However, in the eleventh to thirteenth centuries BCE, the data indicate a drop in immature caprovines. Although the sample size is small, the eleventh- to thirteenth-century BCE strata may represent a less specialized copper production economy than in the following tenth to ninth

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Table 8.4 Area M bone counts for the main ungulates (NISP = 456).

	Capra hircus		*Ovis aries*		*Ovis/Capra*		*Bos taurus*	
	NISP	*MNE*	*NISP*	*MNE*	*NISP*	*MNE*	*NISP*	*MNE*
Head								
Occipital condyle					2	1		
Horn	1	1			8	3		
Mandibular condyle					26	11		
Teeth					8	8		
Axial								
Atlas								
Axis					8	7		
Sacrum					1	1		
Forelimb								
Scapula glenoid	8	4	1	1	14	12	2	2
Humerus complete								
Humerus proximal					5	3		
Humerus distal	4	4			16	11		
Radius complete					1	1		
Radius proximal	2	2	2	2	8	5		
Radius distal	2	2	2	2	12	6		
Ulna complete								
Ulna proximal			1	1	15	8		
Ulna distal					1	1		
Metacarpus complete								
Metacarpus proximal					2	2		
Metacarpus distal					1	1		
Hindlimb								
Acetabulum					34	26	2	1
Femur complete								
Femur proximal	3	3	1	1	25	24		
Femur distal	1	1			11	7	2	2
Tibia complete								
Tibia proximal	1	1			12	10		
Tibia distal	3	3	1	1	18	18	1	1
Fibula					2	2		
Astragalus	6	6	1	1	20	12	2	2
Calcaneus	1	1			17	15		
Tarsal					9	6	1	1
Metarsus complete								
Metarsus proximal					3	3		
Metarsus distal	2	2			2	1		
Lower Limbs								
Phalanx 1	16	15	1	1	23	18	3	3
Phalanx 2	9	8	5	5	13	12	1	1
Phalanx 3	4	4			4	4	2	2
Metapodial complete								
Metapodial proximal					16	4		
Metapodial distal	2	1			23	12		
NISP	65		15		360		16	
%NISP	7.88%		1.82%		43.64%		1.94%	
MNI	4		2		12		2	

centuries BCE. The ninth-century BCE data indicate that 71.84 percent of the recovered bones indicated early fusion, while middle and late fusing specimens were slightly dominated by unfused specimens. The percentages are higher for fused elements during the tenth to thirteenth centuries BCE.

The fusion data have been plotted into survivorship curves and are presented in Figure 8.7. These data indicate that in the early phases at KEN, the faunal remains reflect the behavior more typical of a pastoral community where sheep/goat, especially females, lived to older ages so that they could be exploited for their secondary products.

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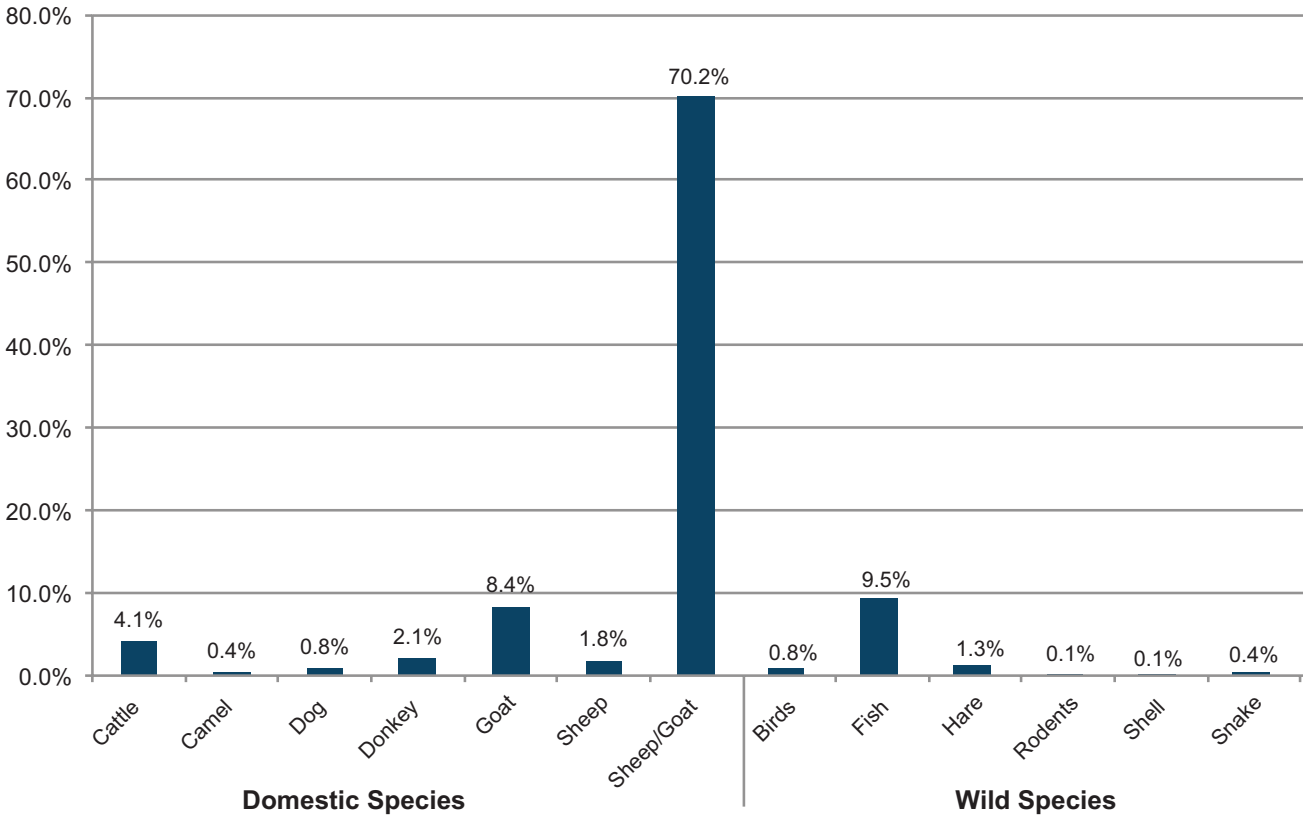

Figure 8.6 Area M taxa.

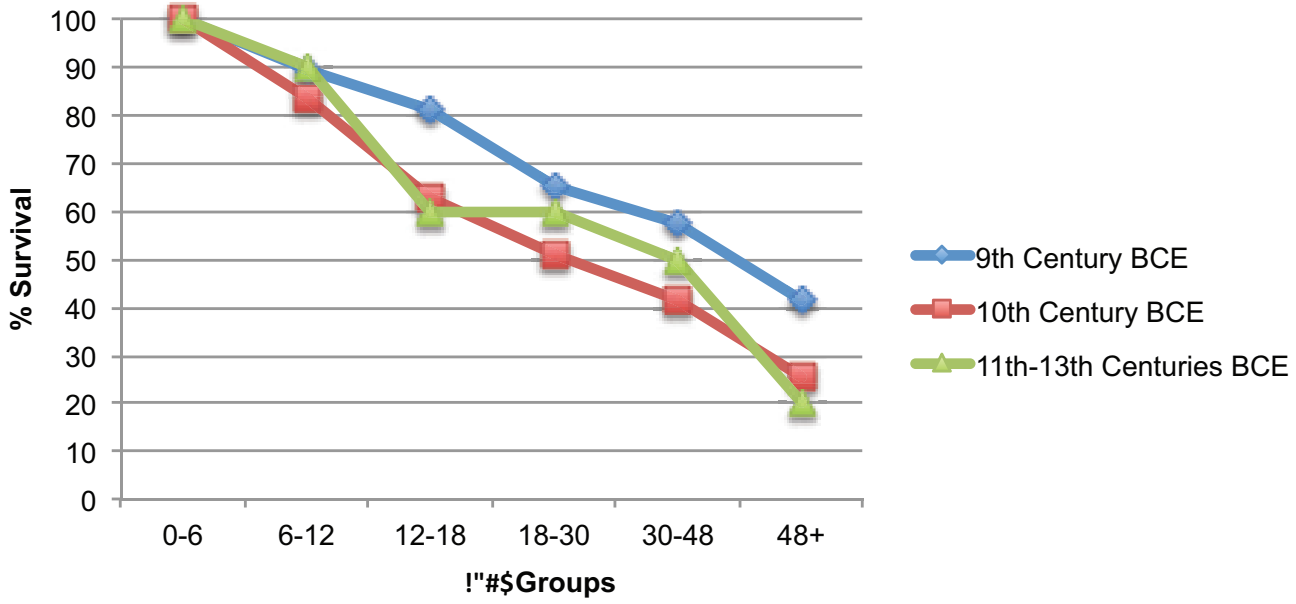

Figure 8.7 Survivorship curve for Area M sheep/goat in the ninth to thirteenth centuries BCE.

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Table 8.5a–c Area M sheep/goat fusion data for ninth (NISP = 213), tenth (NISP = 43), and eleventh to thirteenth (NISP = 20) centuries BCE.

		9th Century BCE		10th Century BCE		11th-13th Century BCE	
Group	*Element*	*Fused*	*Unfused*	*Fused*	*Unfused*	*Fused*	*Unfused*
Group A Fusing 0-6	Prox Radius	8	3	4	0	1	0
	Prox Metapodial	14	1	3	0	1	0
	Subtotal	**22**	**4**	**7**	**0**	**2**	**0**
Group B Fusing 6-12	Dist Scapula	12	0	6	0	4	0
	Dist Humerus	6	8	3	1	2	0
	Subtotal	**18**	**8**	**9**	**1**	**6**	**0**
Group C Fusing 12-18	Prox 1st/2nd Phalanx	34	17	5	3	0	0
	Subtotal	**34**	**17**	**5**	**3**	**0**	**0**
Group D Fusing 18-30	Dist Tibia	8	9	1	0	1	1
	Dist Metapodial	8	13	3	1	1	1
	Subtotal	**16**	**22**	**4**	**1**	**2**	**2**
Group E Fusing 30-48	Prox Humerus	3	1	1	0	0	0
	Dist Radius	4	7	1	2	2	0
	Prox Ulna	2	3	1	0	0	1
	Dist Ulna	0	0	0	0	0	0
	Prox Femur	10	11	3	3	1	0
	Dist Femur	5	4	0	0	0	0
	Prox Tibia	6	6	0	0	0	1
	Prox Calcaneus	5	5	1	1	3	0
	Subtotal	**35**	**37**	**7**	**6**	**6**	**2**
	Total	**125**	**88**	**32**	**11**	**16**	**4**
		213		**43**		**20**	

	Group A			Group B			Group C			Group D			Group E		
	F	U	%	F	U	%	F	U	%	F	U	%	F	U	%
9th Century BCE	22	4	10.3%	18	8	8.5%	34	17	16.0%	16	22	7.5%	35	37	16.4%
10th Century BCE	7	0	16.3%	9	1	20.9%	5	3	11.6%	4	1	9.3%	7	6	16.3%
11th-13th Century BCE	2	0	10.0%	6	0	30.0%	0	0	0.0%	2	2	10.0%	6	2	30.0%

9th Century BCE

Age Interval (mos)	Dying Interval (fused)	Dying Age Interval	Surviving Interval
x	*Nx*	*dx*	*lx*
0-6	22	10	100
6-12	18	8	90
12-18	34	16	81
18-30	16	8	65
30-48	35	16	58
48+			41
NISP	213		

10th Century BCE

Age Interval (mos)	Dying Interval (fused)	Dying Age Interval	Surviving Interval
x	*Nx*	*dx*	*lx*
0-6	7	16	100
6-12	9	21	84
12-18	5	12	63
18-30	4	9	51
30-48	7	16	42
48+			26
NISP	43		

11th-13th Century BCE

Age Interval (mos)	Dying Interval (fused)	Dying Age Interval	Surviving Interval
x	*Nx*	*dx*	*lx*
0-6	2	10	100
6-12	6	30	90
12-18	0	0	60
18-30	2	10	60
30-48	6	30	50
48+			20
NISP	20		

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The survivorship curve for the thirteenth to eleventh century BCE indicates caprovine exploitation is greater at two intervals: 6 to 18 months and 30 to 48 months of age. Animals were culled at an early age, a period when the young meat is more preferable and then again later in their life span when fully matured, perhaps a compromise between meat and secondary products production.

The exploitation of caprovines shifts in the subsequent periods and follows similar patterns for both the tenth and ninth centuries BCE. The curve indicates caprovines were being similarly exploited and both males and female caprovines had an equal chance of surviving into their late years. During these periods, the highest mortality rate for sheep/goat occurred between the age of 12 and 30 months. If the results are accepted, then it could be suggested that the strategy for exploiting these animals parallels Payne's meat production curve where the optimum point for killing surplus animals for meat is between the ages of 18 and 30 months (Payne 1973). Given the high quantity of smelting activity occurring at KEN during these periods, the accessibility of prime animals would have been the preferred means of provisioning the workers.

In Area M, there is very little evidence for body part selection. All body parts are present in the assemblage. Forelimbs and hindlimbs were found in equal proportion. Also found were significant numbers of cranial fragments, neck, body, and specimens from the lower extremities, indicating that the animals were most likely butchered at the site.

A total of 16 bones belonging to cattle were recovered at Area M. Based on fusion analysis, the identified elements represent the remains of two cattle: one adult animal that appeared to have died around the age of 3 to 3.5 years and one immature animal. Although the evidence for cattle at KEN is sparse, mature cattle at the site could validate the emphasis on meat production. However, cattle can also be kept for other reasons, including milk production. In addition, remains of donkey (NISP = 17) and camel (NISP = 3) were also recovered from this area. The incorporation of these animals into the fauna assemblage in Area M is of interest. Both camel and donkey were the primary beasts of burden for moving ore and heavy quantities of processed metal across the southern Levant. At KEN, several of the donkey remains displayed evidence of butchering. Once animals have outlived their usefulness (or possibly before), it appears they were then consumed by the smelters at the site.

Area R

Based on the size, construction, and layout of the building in Area R compared with others at Khirbat en-Nahas, we are confident that this structure served as the primary residence of the ruling elite at the site during the tenth century BCE (see Chapter 2 for details and a discussion of the radiocarbon dating of this area). The architecture found at Area M points to the special function of this building. Found here are the presence of an impressive throne or podium on the exterior of the structure and large buttresses at the entrance of the building. There is also evidence of a well-preserved staircase ascending to an upper level. How the fauna data relate to the function of this monumental building is of particular interest in attempting to understand some of the daily activities carried out by the ruling elite of this phase in the Iron Age. A total sample of 4,382 specimens was processed from the earlier excavations at Area R. Unfortunately, the sample was very fragmented and in very poor condition. Only a small quantity of bones, 268 specimens, was identified from the probes carried out within and in the exterior of the structure. The identified specimens include both domestic and a small sample of wild animals (Figure 8.8). The sample consists of cattle (4.9 percent), donkey (2.6 percent), and sheep/goat (89.2 percent). The wild species identified at this area include birds (1.5 percent), gazelle (1.5 percent), and the remains of rodents (<1 percent).

Similar to Areas A and M, caprovines represent the most abundant taxa in Area R. Of the specimens identified, 195 specimens or 72.8 percent were categorized as belonging to domestic sheep/goat. A breakdown indicates that 29 (11.6 percent) fragments belong to goat and only 1 (<1 percent) could be identified as belonging to sheep. The results of the Area R identified bone counts by NISP, MNE, and MNI are presented in Table 8.6. Excluded from this count are long bone and metapodial shaft fragments, pelvic girdle, skull, and teeth fragments. The remaining specimens (165 or 77.2.6 percent) were too fragmented to identify and were categorized as sheep/goat. Although the sample assemblage is small, it does reveal several important and interesting insights into the use of animals here. The prominence of cattle (4.9 percent) and donkey (2.6 percent) recovered at this area could be a direct reflection of the possible "administrators" overseeing the workers in and around this area. Similarly, the presence of gazelle implies there is some level of opportunistic hunting or perhaps the importing of exotic goods (including fish

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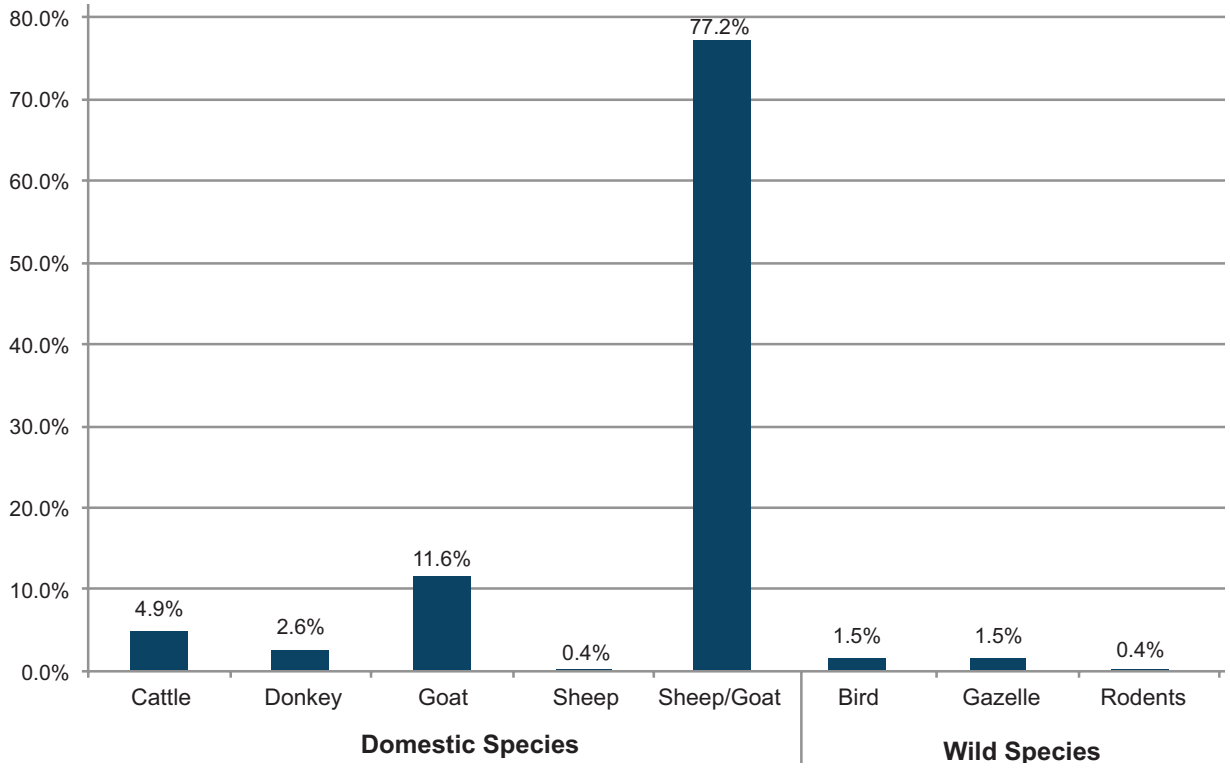

Figure 8.8 Area R taxa.

from the Mediterranean or Red Sea). Gazelles have been consistently exploited in the southern Levant since the Natufian period. In the Faynan region, evidence for the exploitation of gazelles has been documented in the Neolithic (Twiss 2003) and during the Early Bronze Age (Muniz 2007). At KEN, the presence of gazelle occurs mostly in Area S (see below) and Area R. No gazelle bones were located in the probes carried out at Area W (see below), where possible domestic households, including the remains of associated food processing, were sampled. Was this food restricted to elites?

Table 8.7a–c presents the epiphyseal fusion data on the sheep/goat specimens identified from strata dating to the ninth and tenth centuries BCE. Bone fusion stages from the ninth century BCE indicate 42.86 percent of early fusing specimens were unfused as opposed to 75 percent of late fusing specimens. However, given the number of specimens recovered from these layers (4:7), this could be a sampling issue. On the other hand, the data reveal that a fairly high proportion of immature sheep/goat specimens (n = 107) are present in deposits from the tenth century BCE. The bone fusion data indicate that in early fusing specimens, unfused elements totaled 14 percent. Middle and late fusing specimens were at approximately 52 percent and 69 percent unfused.

The fusion data have been plotted into survivorship curves and are presented in Figure 8.9. These data indicate that in the ninth century BCE, the highest mortality rate for sheep/goat was for young animals between 6 and 12 months. If these results are accepted, then the inhabitants at Area R preferred the meat of younger animals. Yet again, this could be the result of a sampling issue. Thereafter, the curve levels out indicating a low mortality rate, resulting in an excellent chance of animals surviving to adulthood. The survivorship curve for the tenth-century BCE data differs slightly. The numbers and survivorship curve indicate animals had an equal chance of surviving until adulthood, although there definitely is a higher preference for younger animals.

Similar to Areas A and M described above, Area R contains no distinct evidence for body part selection. Forelimbs and hindlimbs were found in equal proportion. Cranial fragments, neck, body, and specimens from the lower extremities were also found, indicating complete exploitation of the animal and the possibility that the animals were most likely butchered nearby. Last, a total of 9 (3.4 percent) cattle specimens (MNI = 2) were recovered from Area R. Epiphyseal fusion in these specimens indicates the bones are from

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Table 8.6 Area R bone counts for the main ungulates (NISP = 204).

	Capra hircus		*Ovis aries*		*Ovis/Capra*		*Bos taurus*	
	NISP	*MNE*	*NISP*	*MNE*	*NISP*	*MNE*	*NISP*	*MNE*
Head								
Occipital condyle					1	1		
Horn								
Mandibular condyle					23	18		
Teeth								
Axial								
Atlas								
Axis					4	4		
Sacrum								
Forelimb								
Scapula glenoid	4	4	1	1	3	3		
Humerus complete								
Humerus proximal					3	2		
Humerus distal	1	1			13	10		
Radius complete								
Radius proximal					9	6		
Radius distal	1	1			1	1		
Ulna complete								
Ulna proximal					5	4	1	1
Ulna distal					1	1		
Metacarpus complete								
Metacarpus proximal					1	1		
Metacarpus distal							1	1
Hindlimb								
Acetabulum					19	14		
Femur complete								
Femur proximal	3	3			10	10		
Femur distal					3	3		
Tibia complete								
Tibia proximal	1	1			5	5	2	2
Tibia distal	2	2			3	3	1	1
Fibula								
Astragalus					10	8	1	1
Calcaneus	2	2			6	4		
Tarsal					1	1		
Metarsus complete								
Metarsus proximal	1	1			2	2		
Metarsus distal					2	2		
Lower Limbs								
Phalanx 1	10	10			12	12	1	1
Phalanx 2	2	2			6	6		
Phalanx 3	2	2			5	5		
Metapodial complete								
Metapodial proximal					8	5		
Metapodial distal					9	4	2	2
NISP	29		1		165		9	
%NISP	10.82%		0.37%		61.57%		3.36%	
MNI	2		1		9		1	

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Table 8.7a–c Area R sheep/goat fusion data for the ninth (NISP = 11) and tenth (NISP = 107) century BCE.

		9th Century BCE		10th Century BCE	
Group	*Element*	*Fused*	*Unfused*	*Fused*	*Unfused*
Group A					
Fusing 0-6	Prox Radius	0	1	5	3
	Prox Metapodial	1	0	9	0
	Subtotal	**1**	**1**	**14**	**3**
Group B					
Fusing 6-12	Dist Scapula	1	0	7	0
	Dist Humerus	1	1	7	4
	Subtotal	**2**	**1**	**14**	**4**
Group C					
Fusing 12-18	Prox 1st/2nd Phalanx	1	1	15	0
	Subtotal	**1**	**1**	**15**	**0**
Group D					
Fusing 18-30	Dist Tibia	0	0	4	4
	Dist Metapodial	0	0	4	6
	Subtotal	**0**	**0**	**8**	**10**
Group E					
Fusing 30-48	Prox Humerus	0	1	0	2
	Dist Radius	0	0	1	1
	Prox Ulna	0	1	2	1
	Dist Ulna	0	0	2	0
	Prox Femur	0	1	2	11
	Dist Femur	1	0	1	5
	Prox Tibia	0	0	2	2
	Prox Calcaneus	0	0	4	3
	Subtotal	**1**	**3**	**14**	**25**
	Total	**5**	**6**	**65**	**42**
		11		**107**	

	Group A			Group B			Group C			Group D			Group E		
	F	U	%	F	U	%	F	U	%	F	U	%	F	U	%
9th Century BCE	1	1	9.1%	2	1	18.2%	1	1	9.1%	0	0	0.0%	1	3	9.7%
10th Century BCE	14	3	13.1%	14	4	13.1%	15	0	14.0%	8	10	7.5%	14	25	13.1%

Age Interval (mos)	Dying Interval (fused)	Dying Age Interval	Surviving Interval
x	*Nx*	*dx*	*lx*
0-6	1	9	100
6-12	2	18	91
12-18	1	9	73
18-30	0	0	64
30-48	1	9	64
48+			55
NISP	11		

Age Interval (mos)	Dying Interval (fused)	Dying Age Interval	Surviving Interval
x	*Nx*	*dx*	*lx*
0-6	14	13	100
6-12	14	13	87
12-18	15	14	74
18-30	8	7	60
30-48	14	13	52
48+			39
NISP	107		

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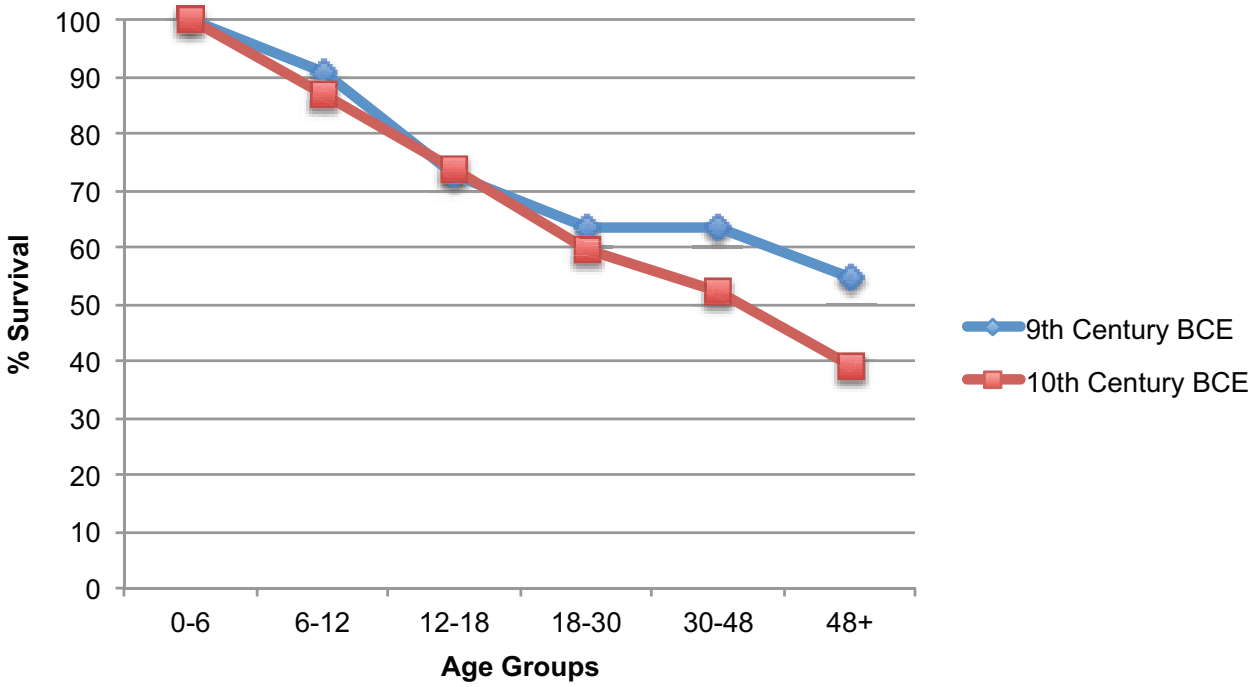

Figure 8.9 Survivorship curve for Area R sheep/goat in the ninth to tenth centuries BCE.

a mature animal. What is most striking about the faunal remains from the monumental building in Area R is the large number of animals less than one year of age that were consumed in this area. This is a pattern one would expect of an elite group who had easy and equal access to meat products. The faunal evidence, coupled with the impressive architecture found at this site, suggests the Area R structure was one used by a higher status group.

Area S

The building complex in Area S was highly specialized and functioned as a center for the crushing of slag. As shown by our research in the hereditary bronze caster workshops of southern India, the extraction of copper embedded in slag is a key process in the recycling of metal (Levy et al. 2008). The large quantity of ground stone artifacts here may indicate that this structure, with its three rooms surrounding a courtyard, functioned as a residence for those who carried out this specialized task in the copper factory (see Chapter 2, this volume). The Area S building dates to the ninth century BCE with early layers of copper production exposed in the different probes made inside and outside the complex.

A total of 7,652 specimens were recovered and processed from deposits at Area S. Of these, 1044 specimens (Figure 8.10) were identified from loci found within and in the exterior of the room structures. The remains include domestic and wild animals. The identified domestic animals include cattle (<1 percent), camel (<1 percent), dog (1.1 percent), and sheep/goat (81.9 percent). Wild species include bird (1.4 percent) and fish (10.4 percent), as well as gazelle (1.4 percent), hare (1.1 percent), rodents (<1 percent), and shell (1.5 percent). As expected, caprovines compose the majority of the collection. Traces of cattle and camel were also recovered, similar to Areas A, M, and R, although donkey is absent here. The wild species recovered from the deposits affiliated with this structure provide an insight into the type of opportunistic strategies practiced by individuals at this site. Perhaps the most surprising species recovered from the excavation are fish and shell. Approximately 79 specimens totaling 10.4 percent of the identified wild species have been identified as fish vertebrae, premaxillare, pharyngeal, and pharyngeal teeth, with 3 specimens measuring in excess of 25 mm. While a comparative analysis is still outstanding, the represented species appear to belong to the families *Sparidae*, *Scaridae*, *Sciaenidae*, and *Labridae* (Lernau 1986) found in the

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Red and Mediterranean Seas. Of the identifiable material, 669 specimens or 64.1 percent were categorized as belonging to domestic sheep and goat. Table 8.8 presents the results of the Area S analysis by identified element. Most identified specimens appear to be from goat (*n* = 71 or 6.8 percent) and sheep, accounting for 32 or 3.1 percent. The ratio for every sheep to goat at Area S is 1:2.2. MNI accounts reveal 2 goats, 2 sheep, and 15 sheep/goats recovered from the various loci. Last, two metapodials (<1 percent) belonging to cattle (MNI = 2) were recovered from Area S. A closer inspection of body part representation in Table 8.8 reveals animals were being fully exploited and all body parts were consumed. Specimen counts for forelimbs and hindlimbs are found in equal proportion, as are cranial fragments. Also found were significant numbers of neck, body, and bones from the lower extremities.

Table 8.9a–c presents the epiphyseal fusion data on the sheep/goats identified from strata dating to the ninth through thirteenth centuries BCE. When compared to other areas, the data reveal that a lower proportion of immature sheep/goat specimens was present for all periods: ninth to thirteenth centuries BCE. Given the building structure has been dated to the ninth century BCE, it is not surprising that most specimens are from loci associated with these strata while the early deposits contain very small samples. The bone counts from this period indicate both fused and unfused specimens are dominant at this site. The data for the thirteenth to tenth centuries BCE are similar.

The fusion data have been plotted into survivorship curves and are presented in Figure 8.11. The survivorship curve for sheep/goat during the ninth century BCE indicates that the highest mortality rate for sheep/goat was for animals between 12 and 18 months. Animals surviving past this stage stood an excellent chance of surviving to 48 months and some beyond. A similar curve can be seen for the sparse data for sheep/goat for the thirteenth to tenth centuries BCE. The data indicate a high mortality rate for animals between 12 and 18 months and then at 30 to 48 months, when they had more than likely outlived their usefulness in the exploitation of secondary products. The ninth-century BCE building complex in Area S provides another indication that during this century, pastoral economic principles were strong at KEN. This may indicate that milking and wool production were more common at KEN in the ninth century BCE compared with that of the tenth century BCE or earlier.

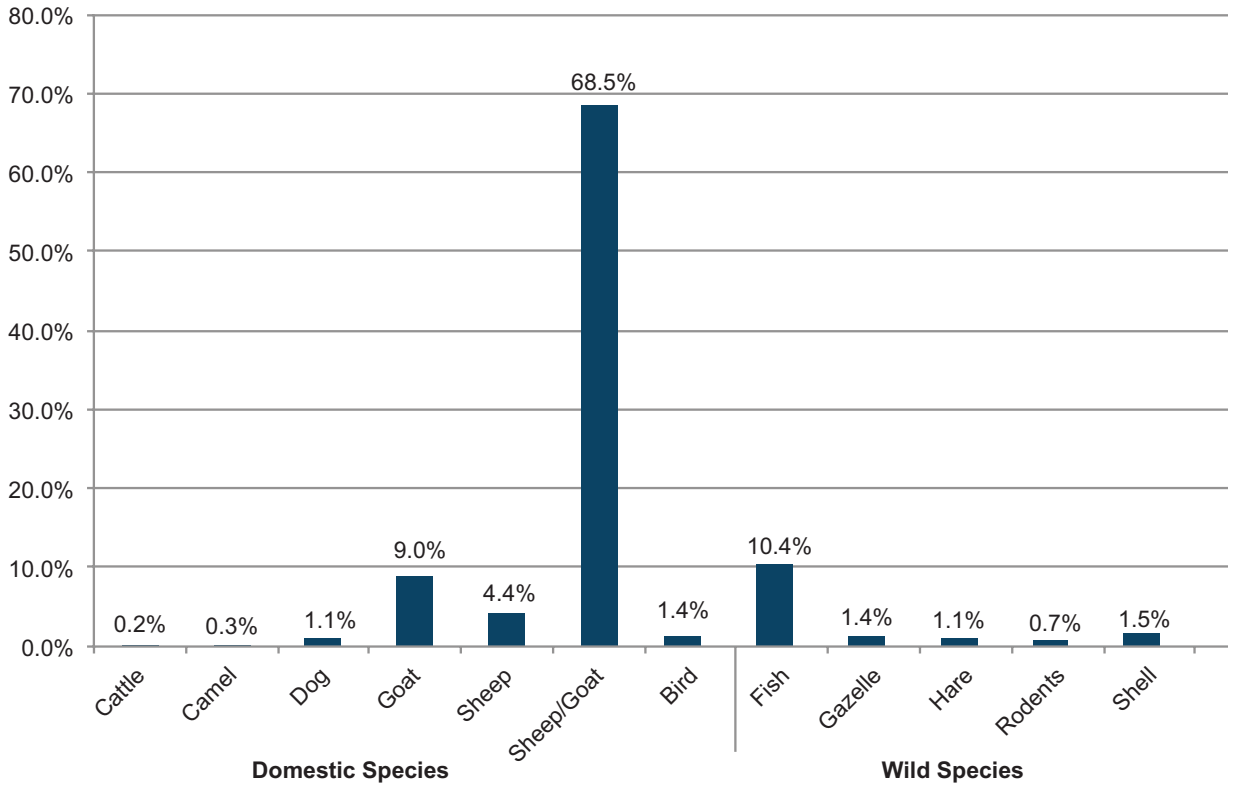

Figure 8.10 Area S taxa.

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Table 8.8 Area S bone counts for the main ungulates (NISP = 671).

	Capra hircus		*Ovis aries*		*Ovis/Capra*		*Bos taurus*	
	NISP	*MNE*	*NISP*	*MNE*	*NISP*	*MNE*	*NISP*	*MNE*
Head								
Occipital condyle								
Horn					3	2		
Mandibular condyle	1	1			49	23		
Teeth	1	1						
Axial								
Atlas					3	3		
Axis	1	1			7	7		
Sacrum					2	2		
Forelimb								
Scapula glenoid	4	4	5	4	34	24		
Humerus complete								
Humerus proximal					20	16		
Humerus distal	1	1	1	1	23	14		
Radius complete								
Radius proximal	1	1	2	2	20	20		
Radius distal					16	16		
Ulna complete								
Ulna proximal	2	2			15	13		
Ulna distal								
Metacarpus complete								
Metacarpus proximal								
Metacarpus distal			1	1				
Hindlimb								
Acetabulum			1	1	38	18		
Femur complete								
Femur proximal	4	4	4	4	36	24		
Femur distal			1	1	19	12		
Tibia complete								
Tibia proximal			1	1	15	8		
Tibia distal			1	1	21	12		
Fibula								
Astragalus	1	1			45	32		
Calcaneus	1	1			11	8		
Tarsal								
Metarsus complete								
Metarsus proximal			1	1	12	5		
Metarsus distal	1	1						
Lower Limbs								
Phalanx 1	26	17	6	6	69	32		
Phalanx 2	16	12	4	4	31	24		
Phalanx 3	3	3			17	14	1	1
Metapodial complete								
Metapodial proximal	1	1			23	6		
Metapodial distal	7	7	4	4	37	8	1	1
NISP	71		32		566		2	
%NISP	6.80%		3.07%		54.21%		0.19%	
MNI	2		2		15		1	

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Table 8.9a–c Area S sheep/goat fusion data for ninth (NISP = 298), tenth (NISP = 15), and eleventh to thirteenth (NISP = 15) centuries BCE.

		9th Century BCE		10th Century BCE		11th-13th Century BCE	
Group	*Element*	*Fused*	*Unfused*	*Fused*	*Unfused*	*Fused*	*Unfused*
Group A Fusing 0-6	Prox Radius	4	4	0	0	0	0
	Prox Metapodial	14	1	0	0	3	0
	Subtotal	**18**	**5**	**0**	**0**	**3**	**0**
Group B Fusing 6-12	Dist Scapula	29	4	1	1	2	0
	Dist Humerus	20	1	2	0	0	0
	Subtotal	**49**	**5**	**3**	**1**	**2**	**0**
Group C Fusing 12-18	Prox 1st/2nd Phalanx	79	24	3	4	3	1
	Subtotal	**79**	**24**	**3**	**4**	**3**	**1**
Group D Fusing 18-30	Dist Tibia	5	9	0	0	1	0
	Dist Metapodial	17	18	0	0	0	0
	Subtotal	**22**	**27**	**0**	**0**	**1**	**0**
Group E Fusing 30-48	Prox Humerus	6	3	0	0	0	1
	Dist Radius	5	3	0	0	0	0
	Prox Ulna	3	6	0	0	2	0
	Dist Ulna	0	0	0	0	0	0
	Prox Femur	5	11	0	0	1	1
	Dist Femur	2	7	1	1	0	0
	Prox Tibia	3	4	1	1	0	0
	Prox Calcaneus	7	2	0	0	0	0
	Subtotal	**31**	**36**	**2**	**2**	**3**	**2**
	Total	**199**	**97**	**8**	**7**	**12**	**3**
		296		**15**		**15**	

	Group A			Group B			Group C			Group D			Group E		
	F	U	%	F	U	%	F	U	%	F	U	%	F	U	%
9th Century BCE	18	5	6.1%	49	5	16.6%	79	24	26.7%	22	27	7.4%	31	36	10.5%
10th Century BCE	0	0	0.0%	3	1	20.0%	3	4	20.0%	0	0	0.0%	2	2	13.3%
11th-13th Century BCE	3	0	20.0%	2	0	13.3%	3	1	20.0%	1	0	6.7%	3	2	20.0%

9th Century BCE

Age Interval (mos)	Dying Interval (fused)	Dying Age Interval	Surviving Interval
x	*Nx*	*dx*	*lx*
0-6	18	6	100
6-12	49	17	94
12-18	79	27	77
18-30	22	7	51
30-48	31	10	43
48+			33
NISP	296		

10th Century BCE

Age Interval (mos)	Dying Interval (fused)	Dying Age Interval	Surviving Interval
x	*Nx*	*dx*	*lx*
0-6	0	0	100
6-12	3	20	100
12-18	3	20	80
18-30	0	0	60
30-48	2	13	60
48+			47
NISP	15		

11th-13th Century BCE

Age Interval (mos)	Dying Interval (fused)	Dying Age Interval	Surviving Interval
x	*Nx*	*dx*	*lx*
0-6	3	20	100
6-12	2	13	80
12-18	3	20	67
18-30	1	7	47
30-48	3	20	40
48+			20
NISP	15		

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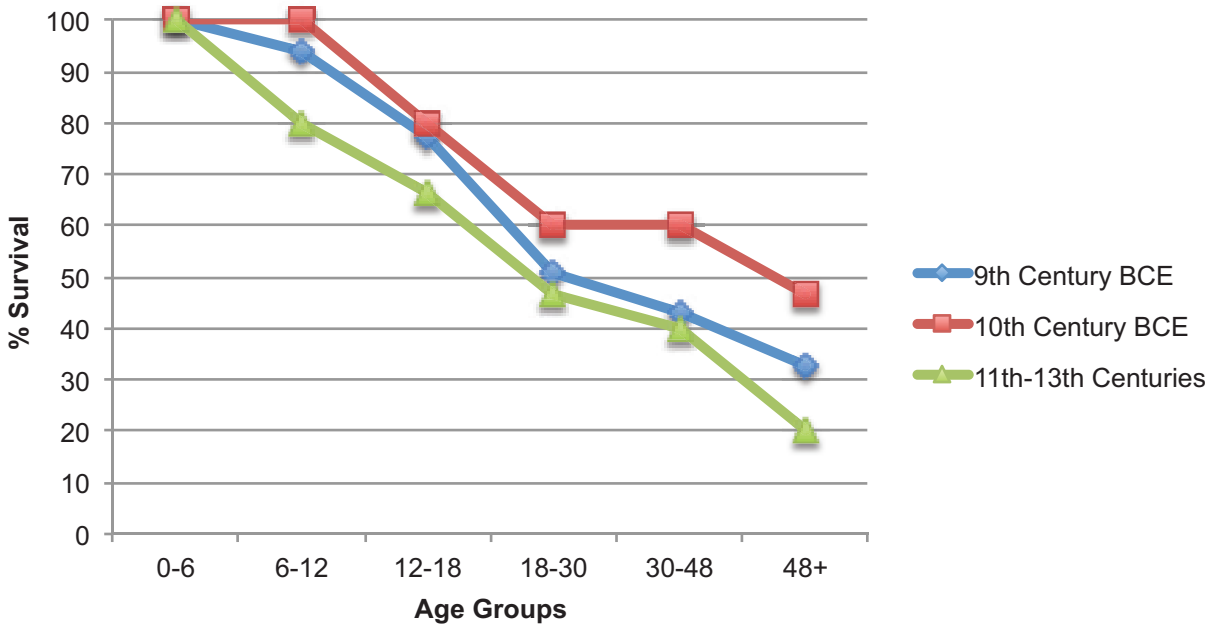

Figure 8.11 Survivorship curve for Area S sheep/goat in the ninth to thirteenth centuries BCE.

Area T

Like Area R, the building in Area T probably belonged to the elite residing at KEN during the tenth century BCE (see Chapter 2 for overview of this building and the radiocarbon chronology). The Area T structure is markedly different from the ninth-century buildings in Areas M and S discussed above. The walls are stout and at least twice as thick as the ninth-century BCE structures. Found within the walls of Area T are the remnants of a stairwell and a second level or tower. If the structure did indeed belong to the tenth century BCE, then a possible argument can be made for a hierarchy involved in overseeing metal production at this time. The assemblage from Area T was made up of 5,995 specimens. Due to heavy fragmentation, only 418 specimens have been identified. The specimens were recovered from deposits including fills and floors identified within the five-room structure that made up Area T. The remains (Figure 8.12) of both domestic and wild animals were recovered by hand and from the sieve. Identified domestic animals include cattle (7.2 percent), donkey (<1 percent), dog (<1 percent), and sheep/goat (78.2 percent). Wild species include bird (3.1 percent), fish (3.3 percent), bat (<1 percent), gazelle (1.9 percent), hare (2.4 percent), rodents (<1 percent), and shell (2.4 percent). Given the proximity of this structure to Areas S and R, it is not surprising the main taxa found here are similar in makeup.

Similar to all areas at KEN, caprovines represent the most abundant taxa in Area T. Of the specimens identified, 236 specimens or 56.5 percent were categorized as belonging to domestic sheep/goat. A further breakdown indicates fragmentation was too great to allow for making the distinction between sheep and goat. Only 8 (1.91 percent) specimens were identified as belonging to goats. No fragments belonging to sheep were identified. The remaining identified specimens (n = 228 or 54.55 percent) were categorized as sheep/goat. Table 8.10 presents the results of the Area T identified bone counts by NISP, MNE, and MNI. The results indicate an MNI of 1 for goat and 14 for sheep/goat. Similar to the other areas, body part selection in Area T indicates no preference for any particular part of the animal. Forelimbs and hindlimbs were found in equal proportion, as were other cranial and postcranial fragments. The amount of fragments identified as belonging to cattle is higher than in the other areas. A total of 30 (7.2 percent) cattle specimens were recovered from Area T. From this sample, an NISP of 15 or an MNI of 1 were categorized as diagnostic specimens. As listed in Table 8.10, these represent the finds from one adult animal.

Table 8.11a–c presents the epiphyseal fusion data on the sheep/goats identified from the various strata associated with Area T and dating to the ninth and tenth centuries BCE. Similar to the other areas, the fused/

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Table 8.10 Area T bone counts for the main ungulates (NISP = 251).

	Capra hircus		*Ovis aries*		*Ovis/Capra*		*Bos taurus*	
	NISP	*MNE*	*NISP*	*MNE*	*NISP*	*MNE*	*NISP*	*MNE*
Head								
Occipital condyle					1	1		
Horn					2	1		
Mandibular condyle					18	12		
Teeth								
Axial								
Atlas					2	2		
Axis					1	1		
Caudal							1	1
Forelimb								
Scapula glenoid	1	1			9	6		
Humerus complete								
Humerus proximal					9	7		
Humerus distal					12	12	1	1
Radius complete								
Radius proximal					13	9		
Radius distal					7	6		
Ulna complete								
Ulna proximal					8	6	1	1
Ulna distal								
Metacarpus complete								
Metacarpus proximal					2	2		
Metacarpus distal	1	1			2	2		
Hindlimb								
Acetabulum					21	21	1	1
Femur complete								
Femur proximal					16	12		
Femur distal					3	3	2	2
Tibia complete								
Tibia proximal					7	6		
Tibia distal					8	6	2	2
Fibula					1	1	1	1
Astragalus					20	19		
Calcaneus					15	14		
Tarsal					4	4	1	1
Metarsus complete								
Metarsus proximal					5	5		
Metarsus distal								
Lower Limbs								
Phalanx 1	4	4			8	6	1	1
Phalanx 2	1	1			2	2	4	4
Phalanx 3								
Metapodial complete								
Metapodial proximal					12	5		
Metapodial distal	1	1			20	13		
NISP	8		0		228		15	
%NISP	1.91%		0.00%		54.55%		3.59%	
MNI	1				14		1	

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Table 8.11a–c Area T sheep/goat fusion data for the ninth (NISP = 99) and tenth (NISP = 88) centuries BCE.

			9th Century BCE		10th Century BCE	
Group	*Element*		*Fused*	*Unfused*	*Fused*	*Unfused*
Group A Fusing 0-6	Prox Radius		9	1	4	1
	Prox Metapodial		7	0	12	0
		Subtotal	**16**	**1**	**16**	**1**
Group B Fusing 6-12	Dist Scapula		5	0	5	0
	Dist Humerus		4	3	3	3
		Subtotal	**9**	**3**	**8**	**3**
Group C Fusing 12-18	Prox 1st/2nd Phalanx		14	7	9	7
		Subtotal	**14**	**7**	**9**	**7**
Group D Fusing 18-30	Dist Tibia		4	1	0	3
	Dist Metapodial		8	3	1	10
		Subtotal	**12**	**4**	**1**	**13**
Group E Fusing 30-48	Prox Humerus		1	1	0	8
	Dist Radius		4	2	0	1
	Prox Ulna		0	1	1	1
	Dist Ulna		0	0	0	0
	Prox Femur		3	5	1	7
	Dist Femur		0	3	0	4
	Prox Tibia		0	6	0	0
	Prox Calcaneus		7	0	1	6
		Subtotal	**15**	**18**	**3**	**27**
		Total	**66**	**33**	**37**	**51**
			99		**88**	

	Group A			Group B			Group C			Group D			Group E		
	F	U	%	F	U	%	F	U	%	F	U	%	F	U	%
9th Century BCE	16	1	16.2%	9	3	9.1%	14	7	14.1%	12	4	12.1%	15	18	15.2%
10th Century BCE	16	1	18.2%	8	3	9.1%	9	7	10.2%	1	13	1.1%	3	27	3.4%

9th Century BCE

Age Interval (mos)	Dying Interval (fused)	Dying Age Interval	Surviving Interval
x	*Nx*	*dx*	*lx*
0-6	16	16	100
6-12	9	9	84
12-18	14	14	75
18-30	12	12	61
30-48	15	15	48
48+			33
NISP	99		

10th Century BCE

Age Interval (mos)	Dying Interval (fused)	Dying Age Interval	Surviving Interval
x	*Nx*	*dx*	*lx*
0-6	16	18	100
6-12	8	9	82
12-18	9	10	73
18-30	1	1	63
30-48	3	3	61
48+			58
NISP	88		

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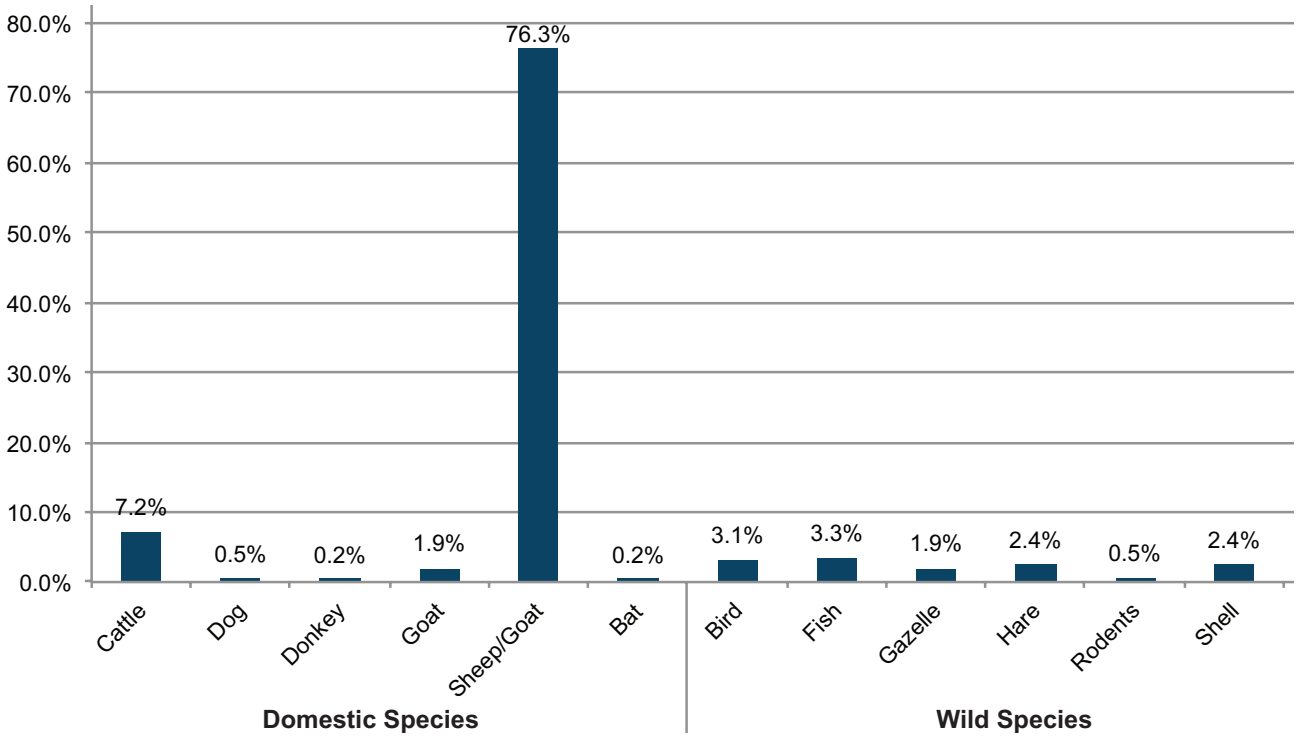

Figure 8.12 Area T taxa.

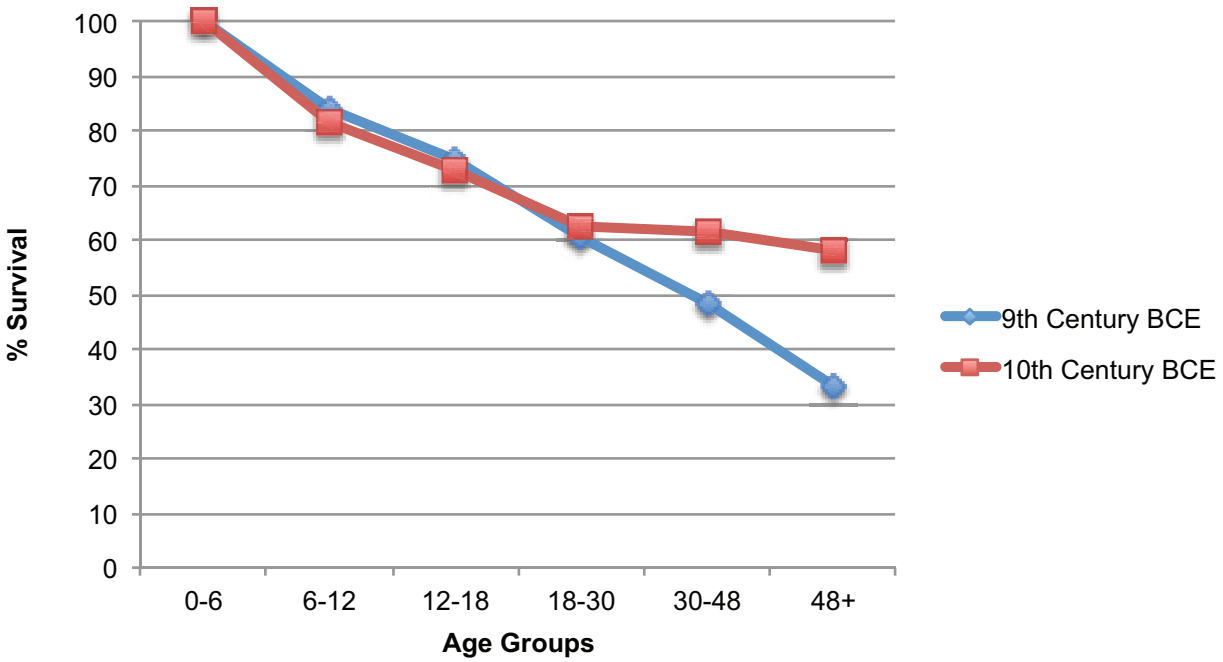

Figure 8.13 Survivorship curve for Area T sheep/goat in the ninth and tenth centuries BCE.

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unfused data reveal both immature and mature sheep/goat specimens were present in the assemblage for both periods. The fusion data have been plotted into survivorship curves and are presented in Figure 8.13. The fusion data indicate for both the ninth and tenth centuries BCE, animals were kept to old age. However, both young and mature animals were exploited to sustain the inhabitants. The similarities in the curve for the two periods could also indicate that the ninth-century BCE samples probably reflect late tenth/early ninth-century BCE deposits. Similarly, the argument could be made that activities during the ninth century BCE at this structure might be directly linked or related to Area S, which lies in close proximity.

Area W

The architecture at Area W consists of 18 rooms ranging in various sizes and includes two interior courtyards containing various installations. The evidence strongly suggests these rooms and courtyards served as a storage facility, living areas, and perhaps even had a cultic function associated with one structure. While significant evidence indicates that copper smelting might have been the foremost activity at this area, no evidence for direct smelting was recovered within the structures. It is possible that part of the architecture at Area W (Chapter 1) represents the home of a high-ranked official and his kin. Inside the structure, a large courtyard containing stairs, well-constructed pillars, and a standing stone was found. This structure probably had a second level used for domestic activities. Part of the excavations at this area included probes that uncovered areas containing household architecture and the remains of associated activities. Excavation of various rooms revealed clay ovens, grinding stones, benches, and stairs.

The sample assemblage from Area W consists of 858 specimens. The sample from this area was heavily fragmented, and only a small sample of specimens currently has been identified. The specimens from Area W were recovered from fills and floors identified within the room structures from three complexes that comprised Area W. Excavators recovered the remains of domestic and wild animals by hand and from the sieve. Identified domestic animals (Figure 8.14) include cattle (<1 percent), dog (<1 percent), donkey (<1 percent), and sheep/goat (93.7 percent). Wild species include birds (<1 percent), fish, hare (1.3 percent), and shell (1.8 percent). Interestingly enough, no cattle remains have been identified in the sample, although this could be a result of sample size.

The sample reveals sheep/goat are also the most abundant species found in Area W. Of the specimens identified, 210 specimens or 93.8 percent were categorized as belonging to domestic sheep/goat. Heavy fragmentation prevented further distinction between the identification of sheep and goat. Only 7 (3.1 percent) specimens were identified as belonging to goats, while 1 specimen (<1

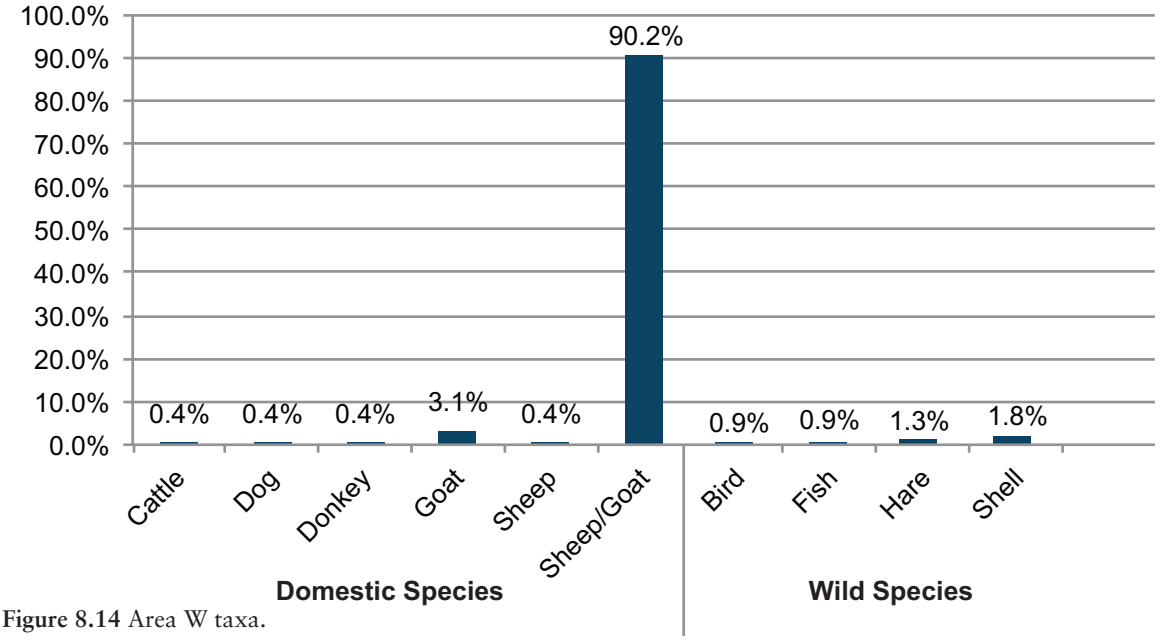

Figure 8.14 Area W taxa.

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Table 8.12 Area W bone counts for the main ungulates (NISP = 76).

	Capra hircus		*Ovis aries*		*Ovis/Capra*		*Bos taurus*	
	NISP	*MNE*	*NISP*	*MNE*	*NISP*	*MNE*	*NISP*	*MNE*
Head								
Occipital condyle								
Horn								
Mandibular condyle					2	2		
Teeth					1	1	1	1
Axial								
Atlas					2	2		
Axis					1	1		
Caudal								
Forelimb					3	2		
Scapula glenoid								
Humerus complete								
Humerus proximal					2	2		
Humerus distal	1	1						
Radius complete								
Radius proximal					1	1		
Radius distal	1	1			2	2		
Ulna complete								
Ulna proximal					1	1		
Ulna distal								
Metacarpus complete								
Metacarpus proximal								
Metacarpus distal								
Hindlimb					12	4		
Acetabulum								
Femur complete								
Femur proximal					1	1		
Femur distal					5	3		
Tibia complete								
Tibia proximal					1	1		
Tibia distal					3	2		
Fibula								
Astragalus					5	3		
Calcaneus	1	1			3	2		
Tarsal					4	2		
Metarsus complete								
Metarsus proximal								
Metarsus distal								
Lower Limbs								
Phalanx 1	2	1	1	1	2	1		
Phalanx 2	1	1			1	1		
Phalanx 3	1	1			3	1		
Metapodial complete								
Metapodial proximal					8	2		
Metapodial distal					4	1		
NISP	7		1		67		1	
%NISP	3.13%		0.45%		29.91%		0.45%	
MNI	1				14		1	

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Table 8.13a–c Area W sheep/goat fusion data for ninth (NISP = 12) and tenth (NISP = 14) centuries BCE.

		9th Century BCE		10th Century BCE	
Group	*Element*	*Fused*	*Unfused*	*Fused*	*Unfused*
Group A Fusing 0-6	Prox Radius	1	0	1	0
	Prox Metapodial	1	0	1	1
	Subtotal	**2**	**0**	**2**	**1**
Group B Fusing 6-12	Dist Scapula	2	0	2	0
	Dist Humerus	1	0	1	0
	Subtotal	**3**	**0**	**3**	**0**
Group C Fusing 12-18	Prox 1st/2nd Phalanx	1	0	1	1
	Subtotal	**1**	**0**	**1**	**1**
Group D Fusing 18-30	Dist Tibia	1	0	1	0
	Dist Metapodial	1	0	0	0
	Subtotal	**2**	**0**	**1**	**0**
Group E Fusing 30-48	Prox Humerus	1	0	1	0
	Dist Radius	0	0	1	0
	Prox Ulna	0	0	0	0
	Dist Ulna	0	0	0	0
	Prox Femur	0	0	0	0
	Dist Femur	0	1	0	1
	Prox Tibia	0	0	0	0
	Prox Calcaneus	2	0	2	0
	Subtotal	**3**	**1**	**4**	**1**
	Total	**11**	**1**	**11**	**3**
		12		**14**	

	Group A			Group B			Group C			Group D			Group E		
	F	U	%	F	U	%	F	U	%	F	U	%	F	U	%
9th Century BCE	2	0	16.7%	3	0	25.0%	1	0	8.3%	2	0	16.7%	3	1	25.0%
10th Century BCE	2	1	14.3%	3	0	21.4%	1	1	7.1%	1	0	7.1%	4	1	28.6%

9th Century BCE

Age Interval (mos)	Dying Interval (fused)	Dying Age Interval	Surviving Interval
x	*Nx*	*dx*	*lx*
0-6	2	17	100
6-12	3	25	83
12-18	1	8	58
18-30	2	17	50
30-48	3	25	33
48+			8
NISP	12		

10th Century BCE

Age Interval (mos)	Dying Interval (fused)	Dying Age Interval	Surviving Interval
x	*Nx*	*dx*	*lx*
0-6	2	14	100
6-12	3	21	6
12-18	1	7	64
18-30	1	7	57
30-48	4	29	0
48+			21
NISP	14		

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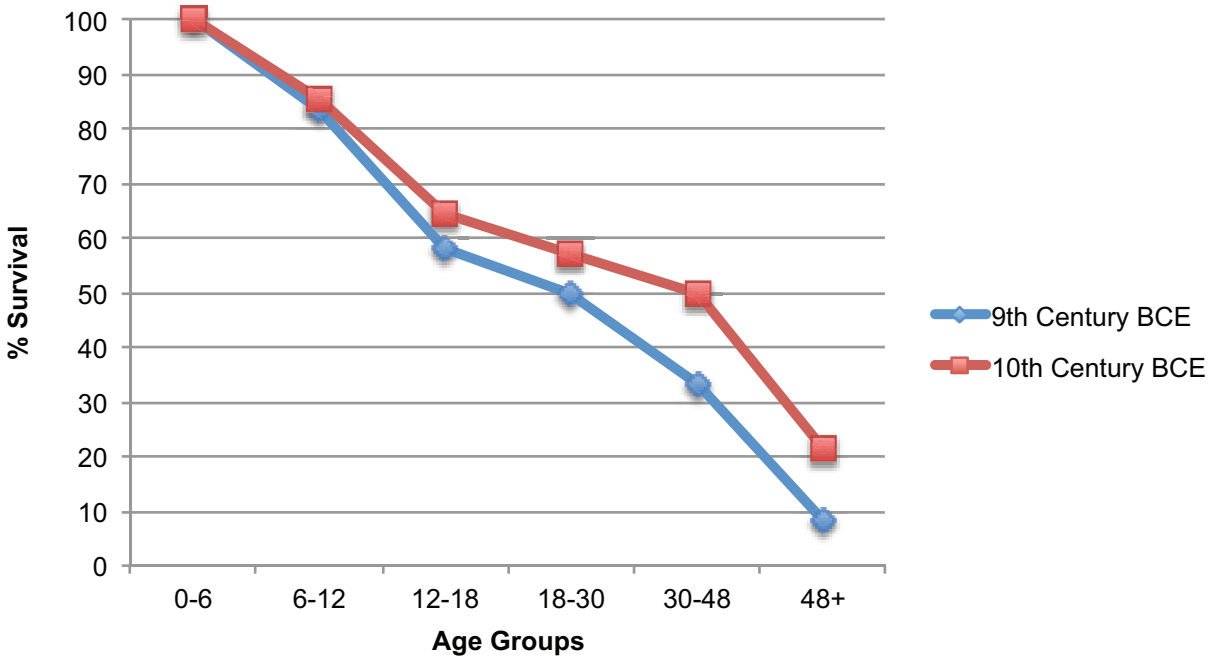

Figure 8.15 Area W sheep/goat survivorship curves for ninth (NISP = 12) and tenth (NISP = 14) centuries BCE.

percent) represents sheep. Table 8.12 presents the results of the Area W identified bone counts by NISP, MNE, and MNI. The results indicate an MNI of 1 for goat and 14 for sheep/goat. Specimens recovered from this area suggest there is no evidence for body part selection in Area W as all parts are represented, with forelimbs and hindlimbs in equal proportion. Significant numbers of cranial fragments, neck, body, and specimens from the lower extremities were also recovered.

The epiphyseal fusion data on the sheep/goats identified from the various strata dating to the ninth and tenth centuries BCE can be found in Table 8.13a–c. The fused/unfused data reveal that a fairly high proportion of mature sheep/goat specimens was present for both the ninth and tenth centuries BCE, with few specimens from immature animals. From the data, it could be inferred that the inhabitants of these structures preferred or were limited to adult animals. However, this interpretation may be a result of sample size. The fusion data have been plotted into survivorship curves and are presented in Figure 8.13. During the ninth century BCE, the data indicate that mortality rates for sheep/goat follow a similar exploitation pattern for both periods. Animals were exploited for both meat and secondary products and survived into adulthood. This type of strategy is similar to the pattern of exploitation evident across the site.

Discussion and Conclusions

Methodologically, the data collected from the assemblage allow us to investigate consumption from two perspectives. First, by looking at consumption as an act, the direct evidence allows us to investigate agents and decisions involving provisioners and consumers (Crabtree 1996; Gunnerman 1997:106–107; Wapnish and Hesse 1988; Zeder 1991). Second, consumption is thought of as a process, thus widening the investigation to include food preparation, presentation, distribution, storage, disposal, and so on. Research in these topics by Milner and Miracle (2002) and Hayden (1996), to name two, shows a range of approaches and methods that can help us address some of these issues (Milner and Miracle 2002:2). In analyzing the faunal remains of a site, there are several steps to consider. The first step is to consider the list of species present at the site. The presence of species in an assemblage gives a first look at the type of animals being exploited at the site. However, it is important to point out that one clearly needs to consider the effects of different taphonomic agents, whether natural or manmade (Lyman 1994; Schiffer 1996), as well as the influence of sample size on assemblage diversity. The latter is especially true of Khirbat en-Nahas given the large-scale industrialized production that occurred at the site.

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Other important issues to consider are the source of food and the distances it would have been transported. For example, can some foods be identified as "exotic"? If so, what are the implications on the cultural and social reality of the site due to these types of species? The contrast between domesticated and wild species, including marine resources, has been frequently stressed in the zooarchaeological literature (Ervynck et al. 2003; van der Veen 2003). Given the significant symbolic weight associated with these different spheres of resources and the common cultural elaboration of rules for keeping these spheres distinct, it seems likely that the domesticated–wild dichotomy may have been an important structuring principle in production sites such as Khirbat en-Nahas and in our study of consumption there.

In considering consumption as an act, it is possible to address provisioning of centers and the diversity (or lack of) animal species exploited by a population. The relationship between limited species diversity and urban provisioning has been discussed in the literature (Wapnish and Hesse 1988; Zeder 1991). For example, Zeder (1991) argues that when urban dwellers are provisioned through indirect channels, the provisioners' interest in meeting distribution requirements would probably favor species that provide the most meat per animal. In addition, Zeder argues that indirect provisioning would lead to a lower diversity of species available to the consumer. She suggests, for example, that by ensuring dependency on centrally distributed resources, provisioners maximize control over consumers. Therefore, the direct procurement of supplementary meat might be actively discouraged.

Based on Zeder's model and the type of abundant species that appear at the site, it is possible to gain insights about provisioners and consumers at Khirbat en-Nahas. This may in turn offer clues into the social organization of the site from a logistical provisioning perspective. If indirect provisioning occurred at the site, we expect a lower diversity of species available to the consumer, which therefore could be interpreted as food resources being centrally controlled and distributed. Thus, since direct procurement of supplementary meat might be actively discouraged, we would find a diet rarely supplemented by available game species such as gazelle, deer, hares, bird, and other types of "exotic" species. On the other hand, if direct provisioning is expected, the assemblage should contain a greater diversity of species available to the consumer. We would expect to find not only domesticated animals but also diversity in species occurring at the site.

Based on the zooarchaeological study at Khirbat en-Nahas, the population had equal access to food items brought to the site. The species list for the faunal assemblage recovered from strata dating to the ninth to thirteenth centuries BCE reflects an animal economy relying largely on the use of sheep, goats, and cattle. These taxa were identified in all areas of the site, indicating equal access to these animals. However, of special interest is the low number of cattle bones (2 or <1 percent) found in Area S. Donkeys were found in all areas except Area S. Preliminary analysis on butchering patterns indicates donkeys were exploited for food, probably after service as beasts of burden in the Iron Age copper production system. The remains of camel were also identified at Areas A, M, and S but are absent at the two large structures found at Areas R and T. These animals probably were not a part of the diet of the ruling elites at KEN but rather meant to provide relatively large quantities of meat for workers at the site.

The wild taxa list from the areas at Khirbat en-Nahas indicates that the diet was at times supplemented by game. The point to consider is whether the majority of the main species (i.e., gazelle, fish, and hare) were brought to the site by hunting parties or as a result of opportunistic hunting. Given the small quantities found in the collections throughout the site, these species are probably the result of opportunistic activities. Bird remains are found in all the excavation areas of the site. Many of the specimens contain traces of butcher marks, although none of the bones currently analyzed contain traces of burning or cooking. The most abundant wild taxa found throughout the site were the remains of fish. These included mandibles, grinders, and vertebrae of varying species and sizes. Many of these samples were burnt. The most productive areas for these taxa were Areas M (NISP = 78) and Area S (NISP = 109). The fact that these two areas were deeply tied to metal production and the "grunt" work linked to the copper *chaîne opératoire* at KEN, especially during the tenth and ninth centuries BCE, may indicate that dried fish was brought to the site to provision the workers. Similarly, shell was also recovered from all areas except Area R. These included land snail (probably invasive), cowry, and other types of coastal bivalve species from either

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the Mediterranean or Red Sea. Small traces of gazelle were also recovered from all areas with the exception of Area M. The largest samples came from Areas S (NISP = 15) and T (NISP = 8). Hare was also exploited at the site, and traces were identified at all areas with the exception of Area R. This fact poses the question, "Why are these two species not represented in the Area R collection but found throughout the other parts of the site?" One reason could be a result of bias in the sample. The faunal samples were recovered from a smaller room and from several courtyard deposits where these species were not represented. A second answer might revolve around the impressive architecture of Area R and the taphonomic processes. Upon the abandonment of the site, the large walls from the Area R structure would have stood longer than most of the smaller buildings found in its vicinity, preventing any type of invasive species.

The rate of different parts of the skeleton in discard activities is also important and useful in pinpointing social differentiation. There is a clear distinction between different portions of an animal in terms of the quantity of meat they provide. For example, the cuts of meat from the rear of the animal could be more valued than the portion from the forelimbs. It does serve as a reminder that these values are very much culturally determined, and our notions of what makes up high- and low-quality meat portions and the values attached may not be appropriate for other cultures, past or present. It also serves as a reminder that the value of meat from young and old animals may vary across cultures. For example, a large older goat may be more preferable to that of a young goat in some cultural contexts (Dietler and Hayden 2001; Hayden 2003). Regardless of these caveats, analysis of body part representation can sometimes be enlightening. The presence or lack of specific bones can disclose information about the inhabitants. For example, we would most likely not find bone deposits containing low meat-bearing bones in an area of a site where an influential individual or a person of status resided. Similarly, bone deposits that include a high proportion of cattle, sheep, or goat horn cores may identify the areas where perhaps specialists resided. Individuals and households have multiple social identities that vary by situation and experience. Elite are involved in activities that create and maintain their power, such as supervising and regulating production. The type of activities can also include overseeing religious ceremonies, acting as religious specialists, or creating and maintaining an atmosphere of domination. As such, the elite should be less involved in domestic activities than the nonelite (Gunnerman 1997:116–117), and elite trash should include residues of their specialist activities (feasting residues, control of production, resources, and storage or religious paraphernalia) and lack remains of mundane domestic tasks (Gunnerman 1997; Turkon 2004). These types of approaches may be useful for identifying areas of social zoning. At Khirbat en-Nahas, the evidence for such individuals is not reflected in the faunal assemblage, although the contextual architectural could be interpreted differently.

Perhaps one of the most surprising results of this analysis is the sheep/goat body part representation for the site. In all areas at Khirbat en-Nahas, there is no evidence for preference of body part selection. Forelimbs and hindlimbs, the high-quality meat-bearing portions, were found in equal proportion in all areas and were heavily exploited. The numbers of cranial fragments were high throughout all the areas. No complete skulls were recovered. There were high numbers of cranial specimens, including mandible, teeth, ramus, condylar, and coronoid process fragments—the result of exploiting the brain and tongue. These fragments, coupled with neck, ribs, vertebrae, and specimens from the lower extremities, all indicate that the animals were most likely butchered at the site as opposed to being slaughtered, processed, and transported to the site.

The survivorship curves of sheep/goat and cattle provide a brief window into the exploitation of animals and the decisions that affect both the herds and the people who exploit them. In all areas, the presence of immature animals was found. The pattern at most areas indicated a high mortality rate for animals 12 to 18 months and for adults 30 to 48 months or after the animals had proved useful for secondary products. Survivorship curves have been constructed for sheep/goat (Figure 8.16) for each period and for cattle (Figure 8.17). The exploitation of sheep/goat in the ninth century BCE appears to follow a similar pattern. While there seems to have been culling of animals during the 12- to 18-month stage of their lives, animals were kept to adult stage and had an equal chance of survival until adulthood. In the tenth century BCE, sheep/goat were heavily culled in the first 1.5 years and then again when they are adults. Similarly, for the eleventh- to thirteenth-century BCE sheep/goats, there was a high mortality rate for young animals 12 to 18 and 30 to

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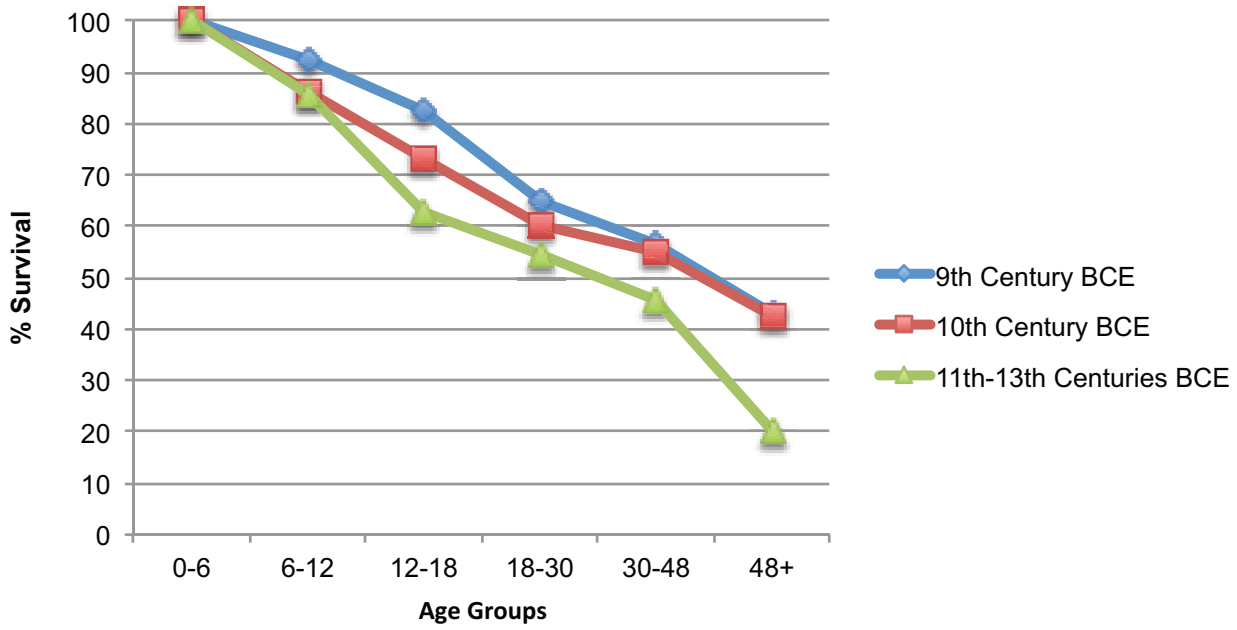

Figure 8.16 KEN sheep/goat survivorship curve for all areas by period.

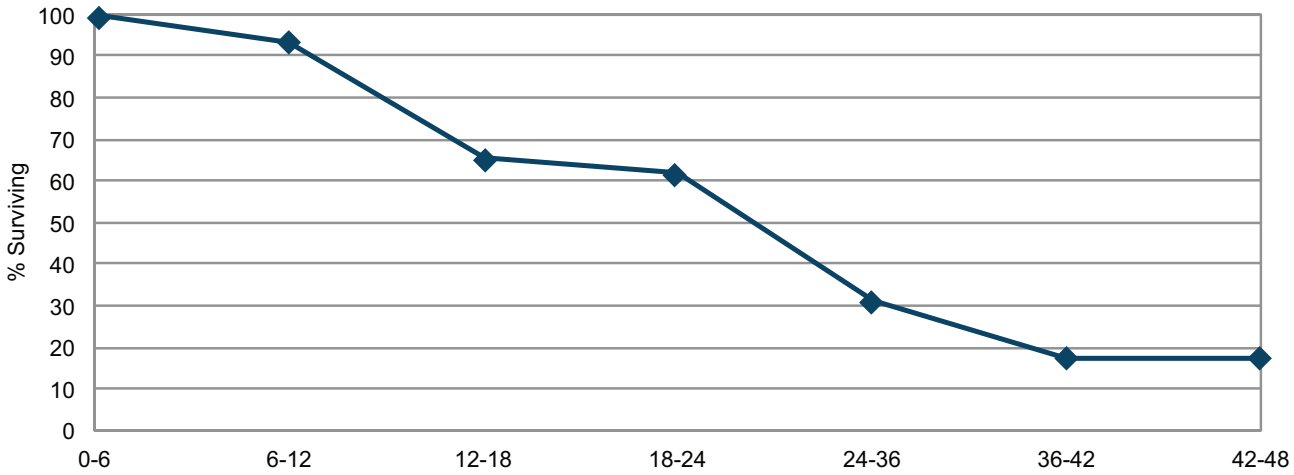

Figure 8.17 KEN cattle survivorship curve for all areas in the ninth to thirteenth centuries BCE.

48 months. The latter brings into question whether the inhabitants of KEN were involved in herding or husbandry. Paine (1971) made a useful distinction between herding and husbandry. Herding centers on the care for the well-being and growth of animals. On the other hand, husbandry is a complex activity that involves the management of the herd in its totality. Husbandry becomes a holistic endeavor and encompasses people, animals, and the decisions involved in their investments, acquisitions, culling, and sales. Husbandry involves the herd owner and his participation in socially significant transactions. Furthermore, these transactions establish social relations of friendship, economic insurance, and political alliances—risk abatement necessary in surviving as a pastoralist. This implies a long-term plan, which has an important consideration in time and decisions relating to the management of the herd. Decisions are made daily, taking into consideration the latest information about the herd. Information for securing the herd includes health,

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nutrition, and productive status of the animals, as well as fodder, water availability, predators, and the immediate availability of labor. Given the complexity of the site, it is suggested that the inhabitants, if they were involved in a pastoralist's lifestyle, were practicing husbandry particularly in the later periods of the site and most likely geared toward a herding strategy during the earlier phases (eleventh to thirteenth centuries BCE). Furthermore, it is suggested here that the data best indicate what Wapnish and Hesse (1988) classify as self-contained production/consumption where animals are maintained and exploited locally. Based on the survivorship curves, animals were raised for meat as well as secondary products (Sherrat 1983).

Following Wapnish and Hesse's (1988) discussion on the classification of animal production, the next obvious question is whether it can be discerned if the site of Khirbat-en-Nahas was seasonal or continually occupied. Unfortunately, information on migratory species does not currently exist, thus making any definite specifics on seasonality all but impossible. The second obvious, but questionable, approach that allows for possible generalizations rests on the lack of patterning of mortality in sheep/goat that is directly tied to the birthing season. Perhaps the most significant difference is the culling of young caprovines during the eleventh and thirteenth centuries BCE and later periods. According to Deniz and Payne (1982), it is common to time the birth of kids to the months of March and April to take advantage of the best feeding conditions during the late spring to summer months. If this holds true for KEN, then a significant number of young animals were exploited during 6 to 12 months of age, which would indicate younger caprovines were exploited some time in the fall and winter seasons. This pattern changes during the tenth and ninth centuries BCE, although exploitation is maximized at an age between 12 and 30 months—the prime age for maximizing meat.

In comparison to the other adjacent regions, cattle remains are relatively low for the KEN assemblage. In previous times and in many areas of the southern Levant, cattle were a major source of food and secondary products, including plough animals (Grigson 1998). Cattle remains have been identified in the region of Faynan as far back as the Neolithic (Twiss 2003) and Early Bronze Age (Muniz 2007). If this is a sampling issue, continuing excavations at this site will undoubtedly reveal whether cattle were being used during this period in this region. While cattle were kept to adulthood, the data indicate that some specimens did die between 1 and 2 years of age. Thus, at KEN, cattle do appear to play at least some type of role in the economy as a source of protein (Grigson 1995). Furthermore, they may have served more than just meat, milk, and skins but possibly for carrying and hauling loads (Grigson 1995; Ovadia 1992). Donkeys are represented in some areas from KEN. It may be possible that horses and, if this is the case, probably mules might have existed, although no evidence has been found. Horses are represented in many collections in earlier periods from this region and have been used in agriculture as well as other activities (Grigson 1993). As well, it has been suggested that they may have been used to transport metals in and around the Levantine region (Grigson 1995). Camels are also represented in several areas at KEN (Table 8.14). The appearance of camel bones almost exclusively in the upper most strata (Strata II–III of the late tenth to ninth centuries BCE), together with other observations from other smelting sites in the 'Araba, led Sapir-Hen and Ben-Yosef (2013) to suggest that the systematic use of camels as a pack animal in the copper trade (and consequently as a common pack animal in the entire southern Levant) started not earlier than the last third of the tenth century BCE and, probably at that time, as part of the major reorganization in the copper production system in the region (cf. Chapter 15, this volume).

The absence of pigs in the KEN assemblage is not surprising (cf. Sapir-Hen and Ben-Yosef in press). As Grigson (1998:254) points out, by the Iron Age, the continuous reduction of pigs suggests little economic importance, and any material located in archaeological sites is probably intrusive or are the remains of wild boar. Whether this claim is applicable to all adjacent areas, the hyper-arid environment of the Edomite lowlands would make it difficult to sustain pigs.

While pigs are absent from the archaeological record at KEN, equids—most likely donkeys—are present and correlate to almost equal amounts with the assemblages recovered from the adjacent areas. The importance of donkeys as pack animals or beasts of burden can be found in numerous depictions (Clutton-Brock 1992; Ovadia 1992). The presence of donkeys, coupled with the remains of camel at KEN and the large quantities of copper production, supports the notion that these animals may have been used to transport material to and from Egypt and Arabia to the southern Levant (see Grigson 1998).

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Table 8.14 Camel remains from KEN and their context (for further contextual details cf. Chapter 15, Table 15.3 this volume).

Cat	Year	Area	Layer	Locus	Basket	
1807	2002	A	A2b	92	1925	Tibia
1313	2002	M	M1b	502	8124	Metapodial
3255	2006	M	M4	670	9901	Metapodial
3287	2006	M	M1a	672	9954	Metapodial
61	2002	S	S1	263	5436	Metapodial
76	2002	S	S2ab	281	5464	Tooth
2219	2002	S	S1	312	7110	P1

Finally, based on the few specimens of wild species recovered at KEN, it can be speculated that wild animals played a small but significant function in Iron Age economies. Food distribution in many societies is a complex and often elaborate process that is closely related to that society's political and economic organization. Food is often allocated through exchange, gifts, obligations, feasts, and festivals (Dietler and Hayden 2001; Hayden 1996). Equality of the distribution will vary and can best be understood in terms of how food is distributed by and to its population. For example, different foods can be segregated to certain individuals, thus making them "luxury" items. Typically, it will be the elites rather than the commoners that will have access to these types of items. At KEN, the few remains of wild fauna remind us that inevitably, hunting during previous periods degraded the last remaining few wild animals species of the region. By the Iron Age, established communities with large populations were most likely to blame for the degradation of habitats that were once occupied by numerous types of wildlife. The small sample of gazelle, shell, fish, and a few bird species indicate that at some level, the inhabitants of KEN were exploiting their local environment as well as important species from the Levantine coast and other highland and lowland regions. Attempting to identify the individuals behind the transactions as well as the consumers is the key factor and one that can best be addressed by incorporating other aspects of the site architecture and its use and function.

This distribution of foods, then, symbolizes and supports the social positions of the different groups. The site of Khirbat en-Nahas and the many activity areas under investigation present an opportunity to further investigate these types of topics. This is especially true when considering the faunal assemblage in light of architecture, public and private space, cooking vessels, and tools. While the analysis of the faunal material recovered at the site is still under way, this phase of analysis represents the first step in the reconstruction of foodways at this site.

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9 Wadi Fidan 40 and Mortuary Archaeology in the Edom Lowlands

Marc A. Beherec, Mohammad Najjar, and Thomas E. Levy

The Wadi Fidan 40 cemetery is the largest (ca. 3,450 m^2) Iron Age cemetery in southern Jordan. Extensive excavations were carried out over three seasons by a joint University of California at San Diego–Department of Antiquities of Jordan team. High-precision radiocarbon dating places the cemetery securely in Iron Age IIA period. The site, overlooking the Wadi Fidan to the south and 'Araba Valley to the west, marks the "gateway" to the copper ore–rich Faynan district. A total of 245 cist graves, as well as other mortuary features, were excavated. By presenting a comprehensive report on all the excavations carried out at Wadi Fidan 40, this chapter considers the problem of ethnic identity, mortuary analysis, and the Iron Age people who inhabited Edom during this period.

Introduction

Cemeteries provide one of the best data sets for investigating the nature of ethnicity and social organization in the archaeological record. Anthropological archaeologists use mortuary archaeology to investigate social rank (Binford 1971; Chapman et al. 1981; Levy and Alon 1982, 1985; Saxe 1970; Tainter 1975; Tainter and Cordy 1977), gender (Cannon 2005; Green 2007; Wright 1996), political economy (Buikstra et al. 2005), social and political behavior (Hodder 1982; Parker Pearson 2000; Shanks and Tilley 1987), and other dimensions of society. This should be distinguished from forensic archaeology, which is more concerned with applying archaeological methods of investigating deceased humans in a legal context—especially for police and other governmental agencies (Haglund 2001). The Edom Lowlands Regional Archaeology Project (ELRAP), with its focus on Iron Age societies in the Faynan district, is fortunate to have excavated the largest cemetery from this period in southern Jordan. In this chapter, we present an overview of the excavations in Wadi Fidan 40 with an aim to understand some of the socioeconomic and ethnic dimensions that are reflected in the large-scale excavations carried out by our team.

Wadi Fidan 40 is a large (ca. 3,450 m^2; 30.673926N, 35.381107E) cemetery excavated by the ELRAP and its predecessor, the Jabal Hamrat Fidan Project, and radiocarbon dated to the Iron Age IIA period. The site is situated on a Pleistocene conglomerate terrace that forms a low plateau overlooking the Wadi Fidan, where it debouches into the Wadi 'Araba. The terrace abuts part of the Jabal Hamrat Fidan mountain

Opposite: Aerial view of the Wadi Fidan 40 cemetery, Jordan. Note the hundreds of Iron Age circular mortuary monuments visible near the surface. *Photo: UC San Diego Levantine Archaeology Laboratory.*

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range on the eastern side of the Jordanian side of the 'Araba Valley. The cemetery marks a western entrance or "gateway" into the Faynan district. Radiocarbon dates from pomegranate seeds taken from grave offerings cluster in the tenth century BCE (Table 9.3). The cemetery is therefore coterminous with the flourishing of copper production and monumental building construction at Khirbat en-Nahas (Levy et al. 2008; Levy 2010; see Chapter 1, this volume) and with Smith and Levy's (2008) redating of so-called Edomite pottery, which has been treated as one of the most important indicators of Edomite ethnicity recognized by archaeologists. Present evidence suggests Wadi Fidan 40 and Khirbat en-Nahas predate the major Late Iron Age sites of Busayra, Tawilan, and Umm el-Biyara by several centuries. They arguably lie within the geographical boundaries controlled by Edom in the Iron Age IIB. Nevertheless, Assyrian historical records refer to a king of Edom in the eighth century BCE. Biblical documents suggest that a people known by the name Edom lived in the land before they were subjugated by the Assyrians. Egyptian records refer to *Shasu* tribes of *Idum* in the New Kingdom. Unless significant textual data are discovered, it remains to archaeology to expose who these people were—both how they lived and how they defined themselves in relation to the peoples around them. We intend in this chapter to bring the mortuary archaeology of Wadi Fidan 40 into this discussion.

Mortuary archaeology is an important tool for examining social structure and identity. Human burials are primarily deliberate interments, generally conducted by members of the deceased's own ethnic group. As such, they are vehicles to reaffirm the group's values and identify an idealized representation of the self-identifying group's values and identity, describing the deceased's social status, ethnicity, and gender through ritual (Parker Pearson 2000). However, the Iron Age (ca. 1200–500 BCE) Edomites are at this time best known from other archaeological and historical evidence, and it is to this that we must first turn.

What It Means to Be Edomite

Our understanding of the ethnic identity of Edom is informed largely by the Hebrew Bible, but while Edomites are generally understood to be a single ethnic group, independent of but related to its neighbors, a closer reading of the texts provides a picture of inhabitants of the land called Edom and what may be a self-identifying group known by that name. The definition of the term *Edom* itself seems to have been in flux, as Edomites and their neighbors were forced to identify and reidentify themselves according to changing political and social realities. Any analysis of ancient Edom must take into account that the term *Edom* may have applied at different times to different groups of peoples—and different groupings of customs. The anthropology of ethnicity demonstrates how these identities are fluid and nonconsanguine (Emberling 1997; Romanucci-Ross and DeVos 1995). Archaeology can help illustrate how these groups and their customs were (or were not) integrated into those of greater Edom and came to be understood as Edomite.

According to the Bible, the apical ancestor of the Edomites is Esau, "who is Edom" (Genesis 36:19), brother of the Israelites' corresponding ancestor, Jacob. Descriptions of the apical ancestors can easily be opposed structurally into Levi-Strauss' raw and cooked analogies (Lévi-Strauss 1969; Table 9.1); it is clear that one important interest of the biblical authors was to define Israel in contrast to Edom (Levy 2008), regardless of whether there is any truth behind these statements. Biblical genealogies list the Horites as inhabitants of Edom alongside the sons of Esau (Genesis 36:20–30). The Deuteronomist understood the Horites as a conquered (indeed, destroyed) people, first inhabitants of the land promised by YHWH[1] to the Edomites just as Canaan had been given to the descendants of Jacob (Deut. 2:12). However, the author of the Genesis lists describes them as "inhabitants of the land" (Genesis 36:20) with their own chiefs alongside the chiefs of Edom.

These lists of the population of Edom further complicate the issue. For example, the Genesis 36:15–19 list of the chiefs of Edom numbers the Amalekites among the tribes of Edom. The Bible usually depicts this group as independent; indeed, the Balaam prophecy curses the Amalekites independently of Edom (Albright 1944; Hoftijzer and Kooij 1991), calling Amalek "the first of the nations" (Numbers 25:20). John Bartlett (1992:14) suggests, "There is little here to suggest that the writer [of Genesis 36] was drawing upon genuinely Edomite material and much that suggests he was preparing a list of names appropriate to the Edom that he knew, with contacts ranging from southern Judah to Midian." However, such lists may in fact represent the changing fortunes of the Edomite state, as different self-identifying groups—whether clans, tribes, or ethnicities—joined Edom and were incorporated into the state according to the logic of kinship. Regardless, the

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Table 9.1 Structural interpretation of the Edom–Israel dichotomy.

Israel	Edom	Passage
Secondary	Primitive	Gen. 25:26–27
Clever	Simple	Gen. 25:26
Tent	Field	Gen. 25:27
Smooth	Hairy	Gen. 27:11
Pastoralist	Hunter	Gen. 25:27; 27:3, 17
Woman loved	Man loved	Gen. 25:28
Liminal (Yakov = fights-with-God)	Earthy	Gen. 32:28
Eats cooked food	Eats semi-raw food (red lentils being undercooked)	Gen. 25:30

archaeologist seeking to understand Edomite ethnicity must first understand that the land of Edom itself is most likely to have been a palimpsest of interacting and interlocking self-defining groups, who in turn may have left identifiable archaeological signatures.

The waxing and waning of Edom's power also affects the debate as to the territorial extent of Edom. The precise borders of Edom remain a matter of dispute, and its relationship to Seir, the land of the Horites, is also dubious. One problem has been the tendency of archaeological researchers to assume Edom was a short-lived Late Iron Age sociopolitical phenomenon with fixed borders (Bienkowski 1995b; Crowell 2004; Finkelstein and Silberman 2006; Finkelstein and Singer-Avitz 2009; Porter 2004). Based on biblical and Egyptian records, Seir is generally understood to have once been an independent territory, although it came to be used as an alternative term for Edom (Bartlett 1989). Ernst Axel Knauf limits the Iron I territory of both Seir and Edom to independent units and not a state, occupying a fragment of the northern Edomite plateau (Knauf-Belleri 1995). William A. Ward (1972, 1992) argues that the New Kingdom *Idum* of the Shasu lies not in southern Jordan but in the Negev, adjacent or nearly adjacent to Egyptian territory. Lars Eric Axelsson (1987) takes an opposite extreme and claims that Edom at this time extended so far across the 'Araba that the desert fortresses of the central Negev may in fact stand along Judah's border with Edom. Laura M. Zucconi (2007:241) argues that the fortresses at Tel Arad, Tel Aroer, Tel Ira, Tel Malhata, Horvat Anim, Horvat Radum, Horvat Tov, and Horvat Uza made up the later border between Edom and Judah in the eighth to sixth centuries BCE. Bartlett (1989:43) suggests that Seir was in the lowlands of the Negev, taking its name from the "hairy" brush there in the same way that Edom, the mountainous area Transjordan, was named for its red rocks. Following Benjamin Mazar (1975:135–153), Zecharia Kallai (1986:117) argues that the copper working areas of Faynan were actually part of Judah, although this would require an inconsistency in the Exodus narrative, since Punon is said to be a stopping point for the Israelites escaping Egypt and therefore was clearly understood by the author to lie outside Israel's borders, regardless of the historicity of this event. By contrast, most archaeologists would follow the borders argued for by Nelson Glueck (1936), which place the western border of Edom at the Wadi 'Araba. While the ELRAP research identifies the ancestral culture core of Edom in the Edom lowlands (Levy 2009a; Levy et al. 2012), there is little consensus among biblical scholars, let alone among most archaeologists, as to what geographical area Edom really occupied and at what time, and what areas of Edom might actually be considered Horite.

Knauf (Knauf 1992; Knauf-Belleri 1995) developed a compelling model, arguing that nomadic, Qos-worshiping "sons of Esau" from the south penetrated Horite settlements near the Wadi Hasa. Knauf actually reverses the process described in Deuteronomy, declaring Horites to be "Canaanite agriculture newcomers, whereas Esau may represent the indigenous nomads who assumed a leading role within the later Edomite state" (Knauf 1992:49). This model is based on Knauf's reconstruction of historical geography, based on the kin lists of Genesis 36 and the scholarly consensus in the mid-1990s (based on Burton MacDonald and J. Maxwell Miller's archaeological surveys) that "the settlements [of Edom] start in a narrow strip along Edom's northern border" (Knauf 1992:48) and expand from that

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center. McDonald and Miller reported settlements with possible Late Bronze and Early Iron I pottery along the Wadi Hasa, in both southern Moab and northern Edom, by Miller's Kerak Plateau Survey (Miller 1991) and MacDonald's Wadi el-Hasa Survey (MacDonald 1992a). Based on what he believed were survivals in the names 'Ain Saubalah, Jebel Saubala, and Khirbat Saubala, Knauf surmised these to be the original settlements of the Horite tribe Shobal (Knauf-Belleri 1995:103).

However, later archaeological investigations have shown that Knauf's ideas need reworking. Piotr Bienkowski (1995c) and his associates showed that two of these sites in the purported Horite heartland had Iron Age pottery but lacked any clear locus of Iron Age activity, while the other two yielded Iron II deposits but no Late Bronze or Iron I material (Bienkowski et al. 1997; Bienkowski and Adams 1999). The only Esauide clan that Knauf located on a map is Zerah, "its name having survived as Udhruh" (Knauf 1992:49; cf. Knauf-Belleri 1995:103, 107), about 10 km east of Petra. But Udhruh's excavators reported only an Iron II settlement (Killick 1987:178). To date, no evidence of Iron I occupation has been reported there. Thus, the evidence no longer supports the conception that Edomite settlement began at the Wadi Hasa, and the sites mentioned in Genesis 36 remain elusive.

Furthermore, Knauf had knowledge of radiocarbon dates from his own and Andreas Hauptmann's (1992) work that Iron Age copper production began very early in the Faynan region but believed on the basis of pottery that this production was controlled from the west (Knauf 1992:49). Indeed, he and C. L. Lenzen labeled copper working at Khirbat en-Nahas from before the end of the eighth century "pre-Edomite" (Knauf and Lenzen 1987:85) and suggested that "the Edomites took over the copper mining area of Faynan in order to exploit it industrially at the same time that they founded towns and villages in the region" (Knauf and Lenzen 1987:87). Archaeological studies conducted since then by Levy, Najjar, and their associates have shown that not only did copper metal product exist in the thirteenth to ninth centuries BCE in the Faynan region (Levy et al. 2004; Levy et al. 2008), but those carrying out the smelting used pottery painted with shapes and decorative patterns very similar to those dubbed "Edomite" (Smith and Levy 2008; Chapter 4, this volume). The lowlands of Edom, specifically the Faynan region, then, is an important place to search for the genesis of Edomite ethnicity, although one must use caution when applying the term *Edomite* to any particular archaeological feature here.

What it means to be Edomite remains an open question. As Levy (2004:253) has suggested, "While text and archaeology must be critically interwoven to obtain the most robust picture of what happened in the past, archaeology provides the most objective lens for clarifying the identity and lifeways of those people who inhabited a given region in antiquity as well as those groups who interacted with them." Several questions remain open. To what extent was the Edomite state kingdom/archaic state? If Edom can be considered an ethnic archaic state, at what point did it coalesce as such? To what extent at different times did the ethnic archaic state extend its boundaries, and what was the initial geographic territory of the state compared to that of the ethnic group? How did the state incorporate the ethnic groups that already existed in newly conquered lands? Archaeology can provide answers, albeit not always completely satisfactory ones, to questions such as these.

Archaeological Manifestations of Edomite Identity

Before turning to Wadi Fidan 40, it is important to consider previous approaches to identify material correlates for Edomite identity. Itzaq Beit-Arieh (1995:33) has attempted to trace an Edomite presence in the Negev. Accordingly, "In my opinion, the findings from sites excavated by Crystal Bennett and others in Edomite territory provide only two salient criteria by which the Edomite culture may be identified. These are the pottery and the script." These remain the most often used archaeological correlates for Edomite presence, although Levy (2008) has also put forward metalworking as an important aspect of Edomite ethnogenesis.

We turn first to the script, the most direct means of analyzing self-identification (see Chapter 14, this volume). Iron Age Edomite script has been reconstructed from inscriptions, chiefly ostraca, found in both southern Jordan and the Negev. Felice Israel (1979), W. Randall Garr (1985), Robert A. DiVito (1993), David S. Vanderhooft (1995), and Bruce Zuckerman (2004) have shown that the available Edomite texts testify to a distinctive cursive Edomite script. These seventh- and sixth-century BCE texts all show certain letters are written slightly differently in texts identified on the basis of provenience or internal data as Edomite.

Breaking with other scholars, however, Vanderhooft emphasizes that the available data do not make it

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possible to determine whether Edomites spoke a distinct dialect, arguing "there are no significant linguistic differences between texts that are demonstrably Edomite and texts written in the contemporary Hebrew of Cisjordan" (Vanderhooft 1995:157). An interesting contrast can be made with Ammonite and Moabite, which are also closely related to Hebrew but known to be more distinct dialects. Of course, the evidence is incomplete—those Edomite inscriptions found to date are short and fragmentary, while texts such as the Mesha stele of Moab and the Amman Citadel inscription of Ammon allow a much greater understanding of those languages (Garr 1985; Jackson 1983). However, the similarity between the four languages, with Hebrew and Edomite being perhaps the closest, testifies to the special relationship Edom had with Israel.

The scripts are functional, and the most useful material tends to be names, which themselves shed light on Edomite identity. An overwhelming majority of these inscriptions include theophoric names related to the deity Qos (Porter 2004). This is no doubt due in part to the circular method of identifying Edomite script by using Qos names (Vanderhooft 1995). However, the preponderance of such theophoric names suggests a group that identified itself along religious lines, much as Israel was at the same time.

More abundant, and therefore more frequently used than Edomite script as a marker of ethnic identity, is pottery. Edomite pottery, as such, was first described by Nelson Glueck based on his surveys in Transjordan (Glueck 1934–1935:123–137). Glueck's definition has since been reconsidered—some "Edomite" pottery has since been found to originate in Arabia and has been renamed Midianite (Rothenberg 1998; Rothenberg and Glass 1983), and the excavations at Tawlian, Umm el-Biyara, and Busayra have allowed further refinement of the typology (Oakeshott 1983). However, John P. Zeitler, in his analysis of "'Edomite' Pottery from the Petra Region," argues, "'Edomite' pottery is nothing more than an antiquarian collective name for Iron II pottery from the Edomite uplands of Jordan and similar types from parts of the Negev" (Zeitler 1992:167). Such a harsh rejection of the term is not warranted, but the term must be carefully applied.

An example of this is the pottery that has been taken to be the most characteristically Edomite, the Edomite painted ware. According to Zeitler, "The painted pottery has often been used as an argument for Neo-Assyrian influence in Edom (Bennett 1982: 187) or thought to be an imitation of Neo-Assyrian palace ware (Glueck 1967: 28; Pratico 1985: 25)" (Zeitler 1992:172). However, it is unclear why Zeitler makes these claims. In reality, Bennett (1982:187) notes, "The bi-chrome and band painted pottery, which occurs on so many sites in Ammon, Moab and Edom and is to be found occasionally in the Jordan Valley, seems to be indigenous, though it is important to point out that at Busayra this pottery only occurs in the neo-Assyrian period." Glueck (1967:10–15) notes numerous examples of this painted ware in Transjordan (particularly Edom) and Timna, suggesting that it has its origins in Late Bronze Palestine (Glueck 1967:13). The work of Smith and Levy (2008; see Chapter 5, this volume) shows this pottery not only is developed from indigenous Late Bronze forms but first appears in the lowlands of Edom.

Glueck (1967), Bennett (1982), and, following Glueck, Pratico (1985, 1993) do isolate certain forms of pottery as probable results of Assyrian influence, and Knauf (1992:53) argues that Edomite pottery forms and decoration are Assyrian inspired and appear suddenly as the result of elite workshops. This is especially important, not only because Edomite monumental architecture seems to be an imitation of Assyrian forms (Bienkowski 1995a), but even more so since at least one form, a vessel form with triangular decoration around the circumference, is believed by Beit-Arieh (1995:34) to be a marker for Edomite ethnicity in the Negev. Charlotte M. Whiting (2007) notes that the introduction of Edomite pot forms into the Negev may have more to do with changing food preparation techniques than changing populations, but as Juan Manuel Tebes (2011) points out, this does not explain why petrographic analysis shows that many of these pots came from the Petra region. Furthermore, changing food preparation techniques are themselves often a marker of movements of people.

Caution must be used in applying the term *Edomite* to pottery. When painted pottery is considered, one must be careful to distinguish between ancestral Late Bronze designs and so-called descendant Ammonite, Moabite, or Edomite designs; such an analysis has not yet been attempted. Indeed, the lack of excavated, stratified Late Bronze Age sites in the region makes such a study impossible at this time. So-called Edomite painted pottery may predate any true Edomite ethnicity. However, the new studies presented by Smith and

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Levy in this volume (Chapter 5) show that objective measurements of pot forms indicate that the Khirbat en-Nahas pottery assemblage shows closer similarities to the later occupational sites on the plateau, including Busayra, than to Cisjordanian sites. Although important differences exist between the later pottery and that from Khirbat en-Nahas, this lowland pottery appears to be ancestral to the later highland ceramics (Chapter 5, this volume).

As shown below, Wadi Fidan 40 offers little evidence regarding Edomite pottery. While outside the scope of this chapter and addressed more thoroughly in Chapter 5 (this volume), it is important to gauge the importance of pottery to ethnic or regional identity. Bienkowski (1992:7) suggests, "A better description [for 'Edomite' pottery] would be 'Buseirah painted ware', since that is where it is most common." In addition, he argues that "Edomite" pottery and script may be regional, rather than ethnic, indicators (Bienkowski 1995a:139). The ceramic assemblages of southern Jordan are noted more for their complexity than for their uniformity (Bienkowski and van der Steen 2001:26). More intensive regional studies correlated against absolute dating are necessary to determine what pottery might be attributed to specific ethnic groups throughout the southern Levant and to determine whether distinct groups, such as the Horites and the sons of Esau, merged to form an ethnic nation.

Levy (2008) has argued that metalworking played an important role in the emergence of Edomite and Israelite identities. He cites the prohibition against cast-metal gods in Exodus 34:17 and the claim of 1 Samuel 13:19 that Israel (unlike Philistia) had no metalworkers, contrasting them against the massive amounts of slag testifying to copper production and the one figurine mold, possibly for a metal goddess statuette, found at Khirbat en-Nahas. Knauf and Lenzen (1987:87), writing before the large-scale Iron Age excavations in Faynan presented here and elsewhere, but having taken part in the Deutsches Bergbau-Museum soundings in the region, suggested that this industrial technology was the famous "wisdom" of Edom mentioned in the Hebrew Bible (Jeremiah 49:7; Obadiah 8). However, copper was a familiar metal to the ancient Israelites, having been used in the region since the Chalcolithic.

Levy's claims may be more applicable to iron working than copper working. The claim in 1 Samuel 13:19 is probably ahistorical. It is not clear what metal is worked in this passage, but it appears to describe ironworkers, not all metalworkers, and not copper workers. However, archaeology does not suggest that the Philistines were any richer in iron than other peoples at this time, and iron was not widely exploited anywhere in the Levant. But what iron was used was typically not for the purpose of tools and weapons, which are what interests the Bible author (Waldbaum 1980:84–85). From a contextual perspective, the passage "serves not only to portray the restrictions imposed by Philistine rule but also to emphasize the importance of divine help in the Israelite victory described below" (McCarter 1980:238), in the narration of the Battle of Michmash Pass. The message is not Israelite cultural separateness; it is Israelite military inferiority, and it is likely an anachronistic gloss meant both to demonize the Philistines and to glorify the God of Israel, a gloss dating from a time when military use of iron was widespread rather than an accurate description of Israelite military weakness. And as Bloch-Smith (2003:418) notes, "The 'archetypical' Iron I 'Israelite' village of Khirbat Raddana had a bronze casting workshop. Bronze slag-encrusted crucibles, tuyères of various sizes, plus an iron blade and bronze daggers, armor scale, needles, javelin points, plow points, a small arrowhead, and spearheads dispel the image of the highland fighter lacking metal weapons dependent on the Philistine enemy to sharpen his plow point." Nevertheless, the passage does show a certain attitude toward ironworking as an alien trait. And while metalworking was practiced in monarchical Israel, it may have been considered a stereotypically non-Israelite or non-Judahite trait. Iron especially was seen as a barbaric, although at times useful, material (Sawyer 1983). This metal is found in lowland and coastal cemeteries, including Wadi Fidan 40, but is conspicuously absent in Iron Age cemeteries of the Judahite highlands (Bloch-Smith 1992).

To date, there is little evidence for copper being worked into final objects at Khirbat en-Nahas. The one mold from Khirbat en-Nahas may in fact be for ceramic images (Area S, Chapter 2, this volume). One ceramic horse fragment and one human figurine fragment were found at Khirbat en-Nahas (see Chapter 2, this volume), and ceramic images are not uncommon in ancient Edom. But the ubiquity of copper smelting in the Faynan region could scarcely *not* have shaped Edom's emergent culture. While metalworking in and of itself cannot be seen as an exclusively Edomite trait, it is hoped that future investigations will reveal particular Edomite metalworking techniques or technology in addition to particular ethnic uses and forms of metal objects.

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Burial in Iron Age Edom Regional Perspectives and New Data

To understand how Edomite ethnicity is expressed in mortuary practices, an examination of burial data from Edom as a whole is necessary. However, such a study is crippled by the lack of comparative examples. Excavated burials at Iron Age sites in Edom are rare and in general poorly published. Furthermore, those burials found at the important Edomite sites of Busayra and Tawilan usually postdate the sites' primary period of settlement and in many cases is not even Iron Age in date. Nevertheless, it is important to consider the burials at these sites, as well as the lesser known Iron Age burial at Tel el-Kheleifeh and the as-yet unpublished tomb burials at Wadi Fidan 4 and those looted at Wadi Fidan 45, along with the cemeteries and graves in the region known only from surface examination, before considering the cemetery at Wadi Fidan 40.

Busayra

At Busayra, generally equated with biblical Bozrah and therefore the most important city in ancient Edom, two burials were reported. One of these consisted of multiple individuals. Excavation notebooks reveal that Burial 20.4.4 in Area A consisted of a "small human: also bones for three skeletons and three skulls, upper limbs, lower limbs, trunk, wrist, molar teeth, and wisdom teeth" (qtd. in Bienkowski 2002:93), laid to rest next to Wall 83, cutting through a plaster floor. It clearly postdates the use of the Iron Age buildings of Area A, although its exact date is uncertain. It may or may not be "Edomite."

A second burial at Busayra is more likely Iron Age in date but was even less thoroughly recorded. Sedman (2002:415) notes "Crystal Bennett's personal notebook dated 4 July 1972 contained the following entry: 'Tunnel is a burial with earrings'. This context was numbered as E.1.3 cave, but was not properly recorded." Photographs were taken showing bones in a cave, but the Square E1 notebooks contain no data regarding a cave or burial (Bienkowski 2002:42). Seven copper or copper alloy objects were recovered from the burial, including one "mulberry"-type earring, one "boat-shaped" earring with applied balls, and fragments of what are probably other earrings. The more complete earrings have parallels at eighth- to fifth-century sites in Cisjordan (Sedman 2002:414–416).

Tawilan

Numerous burials were uncovered at Tawilan; indeed, of Bennett's six excavation areas, four (I, II, IV, and VI) yielded interments. However, most and perhaps all of these burials postdate the Edomite occupation of the site, and many were not adequately recorded. In Area I, "some child burials" were found. Details are lacking, although the two that were photographed were "below topsoil and large stones, which might imply a late burial contemporary with those [post-abandonment burials] in Area II" (Bennett and Bienkowski 1995:19). A skeleton was found buried with Nabatean potsherds in Pit 5.2 in the Area IV test trench, and a child's skeleton, also associated with Nabatean or Roman potsherds, was found in Locus VI.1.7 of Area VI (Bennett and Bienkowski 1995:51). Most interesting, however, are the burials of Area II.

In Tawilan Area II, two groupings of burials were excavated. The excavation report notes that 36 burials were excavated. It appears from Table 3.1 (Petocz 1995:34) that the bones of a child and an adult in the fill of Pit F.44 and two burial pits, 4.6 and 4.7, in Trench 4 are excluded from this total. Full details are provided on only 29 of the burials. These 29 can be divided into two distinct groups. Twenty-seven are clustered into Group 1, all of which were oriented with their heads to the west, lying on the right sides, some covered with capstones. Some of these burials included metal bracelets and beads, apparently including stone beads, cowrie beads, and *Conus* species beads, although complete information has not been published on grave goods. These burials clearly postdate the site occupation, given that many of them damage architecture in the area. They are interred in postoccupational fill of Phase IV that included the famous Tawilan cuneiform tablet. Burial XXVI included a cooking pot, identified by Bennett as Roman, although this was vandalized before it was collected or photographed. The burials are sealed by Mamluke activity in Phase VI (Bennett and Bienkowski 1995:327–329; Petocz 1995:32–33; Reece 1995:93, 95). In short, the Group 1 burials date from sometime between abandonment and the Mamluke period and are likely Roman.

Area II also contained a second group of burials, the story of which is less straightforward. Group 2 consists of two burials, lying face-upward with heads to the southwest, buried beneath capstones. These were buried to the south of Room B of the Area's Northern Complex, the older of the area's two

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building complexes. No grave goods were found with Burial XXIII, an adult. Burial XXV was found with fragments of a bronze earring and part of a cosmetic palette. An oil lamp fragment, an Iron Age rim sherd, and a Hellenistic sherd were said to have been found in the burial pit. Years after the grave was excavated, a cache of 18 gold rings and earrings and 334 or 336 carnelian beads inside a bronze bowl covered with a coarse ware sherd was found under a stone near Burial XXV (Bennett 1984:4; Petocz 1995:33–35). Initial analysis by Rachel Maxwell-Hyslop (1984) indicated that the hoard as a whole was not out of keeping with a sixth to fifth century date. However, subsequent analysis of the jewelry by Jack Ogden (1995) suggested that the hoard contained pieces that all appeared to stylistically belong to the tenth century BCE and that some of the pieces even may have been produced in the same workshop. Dani Petocz, area supervisor of the 1982 excavation team, believed the hoard was not associated with Burial XXV. He argued that it was located outside of the burial pit and suggested that, even if an association is accepted with Burial XXV, "the jewellery has been dated to the 10th-9th centuries BC, much earlier than the late Iron II/Persian context of Phase V in which it is found" (Petocz 1995:35) and therefore must be heirlooms. However, the presence of this early jewelry, coupled with the possible longevity of some Edomite pottery forms recently established by Smith and Levy (2008; Chapter 4, this volume), may necessitate a rethinking of the dating of Burial XXV and the Northern Complex. Whatever the case, and as intriguing as the Group 2 burials are, their problematic dating makes them of little value to a study of Edomite burial.

Tel el-Kheleifeh

At Tel el-Kheleifeh, Glueck (1940:9) uncovered what he described as a "mastabah-like" grave "sunk partly into the floor-level of the dry moat" between the two offset-inset fortification walls. Glueck believed it to be a single burial. A millstone, a mortar, and a cosmetic palette fragment were recovered. In addition, beside the skull fragments were "two three-handled jars, the only ones of the type recovered in the excavations. Inside one of them was a delicate little bowl, containing bones of a small bird, a small animal, and

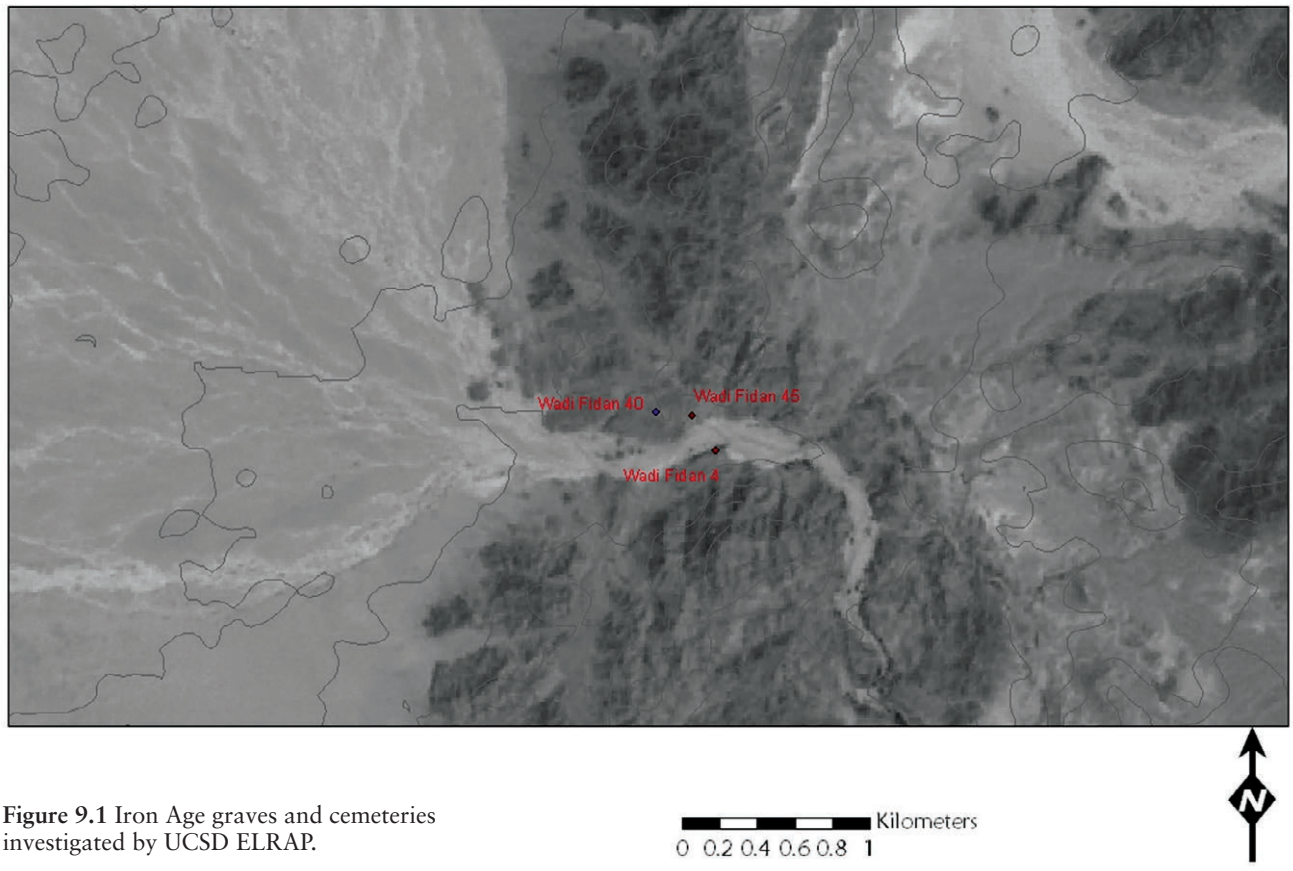

Figure 9.1 Iron Age graves and cemeteries investigated by UCSD ELRAP.

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a small fish" (Glueck 1940:10). Glueck thought that the burial only shortly postdated the fortress, even suggesting that the entombed was the fortress' builder. Unfortunately, however, the burial was only preliminarily published, and its pottery was not presented. Furthermore, the fact that Tel el-Kheleifeh cannot be said to be an exclusively Edomite site makes this burial of limited use to this study.

Wadi Fidan 45

Wadi Fidan 45 is a small cemetery near Wadi Fidan 40 (Figure 9.1). When first recorded in 1998, it was described as a "series of five tombs" that could not be dated (Levy et al. 2001:175). The site, extending over an area of around 75 m^2, consists of a tumulus that appears to cover a grave and five cists arranged along the cliff face on the eastern end of the same landform on which Wadi Fidan 40 is located. The site has a commanding view of the Ayn Fidan and Wadi Fidan. Unfortunately, the site was looted sometime before 2009.

During the 2009 ELRAP field season, the looters' backdirt was sieved and the site more adequately surveyed. No other excavations were conducted at the site. The cists all appeared to be completely emptied, but the tumulus may yield further data if excavated. Cist 1, measuring 0.76 m long, 0.54 m wide, and 0.38 m deep, was constructed of six sandstone side slabs. It was oriented roughly east–west. Cist 2 measured 1.20 m long, 0.93 m wide, and 0.21 m deep. Three side slabs remained in place, and three sandstone slabs, apparently capstone fragments, were observed in the looters' backdirt. The exposed portion of Cist 3 measured 0.58 m long, 0.54 m wide, and 0.12 m deep, but it may have been incompletely exposed. Cist 4 was almost entirely eroded away, but one sandstone side slab remained in place measuring 0.47 m long, 0.19 m wide, and 0.08 m deep. Finally, Cist 5 was also heavily eroded but may have been incompletely exposed. What was visible measured 0.21 m long, 0.07 m wide, and 0.04 m deep. The only artifacts found were two stone flakes in the backdirt next to Cist 1 and iron fragments that may be part of a bracelet in the backdirt beside Cist 2.

The tumulus was made up of a ring of stones, two to three stones wide measuring roughly 3 m in diameter. The east side, facing the wadi, is only one stone high, but the west side, away from the wadi, is three stones high. One flint core was found next to the west side of the tumulus. Thirty-two beads were recovered from the backdirt around the tumulus, including 13 ostrich eggshell disk beads, a flint blade-flaked drilled to make a pendant, a red stone cylinder disk and a red stone bead fragment that could not be identified as to shape, three blue and white agate beads (two short barrels and the third too small a fragment to identify), a cowrie with the top cut off, a univalve cut along its axis to form a disk bead, a white and green cupric disk bead, a yellow apatite short cylinder bead, and a red stone short cylinder bead. Six blue glass short-barrel beads were also recovered at the site. Two copper beads were found, one of them formed by beating a single copper sheet into a tubular form and the other being too corroded to describe. A small amount of bone and one tooth fragment were also recovered.

Wadi Fidan 4 Iron Age Tombs

Wadi Fidan 4 is primarily an Early Bronze I village and metalworking site located on the south bank of Wadi Fidan, opposite Wadi Fidan 40. The site was believed by its first excavators to be the town connected with the Wadi Fidan 40 cemetery (Adams and Genz 1995). When first excavated by the Deutsches Bergbau-Museum and the Department of Antiquities of Jordan, led by Russell Adams and Hermann Genz (1995), the site was believed to be Chalcolithic, but later studies show it to be Early Bronze (Levy et al. 2001). Three tumuli were noted at the site, noticeably later in date than the occupation phase (Adams and Genz 1995:8). Salvage excavations during 2003, led by Levy and Najjar for the joint University of California at San Diego (UCSD)–Department of Antiquities of Jordan (DOAJ) team revealed that these tumuli were indeed Iron Age tombs. UCSD excavated one of these tombs at the beginning of the season, while the DOAJ excavated the other two later. None of these materials has been published, and only the results of the excavation of Tomb 1 are presently available to the authors and published here.

Tomb 1 at Wadi Fidan 4 consisted of a (ca. 25-m^2) cairn, immediately beneath which were revealed the capstones of a cist grave (Figure 9.2). Within this grave were a total of eight individuals. The first skeleton (L605) was an adult buried in an extended position with its head to the south; no grave goods were found in association with this burial. The second (L663) was a disarticulated, somewhat fragmentary burial, also without grave goods. The third individual

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(L701) was an articulated adult burial in a semi-flexed position with its head to the north and found wearing two copper or bronze anklets (EDM 50680, 50681)—one on each leg—and associated with a small, probably Egyptian figurine pendant pierced through the ears (Figures 9.3 and 9.4; EDM 50700; see Chapter 11, this volume), three univalve shell beads cut along their axes, one shell pierced opposite its natural opening (EDM 40031, 50700, 50747), and five cowries with their tops cut off (EDM 50747, 50748, 50749, 50750, 50751, 50768). The fourth burial consists of a semi-flexed adult oriented to the north, lying on the left side facing east (Figure 9.2; L720). Next to this adult was found the poorly preserved remains of a juvenile in a flexed position at the adult's midsection with the head pointing north, facing the adult, and, between this juvenile and the cist wall, a younger infant in an extended position (Figure 9.2; L721), associated with a cowrie with the top cut off (EDM 50863). Beneath the cranium of the juvenile were found a copper or copper alloy earring (Figure 9.5; EDM 50808) and what appears to be a necklace consisting of an Egyptian seal (Figures 9.6 and 9.7; EDM 50809); a pearl fragment; 20 carnelian axe- or adze-shaped beads; one dark red jasper axe- or adze-shaped bead (Figure 9.8); one dark brown bedded stone bead; one red-orange carnelian bead; four cowrie beads and three other shell beads; two white alabaster beads;



Figure 9.2 Wadi Fidan 4, Iron Age Tomb 1, individuals 4, 5, and 6.



Figure 9.3 The figurine from Wadi Fidan 4, Tomb 1, Locus 701 (EDM 50700).



Figure 9.4 The figurine from Wadi Fidan 4, Tomb 1, Locus 701 (EDM 50700), side view.



Figure 9.5 The copper or copper alloy earring from Wadi Fidan 4, Tomb 1, Locus 720 (EDM 50808).

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Figure 9.6 The Egyptian seal from Wadi Fidan 4, Tomb 1 (EDM 50809), Locus 720.

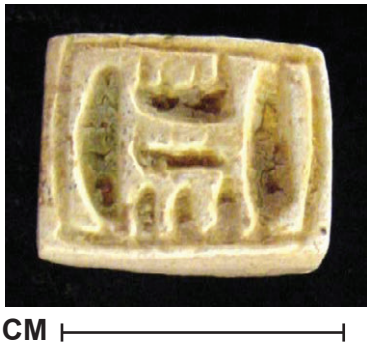

Figure 9.7 Opposite side of the Egyptian seal from Wadi Fidan 4, Tomb 1 (EDM 50809), Locus 720.

one opaque yellow, probably apatite bead; and 17 very delicate, tiny (less than 3 mm, with most being less than 2 mm in circumference) white, probably shell beads (EDM 50810). The axe- or adze-shaped beads are paralleled by a single, broken bead at Wadi Fidan 40 (Grave 14) and beads at Tell el Ajjul, Tomb 1152 (Petrie 1932:Pl. XXV). The seventh individual (L736) is an adult, apparently oriented with the head to the north in a semi-flexed position but poorly preserved, found with only two cowries with the tops cut off (EDM 51086, 51088) and two opaque white alabaster beads (EDM 50888). The eighth skeleton is an adult (L758), again oriented with the head to the north in a semi-flexed position. This last skeleton was found in association with a scarab (Figures 9.9 and 9.10; EDM 40046), three cowries with the tops cut off, three univalve shells cut along their axes to form disk beads, one small gray siltstone bead (EDM 51101, 51123, 51167), a carnelian bead, two yellow apatite beads,

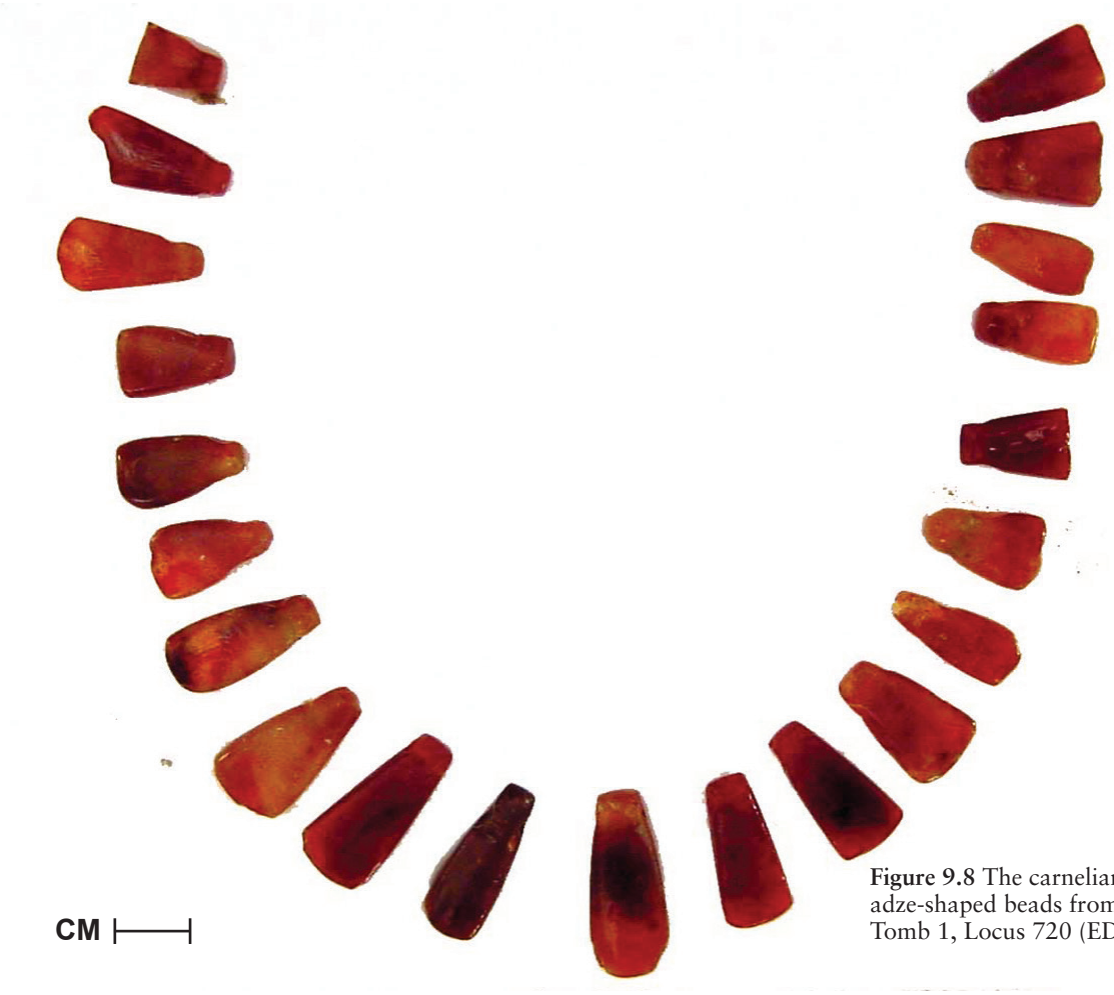

Figure 9.8 The carnelian and jasper adze-shaped beads from Wadi Fidan 4, Tomb 1, Locus 720 (EDM 50810).

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Figure 9.9 The scarab from Wadi Fidan 4, Tomb 1, Locus 758 (EDM 40046).



Figure 9.10 The scarab from Wadi Fidan 4 (dorsal view), Tomb 1, Locus 758 (EDM 40046).



Figure 9.11 The copper leech earring from Wadi Fidan 4, Tomb 1, Locus 758 (EDM 40043). *Photos: UC San Diego Levantine Archaeology Laboratory.*

a small white stone bead (EDM 51185), a carnelian short barrel bead (EDM 51202-A), a copper or copper alloy earring (Figure 9.11; EDM 40043), and fragments of two iron bracelets, one of which was found on each wrist (EDM 51124, 51168). In short, the first adult burial encountered and one small infant were found lying extended, while the rest of the burials, when their positions could be ascertained, were semi-flexed. All the individuals except the first were buried with heads to the north; the topmost individual's head was pointed south. Grave goods ranged from nothing to include shell and stone beads, copper anklets, iron bracelets, a copper leech earring, an Egyptian seal, a scarab, and a figurine. The seal dates from the LBIIA to the Iron IA, while the scarab dates to about the tenth century (Chapter 11, this volume).

Mortuary Sites Found in Other Project Surveys

Other burials and cemeteries are known only from survey. The Wadi el-Hasa Survey recorded five sites with graves and Iron Age pottery (WHS sites 10, 42, 86, 604, 644). The Southern Ghors/Northeast 'Araba Archaeological Survey documented 19 sites with graves and Iron Age pottery (SGNAS sites 5, 49, 62, 69, 72, 79, 108, 111, 124, 127, 160, 161, 162, 168, 171, 187, 188, 192, and 196). Thirty-three sites with both Iron Age pottery and graves or possible graves were documented by the Tafila-Busayra Archaeological Survey, including the important site Sela' (TBAS sites 021, 036, 049, 052, 056, 059, 062, 063, 068, 072, 073, 075, 079, 085, 089, 121, 125, 134 [Sela'], 142, 145, 146, 158, 160, 161, 167, 169, 173, 175, 176, 177, 217, 248, and 260; MacDonald et al. 2004). The ELRAP has added more graves to these totals. Eight cemeteries or graves with Iron Age pottery were documented by the Wadi al-Jariya Survey (WJS 24, 35, 60, 61, 515, 520, 521, 524), five in the Wadi al-Guwayb Survey (WAG 562, 564, 582, 590, 639), and nine in the Wadi Fidan (WFD 4, 10, 15b, 40, 45, 54, 62, 89, 123). Unfortunately, it was seldom clear whether the graves at any of these sites were contemporaneous with the pottery, and in many cases little detail was recorded on the graves.

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Summary

In summary, there are few excavated Iron Age burials in Edom to which to compare Wadi Fidan 40, and none that are unarguably Edomite. Although none of these burials are included in her analysis, they all follow what Elizabeth Bloch-Smith (1992) defines as an Iron Age lowland/coastal Levantine burial pattern, in mostly individual cist graves rather than the communal rock-hewn graves of the Judahite highlands. While Busayra and Tawilan each have burials, these cannot be firmly dated to the Iron Age. Tel el-Kheleifeh has one documented burial in a mud brick tomb that seems to date to the later Iron Age habitation at the site and may or may not belong to an Edomite individual. Recently, in 2012 a well-preserved Iron Age tumulus with 23 skeletons and burial offerings similar to the tumuli burials at WFD 4 was excavated by UCSD ELRAP on the summit of WFD 61. Thus, Wadi Fidan 4 and 45, both visible from and very close to Wadi Fidan 40, provide the best comparative material both in terms of date and in similarity of the material culture.

The Wadi Fidan 40 Cemetery

A History of Research

The Wadi Fidan 40 site has been investigated since about 1980. It has also been designated by at least four different site numbers (Table 9.2). The site was first documented by T. D. Raikes in his survey of the Wadi Fidan. Raikes's pioneering survey documented the most important large sites in the Wadi and noted some of their features and lithics. Raikes designated Wadi Fidan 40 as Wadi Fidan Gorge Site D and presented sketch maps of a few of the stone circles and pavements at the site. Raikes believed that these structures represented the floors of small edifices with light superstructures (Raikes 1980:53) and suggested that the unpaved stone circles were "perhaps fireplaces" (Raikes 1985:98).

The site was next documented by Burton MacDonald and the Southern Ghors and Northeast 'Araba Archaeological Survey. This survey designated the site SGNAS Site 14. SGNAS noted several looted graves, particularly in the western portion of the site, as well as a "medium" lithic and a "low" sherd scatter. They list Chalcolithic/EB, EB IVB, and undated material present (MacDonald 1992b:250–251).

The first probes at the site were carried out by R. Adams's Wadi Fidan Archaeological Project. Adams (1991) designated the site Wadi Fidan 009. This project excavated a total of six graves and examined other looted graves. The project found no datable material in the graves excavated but did find iron bracelet fragments in backfill from looted graves. Adams was the first to note that at least two different surface structures existed at the site, one being cairns and the other being stone circles with pavements. Believing that it was the cairns that were robbed because they were "more obviously graves," Adams argued that these were of a different period from the rest of the graves at the site. Adams drew parallels between the graves of Shiqmim (which had stone circles and cists) and probably also followed MacDonald (1988) in arguing that the paved graves, including the six excavated, were Chalcolithic to Early Bronze.

In 1997, as part of the Jabal Hamrat Fidan Archaeological Project, Levy and Adams carried out the first large-scale excavations at the site. "In the light of the first systematic archaeological survey carried out in the Jabal Hamrat Fidan in the spring of 1998 . . . the cemetery first sampled by Adams (1991) [as Wadi Fidan 009] is now referred to as Wadi Fidan 40" (Levy et al. 1999:296), and it is this designation by which the site has been known since. When excavations commenced, working with Adam's interpretation, it was believed

Table 9.2 Site designations and primary publications relating to WFD 40.

Project	Site Designation	Estimated Age	Major Publications
Raikes's survey	Wadi Fidan Gorge Site D	Neolithic or later, or "palaeolithic onwards"	Raikes 1980, 1985
Southern Ghors and Northeast 'Araba Archaeological Survey	SGNAS Site 14	Chalcolithic/ Early Bronze	MacDonald 1988; MacDonald 1992b
Wadi Fidan Archaeological Project (excavation and survey)	Wadi Fidan Site 009	Chalcolithic/ Early Bronze	Adams 1991
Jabal Hamrat Fidan Project/Edom Lowlands Regional Archaeology Project (excavations and survey)	Wadi Fidan Site 40	Iron Age	Levy et al. 2004; Levy 2009a

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that Site 40 was the cemetery used by the Early Bronze I inhabitants of Wadi Fidan 4. Site notes often refer to the site as the "Wadi Fidan 4 cemetery." The UCSD–Department of Antiquities of Jordan excavations determined that not only was the site not the cemetery of Wadi Fidan 4 but was in fact several thousand years younger, dating from the Iron Age. However, it should be noted that a paucity of Early Bronze potsherds have been found occasionally in grave fill at the site, suggesting an Early Bronze residue was turned over by the gravediggers. These excavations also obtained the first radiocarbon dates for the site, all from pomegranate seeds, and all dating from the eleventh to the ninth centuries BCE (Table 9.3).

In 2003, the Jordan Valley Authority planned the construction of a dam across the Wadi Fidan—a massive structure that would have destroyed portions of Wadi Fidan 40 in addition Wadi Fidan 4 and about 20 other sites (Levy 2003). In response, Levy and Najjar were asked by the Department of Antiquities of Jordan to return to Wadi Fidan 40 to conduct emergency excavations. The project excavated a previously unexcavated area of the Wadi Fidan 40 to the east of the 1997 excavations, designating it Area E. The dam project was abandoned in its preliminary phases before work was begun. In 2004, Levy and Najjar returned for a second emergency excavation at the site. This project produced more radiocarbon dates and a stamp seal, further confirming the tenth-century BCE use of the site. In 2009, an additional single grave was excavated. A preliminary publication of the 2004 excavations was published (Levy et al. 2005), but the present chapter is the first publication of most of these data.

Wadi Fidan 40 and Its Burials

The Wadi Fidan 40 dominates the entrance to the Wadi Fidan Gorge. Graves were dug through the loose, poorly sorted Pleistocene gravels, cobbles, and boulders, often cutting into the poorly cemented conglomerate bedrock. Many of the cobbles and boulders were then used in building some of the grave architecture, likely with the addition of stones from the wadi below.

As noted above, the Wadi Fidan 40 cemetery extends over an area of around 3,450 m^2. If one assumes 10 graves per 5 x 5–m square, as many as 1,380 graves are present (Figure 9.12). Ten graves per 5 x 5–meter square is not an unusual number for the excavated area of the cemetery, although small drainages are found between Area C and Area E. No graves were observed eroding from these drainages, so it is likely that fewer than the 1,380 graves estimated are actually found at the cemetery. This is only about one-third the number of graves estimated in previous publications (Levy et al. 1999), making it necessary to reinvestigate this issue in the future. In any event, the large Iron Age cemetery at WFD 40 is an anomaly in the desertic regions of southern Levant. The Iron I in Israel is notable for its lack of burials (Kletter 2002). Although this is no doubt due in part to preservation biases (Bloch-Smith 2004), it may also be due in part to cultural concerns regarding egalitarianism (Faust 2004, 2006). In southern Jordan, it is particularly remarkable given that the period is believed by many to be a time when the Edomite state did not exist and when Edom itself was allegedly unsettled (Bienkowski 1992). As will be shown below, the Wadi Fidan 40

Table 9.3 Wadi Fidan 40 radiocarbon dates.

Grave	Sample No.	^{14}C Date BP	Calibrated Date BC 1 Sigma	Publication
59	OxA-14233	2839 ± 28	1050–970	Levy et al. 2005:482
59	OxA-14234	2819 ± 26	1005–925	Levy et al. 2005:482
59	OxA-14235	2795 ± 30	980–905	Levy et al. 2005:482
59	OxA-14236	2859 ± 26	1070–970	Levy et al. 2005:482
59	OxA-14237	2863 ± 27	1090–970	Levy et al. 2005:482
59	OxA-14238	2779 ± 31	980–890	Levy et al. 2005:482
59	OxA-14431	2758 ± 35	970–840	Levy et al. 2005:482
92	Beta-111366	2800 ± 70	1015–845	Levy et al. 1999:303
701	OxA-14239	2784 ± 28	980–895	Levy et al. 2005:482

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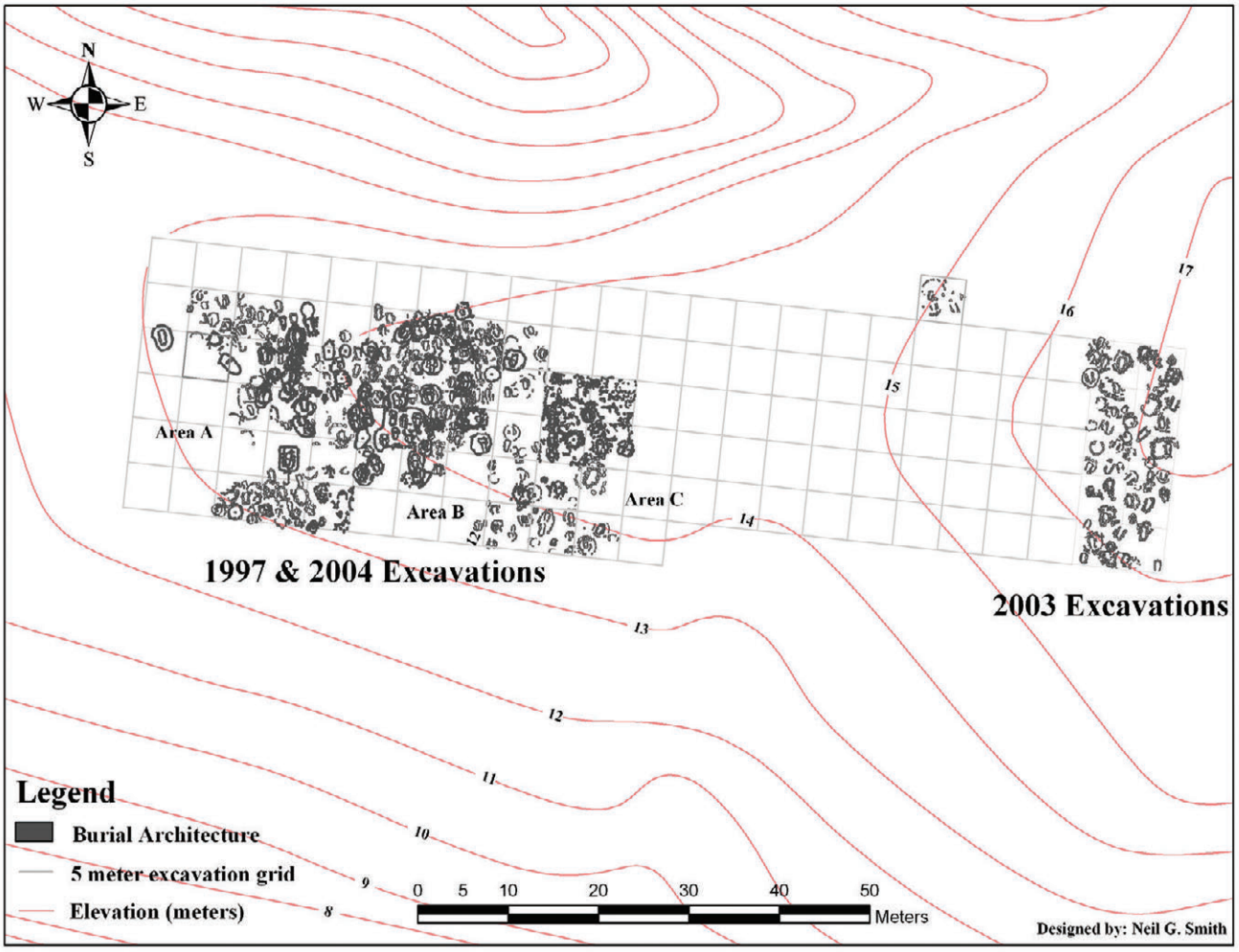

Figure 9.12 Map of excavated Iron Age graves of Wadi Fidan 40.

cemetery demonstrates the presence of a considerably large around tenth-century BCE human population in the copper ore–rich Faynan region and conflicts with these earlier interpretations concerning the occupational history of Edom during the earlier phases of the Iron Age.

The most common type of burial, represented by 245 excavated examples, was found within stone cist graves (Table 9.4S). To construct a cist grave, a hole was dug in the fill and conglomerate to an average depth of around 1.01 m. The walls of the resulting pit-basse were then lined with large flat slabs of red Nubian sandstone, averaging roughly 60 x 40 cm by 10 to 15 cm, creating a stone cist with an average length of around 1.09 m, width of 0.47 m, and depth of 0.45 m. However, cists ranged from 0.26 to 2.06 m in length, 0.20 to 1.01 m in width, and 0.20 to 0.76 m in depth. The average capstone depth below surface was 0.43 m. Although sandstone boulders are found in Wadi Fidan, the quantity and homogeneity of sandstone used suggest that it was cut further up the wadi and carried to the site. The floors of 15 cists were paved of flat stones, although most cist floors consisted of conglomerate bedrock. Cobbles—usually dolerite—were laid across the top of the side slabs as capstone support stones. Stone slabs, usually of sandstone and of about the same dimensions as the side slabs, were placed on top of these to serve as capstones. The capstones were in turn often covered with a coating of mud plaster.

There are three main types of cist at Wadi Fidan 40—*trapezoidal cist*, *L-shaped cist*, and *rectangular cist*. Rectangular cists, which made up 32 of the cist assemblages in the cemetery, were with one possible exception constructed to hold children or secondary burials (Figures 9.13 and 9.14). Trapezoidal cists, the most

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Figure 9.13 The rectangular cist and secondary burial of Grave 357.



Figure 9.14 The rectangular cist and infant burial of Grave 330. The stones used in this cist are all readily available wadi cobbles. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

common cist type, which tend to be wider in the north than in the south, make up 154 of the graves (Figures 9.15 and 9.16). L-shaped cists, which constitute 13 of the graves, have an extension at a right angle to the base (Figure 9.17). The L-shaped and trapezoidal cists were constructed to hold the bent legs of a semi-flexed individual. Trapezoidal cists have an advantage over L-shaped cists in that they can more easily be reused—L-shaped cists, when originally constructed, were tailored to the measurements of the interred (Figures 9.18 and 9.19).

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Figure 9.15 The trapezoidal cist of Grave 338, built to accommodate the dimensions of a flexed burial.

When L-shaped cists were reused, the leg niche was often ignored or used for the secondary remains of the original occupant. Insufficient data were collected on 47 of the cists to determine their shape. No photographs were taken of these cists, and their shape cannot be determined from the supervisors' excavation notes. No chronological distinctions could be made between the three kinds of cists. Indeed, in the case of Grave 337 and Grave 348, two graves were covered by an unbroken line of capstones and are believed therefore to be cotemporaneous. Grave 337 is a trapezoidal cist, and Grave 348 is an L-shaped cist. All three cist types were probably used at the same time.

The cists are striking for their uniformity. The majority are trapezoidal shaped, wider in the north than in the south. By contrast, among the published graves at the large Late Bronze and Iron Age cemetery Tel es-Sa'idiyeh on the east bank of the Jordan River (Tubb 1985), Elizabeth Bloch-Smith (1992:159) counted 14 variations of mud brick and stone cists, ranging from pits partially lined with stones and sherds to completely stone-lined cists not dissimilar to those at Wadi Fidan 40. Subsequent analyses of the Tel es-Sa'idiyeh cemetery by John D. M. Green (2006, 2007, 2009, 2010, in press), in light of excavations by Jonathan Tubb (Tubb 1986, 1988a, 1988b, 1988c, 1990, 1995; Tubb and Dorrell 1991, 1993, 1994; Tubb et al. 1996, 1997),



Figure 9.16 The trapezoidal cist of Grave 524. Note the paved floor. A total of 15 cists were found with paved floors. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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Figure 9.17 The L-shaped cist and semi-flexed burial of Grave 340.



Figure 9.18 The infant burial in the reused L-shaped cist of Grave 308. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

have done much to improve our understanding of that multiperiod and probably multiethnic burial ground. Green (2006:2.428–431) also notes that these cists can be divided into four main types: deep mud brick–lined cists, shallow mud brick–lined cists, boulder-lined cists, and stone-built cists. Of these, the last is most like the design of the cists at Wadi Fidan 40 (J. D. M. Green, personal communication, July 22, 2011). But even this grave, with its corbelled roof and stacked stone walls, is in many ways unlike the cists at Wadi Fidan 40, which tend to be made with stone slabs. And while our understanding of its dating is more complete, the burial practices at any one period at Tel es-Sa'idiyeh are still diverse. The uniformity of burial architecture at Wadi Fidan 40 suggests a single population used the cemetery over a period of time.

The second most common form of subsurface architecture is a simple pit cut into the conglomerate covered over by capstones (Table 9.5). Thirty-four of the excavated graves were constructed in this fashion. Just three individuals in two graves, all of them children, were primary burials in simple pits (Grave 349 and the infant in the balk of Grave 540). Bloch-Smith (1992) suggested that pit graves in the Levant are in a sense simplified cist graves (or, put another way, cists are complicated pit graves). This connection between cists and pits would seem to be signified by the capstones and by the two graves, 68 and 72, which are identically lined along their northern sides (Figure 9.20).

Cists were generally constructed to hold an individual's flexed or semi-flexed remains, although the stones forming the end of some cists were later removed to allow the placement of extended burials (Figure 9.21). Of the 110 interments that were intact enough for such examination, 97 were semi-flexed (Figure 9.15) or flexed (Figure 9.19) and just 13 were extended (Table 9.6S). One additional individual (in Grave 200) lay with legs extended and upper body hunched over, as though in an attempt at an extended burial. Extended burials nonetheless are found across and in each area of the site. At Wadi Fidan 40, extended burials seem to be a later development, which at times necessitated

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Figure 9.19 The flexed burial and trapezoidal cist of Grave 549. Note the secondary burial, believed to have been the original interment of the cist, pushed to the end of the cist north of the primary burial.



Figure 9.20 The Grave 72 pit burial. Note the stones lining the northern end. Such poor preservation is typical in graves without cists or where cists have filled with sediment. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

the modification of reused cists. All of the dated graves at Wadi Fidan 40—Graves 59, 92, and 701, which were radiocarbon dated, and 91, which included a tenth-century stamp seal (Levy et al. 2005:39–40)—were extended burials in cists with the stones at one end removed (Figure 9.21). This suggests that the last phase of use at the cemetery has been used to date the whole. Interestingly, of the adult burials at WFD 4, Tomb 1, only the topmost is extended, suggesting the custom changed with time in the Wadi Fidan and that only at the end of the cemetery's life were the dead buried in this fashion. However, this cannot be proven with the few absolute dates from the cemetery. An alternative explanation, that certain high-class individuals had cists modified for their interment at the same time that semi-flexed burial was the norm, is equally probable.

Burial position at other Iron Age burial sites in the southern Levant has been understood to be linked to imitation of foreign customs or the gender of the deceased. Tightly bound burials at Tel es-Sa'idiyeh, both flexed and extended, were found to be wrapped in Egyptian linen—suggesting that perhaps other tightly bound burials are Egyptian influenced (Tubb 1995:141). Rivka Gonen (1992) has suggested that individual burials in pits and cists derive from Egypt in the Late Bronze Age, the ancestral custom having been multiple burials in caves. The burials at Wadi Fidan 40 were often covered with a shroud of animal skin and goat hair rather than linen and tended to be individual burials within pit and cist graves. Occasionally, offerings included Egyptian artifacts. Although shrouds should not be presumed to come from Egypt, these facts may indicate Egyptian influence, which would not be surprising given Egypt's proximity.

At Tell el-Mazar, Khair Yassine (1983:32–33; 1984:8) associates semi-flexed and flexed bodies (a position termed *crouching*, as opposed to a "stretching," extended position) with the gender of the deceased.

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Table 9.5 Wadi Fidan 40 pit burials with capstones.

Grave No.	Area	Season	Capstone Depth Below Surface (m)	Burial Length (m)	Burial Width (m)	Burial Depth Below Surface (m)	Number of capstones
9-2004	A	2004	0.50	1.18	0.52	1.06	4
26A	C	1997	0.86	1.39	0.54	1.22	3
55-2004	A	2004	0.56	0.43	0.29	1.14	4
38B	B	1997	0.82	0.57	0.49	1.12	2
38N	B	1997	0.45	0.60	0.54	0.61	2
68*	A	1997	0.46	1.26	0.46	1.01	4
71	A	1997	0.47	1.20	0.50	1.05	4
72*	A	1997	0.51	1.40	1.00	1.15	4
75	C	1997	0.63	1.00	0.60	1.24	10
82-2004	A	2004	0.43	0.49	0.36	0.58	4
90-2004	A	2004	0.54	1.24	1.15	1.14	4
99	C	1997	0.23	0.27	0.17	0.60	1
105	A	1997	0.64	0.63	0.53	1.14	2
300	A	2004	0.47	0.50	0.28	0.95	3
301	A	2004	0.31	0.91	0.79	0.80	2
317	A	2004	1.15	1.00	0.45	1.91	2
319	A	2004	0.41	1.01	0.88	0.96	3
320	A	2004	0.25	1.03	0.57	0.87	4
321	A	2004	0.44	0.82	0.38	0.99	4
325	A	2004	0.34	0.80	0.40	0.70	3
327	A	2004	0.11	0.52	0.30	0.28	3
341	A	2004	0.52	0.63	0.41	0.82	1
355	A	2004	0.38	0.68	0.44	0.84	3
359	A	2004	0.35	0.79	0.52	0.81	2
363	A	2004	0.51	1.50	1.06	1.14	4
364	A	2004	0.19	0.41	0.28	0.51	2
555	B	2004	0.38	1.30	0.44	0.72	2
713	C	2004	0.43	1.40	0.43	1.51	4
716	C	2004	0.44	0.40	0.30	0.91	2
717	C	2004	0.65	0.45	0.32	0.90	2
721	C	2004	0.79	0.59	0.46	1.10	3
733	C	2004	0.62	0.80	0.33	1.04	2
741	C	2004	0.63	0.67	0.21	1.06	2
2009	A	2009	0.70	1.10	0.50	1.05	5

*Graves 68 and 72 were partially lined with stones.

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Figure 9.21 Grave 91. Note the removal of the southern side slab of the cist to accommodate this extended burial. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

However, this is in disagreement with the findings of the physical anthropologists who studied the human remains from the site. Indeed, based on their table (Disi et al. 1984:181–183), the physical anthropologists agreed with the archaeologists on 15 skeletons and disagreed on 11, with the physical anthropologists noting no correlation between burial position and gender. At Wadi Fidan 40, no correlation was observed between position and gender of the deceased that could be sexed, although it should be kept in mind that at this point, the majority of the human remains are unsexed either due to their biological age or poor preservation. The work of Melanie Beasley, who is currently analyzing the remains in the UCSD Levantine Archaeology Osteology Lab, may correct this lacuna.

The Wadi Fidan 40 cists are usually oriented approximately north–south, and burials in cist pits are regularly oriented with the head toward the south. A minority of the burials are oriented to the north. Of the 146 burials that were intact enough to determine orientation, 116 were oriented to the south, while 26 were oriented to the north. The infant of Grave 380 was oriented to the west, and the infant in Grave 226 was oriented with the head to the east. The latter was, however, in a cist oriented north–south and may have once lain at the feet of a second inhabitant or simply been placed in such a way to take advantage of a previously looted tomb. One cist, that of Grave 262, was constructed oriented east–west. Extended burials were placed oriented to the north and south in roughly equal numbers. This tendency to orient all of the graves of a cemetery in a particular fashion is common in the Levant during this period (Bloch-Smith 1992).

The burials in general were placed to face the west. Seventy-seven burials faced west, while 13 faced east. Seven, all extended, lay face-up. There was no clear correlation between whether the interred were oriented north or south and whether those individuals faced east or west. It should be noted that the burials tend to face toward the Fidan's outlet to the Wadi 'Araba, away from the Edomite plateau. It is possible that the majority of burials were deliberately placed to face to the west due to a perceived connection with Egypt or Cisjordan. However, this is merely speculative.

Secondary burials are also extremely common in the cemetery (Table 9.6S). In some cases, a cist was even constructed for a secondary burial (Figure 9.13), possibly for an individual not originally interred in the cemetery. However, secondary burials in general seem to result from reuse of the cists. In some cases, the original interment was pushed to one end of the cist, usually at the feet of the new primary burial (Figure 9.19). In a few instances, the broken remains of a secondary burial were laid over the newly interred primary corpse, a very intimate mingling of the dead (Figure 9.22). Finally, we have suggested that occasionally, the previous interment was removed from the cist and, after a new individual was interred and the capstones put in place, it was deposited above the capstones (Levy et al. 1999) —a practice Jonathan Tubb noted at Tel es-Sa'idiyeh and termed "derived secondary" burial (Tubb 1995:141). However, it is impossible to say at this point whether secondary burials in the grave fill are "derived secondary" burials or perhaps individuals taken from other graves and buried with kin. In numerous cases, human remains are found in the fill of obviously disturbed graves. These human remains,

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Figure 9.22 The primary burial of Grave 102, covered by the fragmented remains of a secondary burial located near the extended burial's lower body.

although indistinguishable from secondary burials, are probably castoff by ancient looters from the process of robbing tombs. Secondary burials in grave fill were sometimes very carefully arranged (Figure 9.23), but in most instances, the treatment of the disarticulated remains, either within or without cists, could not be differentiated from the work of tomb robbers.

Wadi Fidan 40 and the Wadi Fidan 4 tombs are notable for the uniformity of their subsurface architecture, and it is tempting to use cist graves as an ethnic marker. Bloch-Smith (1992) has shown that these graves, however, are found across Israel and Transjordan, with the exception of the Judahite highlands. But cist graves also serve utilitarian purposes. They function to deter if not prevent humans and other animals from digging up the dead. Like their modern counterparts used in most United States cemeteries, concrete vaults, they also serve to stabilize the ground surface and its associated architecture, which would otherwise collapse as the interred decompose (Heimbuch et al. 1980). Such surface architecture is also of particular importance in the construction of identity, in that it remains visible on the surface as the site is revisited and can be the focus of cult. Taken together, a multiplicity of meanings and functions are no doubt embedded in the cist graves that are so common in the Wadi Fidan Iron Age mortuary monuments.



Figure 9.23 Individual 319B, a secondary burial in fill of Grave 319. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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Items of Personal Adornment

Personal adornment found with deceased individuals in mortuary contexts provides an important source of data concerning the ethnic identity, death ritual, and social organization of the cemetery population. For example, anthropological archaeologists working with mortuary populations across time and space have found personal adornment extremely useful to establish these kinds of socioeconomic interpretations (Braunstein 1998; Chesson 2001; Harrison 2001; Levy et al. 2005; Miles 1965; Parker Pearson 2000; Rothschild 1979; Tainter 1975). At the Wadi Fidan 40 cemetery, the most common grave goods were articles of personal ornamentation. These adornments included copper and iron objects and shell, limestone, and bone rings and bracelets. However, the most common items of personal adornment were stone and shell beads and pendants.

Metal items were the most unusual and probably most costly items at Wadi Fidan 40. Despite the large quantities of copper produced at contemporary tenth-century BCE Khirbat en-Nahas, there is little evidence that it was worked into final products for local use. To date, only one figurine mold was found at the site, which was found in a specialized slag processing complex (Levy 2008; Area S; see Chapter 2, this volume). Ceramic figurine fragments have been found at the site, and the mold is likely for ceramic rather than metalworking. From a world systems perspective, some core power might have been extracting the copper from the region and forming it into finished products elsewhere, only to return a fraction of the final products to the region after greatly enhancing the material's value (Algaze 1993). Whether the metalworking was done in the region or abroad, the lack of finished metal products being made in the region suggests that those final products that were found were especially valuable.

Iron was the rarer metal at Wadi Fidan 40. One apparently utilitarian iron object was found—three fragments of what appear to be an iron blade found beneath the skull of Grave 9-2004 (EDM 86776, 86798). An iron bracelet was discovered on the left arm of the individual in Grave 92 (B2134; Figure 9.24), a mature adult female, and an iron ring with a chevron design was found on the left hand of the individual in Grave 54, a 15- to 21-year-old of indeterminate sex (B2542). All three of these individuals were buried in an extended position. Grave 9-2004 consisted of a pit covered with capstones, but Grave 92 and Grave 54 were cists with the ends removed to accommodate their bodies. As noted above, extended burial is an unusual burial style at Wadi Fidan 40, and this may be a marker of status. Both the individuals of Grave 92 and Grave 54 were also buried with copper items, described more fully below.

Eleven graves contained copper metal items. These copper objects were highly varied, including earrings,



Figure 9.24 Detail of Grave 92 iron bracelet in situ on the left arm of this mature female. The first radiocarbon dates from the cemetery were taken from the desiccated pomegranates in this photo. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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Figure 9.25 The unidentified copper object from Grave 356 (EDM 70367). *Photo: UC San Diego Levantine Archaeology Laboratory.*

bracelets, anklets, rings, a bead, an ornamental object, and unidentified copper pieces. A small unidentified copper metal fragment was found associated with two stone beads in the fill of robbed Grave 252 (EDM 80735). Another unidentified copper piece was found at the waist of the 18- to 22-year-old male in Grave 356 (Figure 9.25; EDM 70367), between the individual's lumbar vertebrae and his extended arm and in association with an unidentified organic stain (Figure 9.26). Cowrie beads were sometimes found at the waist on other individuals, and it is possible that this copper object was once mounted on a belt. But vessels were also sometimes placed in this location, and this object may have been placed in front of this male individual (see Table 9.6S for bioanthropological data). This grave was also reused, and it is possible that this is a fragment of an object buried with the original occupant. An unidentified piece of copper metal, perhaps an earring fragment, was also found in Grave 701 (EDM 89092).

Metal Earrings and Bracelets. Metal earrings were found in two graves, Grave 345 and 371, both those of children. Two copper leech earrings were found with the child in Grave 345 (Figures 9.27 and 9.28; EDM 86994, 87004). The end of this cist was removed at some point, but child interred was laid in a semi-flexed position, despite the fact that he or she took up only a fraction of the total length of the cist (Figure 9.29). This child was also buried with a ceramic bowl.

Grave 371 included three copper earrings, a copper bracelet, and a copper ornament. Two of the earrings are solid tassel earrings (Figures 9.30 and 9.31; EDM



Figure 9.26 The unidentified copper object from Grave 356 in situ (red circle). *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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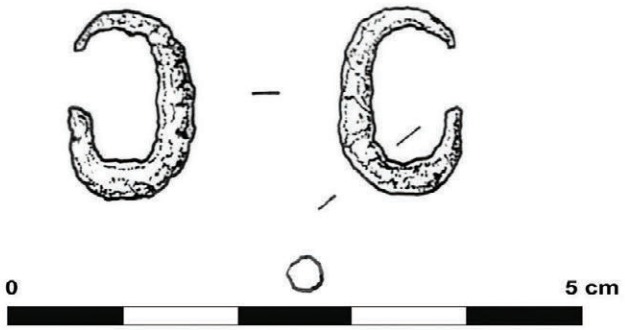

Figure 9.27 A copper earring from Grave 345, L3119, B3060 (EDM 86994).[2]



Figure 9.28 A copper earring from Grave 345 (EDM 87004). This earring was found associated with a child burial.



Figure 9.29 Overview of the Grave 345 child burial. This cist was previously modified for an adult burial by the removal of the endstones. Two copper or copper alloy earrings and a ceramic bowl were found with this burial. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

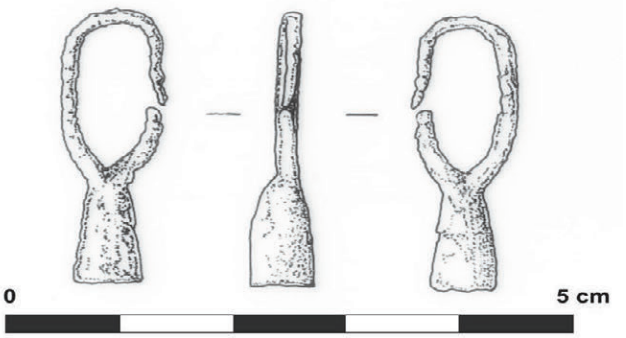

Figure 9.30 A copper earring, one of three, from child's Grave 371, L9243, B3244 (EDM 70387).

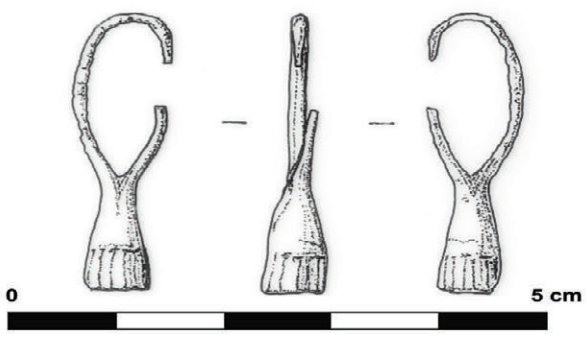

Figure 9.31 A copper earring, one of three, from child's Grave 371, L9243, B3245 (EDM 70390).

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70387, 70390), while the third is a leech earring (Figure 9.32; EDM 70391). A copper ornament with a dual spiral motif was also found in the grave (Figure 9.33; EDM 89220). This was called a pendant in the initial publications (Levy et al. 2005), but its exact nature could not be determined and may have been sewn onto clothing or otherwise mounted on perishable material than suspended as a pendant. It may have even served as the backing for an object that did not otherwise survive. Objects with similar dual spirals are common across the Near East—and, as Ogden (1995:74) points out—"most parts of the world." A bronze dual spiral

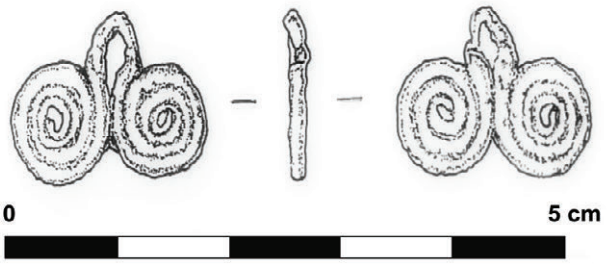

Figure 9.33 The dual spiral copper object from child's Grave 371, L3243, B3235 (EDM 89220). This motif is common across the Near East (Ogden 1995:74).



Figure 9.32 A copper earring, one of three, from child's Grave 371, L9243, B3246 (EDM 70391).



Figure 9.34 The copper bracelet from child's Grave 371, L9243, B3240 (EDM 70369).



Figure 9.35 The copper bracelet from Grave 371, in situ on the right arm of the interred (EDM 70369). Three earrings and a dual spiral were also found in this grave. This child burial was found with the largest number of copper grave offerings and may reflect inherited rank. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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attached to a figurine was found in the gatehouse at Khirbat en-Nahas (Chapter 2, this volume). A dual spiral formed part of a pendant in the Tawilan gold hoard, although the spirals themselves are probably not visible due to other applied decorations (Ogden 1995:73–74). The closest parallel to this dual spiral, however, is probably the Late Bronze example from the Governor's Tomb at Gaza, which was found beneath the skull of one of the last interments (Petrie 1933:6, pl. IX). A copper bracelet was also found about mid-shaft of the right forearm of the entombed in Grave 371 (Figures 9.34 and 9.35; EDM 70369), a child around age six to eight years.

A copper bracelet was also found in Grave 97, also with a juvenile (Figure 9.36; B3620). This bracelet was likewise found on the right forearm. This individual was also buried with a vessel, but in this case the vessel was wood (Figure 9.37).

In addition to the iron bracelet previously mentioned, a copper anklet was found at about the middle of the calf on each leg of the individual in Grave 92 (B2134). These anklets touched as she was laid in the grave, with the left leg over the right (Figure 9.38).



Figure 9.36 The copper bracelet from Grave 97 (B3620). *Photo: UC San Diego Levantine Archaeology Laboratory.*



Figure 9.37 The burial of Grave 97. Note the copper bracelet on the right forearm. This burial provides an additional example of a child whose prestige burial goods may reflect inherited wealth typical of a rank society.



Figure 9.38 The Grave 92 burial. Note the copper anklets around the mid-shafts of both lower legs. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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Metal Rings. Copper rings were found in three graves. At least two of these were toe rings, and none could conclusively be called finer rings, but in most cases, it could not be determined whether these were finger or toe rings. A copper or copper alloy ring was found on the third toe of the left foot (Figure 9.39S; B2543), and another copper or alloy ring was found on the second toe of the right foot (Figure 9.40; B2544) of Grave 54, which also had the iron finger ring (Figure 9.41). A copper ring fragment was found with the infant of Grave 66 (B2598) but might have belonged to the original inhabitant. A secondary burial believed to have been removed from the grave was found above the capstones. Finally, two copper rings were found in Grave 12, the badly disturbed grave of a juvenile and one of the richest graves in the cemetery (B2320, B2323). It is impossible to say if these are finger or toe rings, although notes state that one of them came from sieved sediments "from the foot area," and according to project osteologist Beasley, the bone seen encircled by one of the rings in site photos is probably a toe.



Figure 9.40 Grave 54, right foot, detail. Note the toe ring on the second toe (B. 2544). *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*



Figure 9.41 The copper toe rings (top, B2543, B2544) and iron finger ring (bottom, B2542) from Grave 54. *Photo: UC San Diego Levantine Archaeology Laboratory.*

Despite the fact that beads were the most common artifact at Wadi Fidan 40, only one metal bead was recovered. One copper bead was found associated with stone and shell beads in the cist of Grave 253 (EDM 80743).

Shell, Bone, and Limestone Bracelets. Shell, bone, or white stone bracelets were common in the cemetery. Unfortunately, only one complete and in situ example was found: a Lambis shell bracelet on the right arm of a young adult woman buried in Grave 706 (Figures 9.42, 9.43S, and 9.44; EDM 88493). Fourteen additional graves contained bracelet fragments (Graves 67, 101, 223, 227, 237, 247, 253, 257, 306, 329, 346, 515, 543, 706, and 718). Some of these seem to have encircled the entire wrist, while others are pierced and probably were tied to the wrist. Ten individuals were intact enough to determine age; all of these were adults. All five individuals who could be sexed were female. Shells constructed from Lambis, or spider conch, shells were popular burial items in the Levant at least from the Chalcolithic onward (Bar-Yosef et al. 1977). These shells were likely gathered from the Red Sea, and an intact bracelet carved from such a shell would no doubt be a prized prestige item. Lambis artifacts are also known at Tawilan, Ghrareh, and many sites in Cisjordan (Reese 1995:95). The stone bracelets may have been imitations of these shells.

Stone Rings. Chalk or limestone was also used to create rings or toe rings. One such toe ring was recovered from Grave 203 (Figure 9.45S; EDM 80968). Another was recovered from Grave 227 (EDM 80455), believed to be associated with an adult female who was also buried with a bracelet made from the same material.

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Figure 9.42 Grave 706 a relatively complete articulated flexed burial lying on its left side. Note the shell bracelet on the arm.



Figure 9.46: The neck and skull of the Grave 87 interment, after the removal of most of the postcranial skeleton. Note the elaborate multistrand choker. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

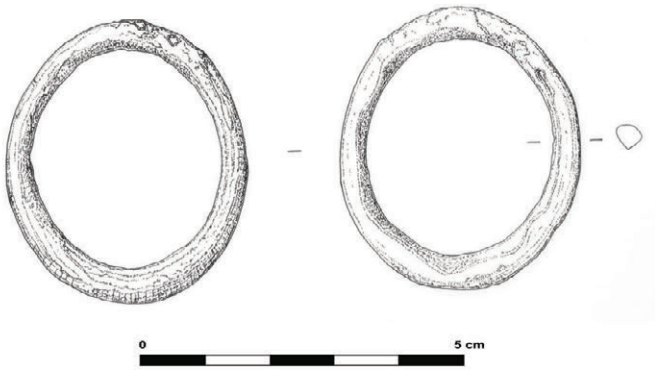

Figure 9.44 Drawing of the Lambis shell bracelet from Grave 706, L2480, B6856 (EDM 88493).

Beads and Pendants. By far the most common grave offerings in the cemetery were beads and pendants. Beads at Wadi Fidan 40 were found strung as necklaces, anklets, and bracelets. Most that survived were strung on single strands, but in one case, a complicated multistrand choker was excavated (Figure 9.46). One particularly wealthy grave, Grave 14 of an adult/child, demonstrates the use of these beads; in it, the deceased man/woman was found with bead bracelets around each wrist, bead anklets, and cowries at the waist (Figure 9.47). Other uses of beads are also likely. For example, beads may have been sewn onto garments. The numerous tiny, probably shell beads from Grave 14, identical to the tiny beads at Wadi Fidan 4, were likely sewn onto clothing. Graves in Egypt sometimes included entire shrouds (Vilímková 1969:41, pl. 85) or dresses (Berman et al. 2003:74) made of beads. Beads may have also been used as hair decorations or to adorn the anthropomorphic stones at the site, or may have simply been left as offerings.

The beads were identified by the primary author in 2007 (Table 9.7). This identification was primarily done by visual means using a simple magnifying glass (˝10). In some cases, basic hardness and other physical tests were conducted. A few stones were examined by X-ray fluorescence (XRF) in 2009. Regrettably, the beads excavated from Areas A and C in 1997 were unavailable for direct examination; these were identified using photographs. The identifications offered here should therefore be viewed as preliminary.

The most value laden (based on manufacture and trade distance) of these beads and pendants were a scarab (in Grave 92, B2152) and stamp seal (in Grave 91-2004, EDM 86873) from Egypt. These are discussed more fully in Chapter 11 (this volume). These items may not

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Figure 9.47 The bead assemblage from Grave 14. *Photo: UC San Diego Levantine Archaeology Laboratory.*

have been of great value in all of the Levant—they are not uncommon at other cemeteries. However, their rarity at Wadi Fidan 40, and the fact that the Grave 92 scarab was found in association with other valuable objects, suggests that they are high-prestige objects in this context. Such items served as amulets in Egypt for people otherwise unconnected with the royal court (Hall 1913), but they also may have served as markers of identity and true seals for their owners. Both were found with older adults, the scarab with a female and the stamp seal with an individual of indeterminate sex. The stamp seal was found in sieved sediments from the left chest area, beneath where the right hand lay crossed over the chest. The scarab was incorporated into a necklace (Figure 9.48S). Both individuals with these expensive objects lay in an extended position, which may have been a sign of high status, with the end of their cists removed to accommodate their burial. The female in Grave 92 was entombed with a wealth of other items, while the individual in Grave 91-2004 was buried with just three other beads.

The other beads from ancient synthetic materials are glass and possibly faience. Just three very small pieces were noted as possibly faience. Five glass beads were noted. One of these was not available for analysis, but three are wound glass, typical of Egyptian glass bead making (Petrie 1909:125). One of the blue glass beads, a surface find, was identical to the blue glass beads found at Wadi Fidan 45. Most interesting among the glass beads is the complicated black bead with white designs found in Grave 12 (Figures 9.49 and 9.50S).

Iron Age beads made out of cupric minerals are notable for their rarity in the Wadi Fidan 40 cemetery. This total includes all the copper-rich minerals, which might be gathered either in Faynan or Timna or the Sinai, including malachite and turquoise. The most interesting of these beads are the 11 spherical beads, all from the fill and cist of looted Grave 542, which seem to have been deliberately crafted to imitate lapis lazuli (Figure 9.51). Grave 542 was severely looted, and no other artifacts were found in this grave. The beads bear a striking visual resemblance to the lapis beads in the contemporary necklace of Psusennes I, from his tomb at Tanis (Montet 1951:138–139). Lapis was highly prized in Egypt and Mesopotamia but was not available locally. Lapis was most likely imported or traded from the Badakhshan region of northeastern Afghanistan (Aston et al. 2000:39). However, a hardness test on a broken surface of one of the beads from Grave 542 showed the stone to be softer than lapis (about 4.0 on the Moh's scale, contrasted to the 5.0–5.5 of lapis). XRF testing showed the stone to be rich in copper. These, therefore, appear to be imitations in cheaper local stone of highly valued exotic materials. These 11 are the only beads of their size and shape found in the cemetery.

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Table 9.7 Wadi Fidan 40 beads and pendants by material.

Material	Count	Percentage of Sample
Agate	152	2.91
Alabaster/calcite	212	4.05
Amazonite	298	5.70
Apetite	5	0.10
Aventurine	42	0.80
Bivalve drilled shell	4	0.08
Bone	11	0.21
Carnelian	626	11.97
Citrine	30	0.57
Ceramic	2	0.04
Coral	5	0.10
Copper	1	0.02
Cowrie	21	0.40
Cupric	118	2.26
Dentalium	226	4.25
Dolerite	2	0.04
?Faience	3	0.06
Flint	131	2.50
Garnet	1	0.02
Glass	5	0.10
Hematite	2	0.04
Jet	1	0.02
?Lapis lazuli	1	0.02
Limestone	185	3.54
Onyx	3	0.06
Ostrich eggshell	2,447	46.78
Pearl	1	0.02
Quartzite	2	0.04
Rock crystal	9	0.17
Sandstone	3	0.06
?Seed	1	0.02
Shell (worked, unidentified)	620	11.85
Siltstone	13	0.25
Univalve	23	0.44
?Wood	1	0.02
Total	5,231	100

? = identification questionable.

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Figure 9.49 The black glass bead with white design from Grave 12.



Figure 9.51 Eight of the 11 beads from Grave 542 apparently crafted in imitation of lapis lazuli (EDM 89197).

The most interesting stone in the collection is amazonite. Amazonite is a green to blue microcline feldspar. In most cases, the stone is easily recognizable due to its distinctive coloring and perpendicular cleavage planes. The stone was highly prized in Egypt. A term usually translated *amazonite* appears in lists of the six most valued stones of Egypt at the Ptolomaic temples of Edfou and Dendera. The term appears frequently in lists of gemstones. Amazonite was one of the stones considered suitable for creating a heart scarab, an amulet meant to ensure a beneficent afterlife. Amazonite is even used as a name for Thoth in the Book of the Dead (Harris 1961:116).

Despite its high value in nearby Egypt and the relative poverty of much of Wadi Fidan 40 (that may be due to grave robbing in antiquity), sometimes largish pendants are found in some of the Wadi Fidan 40 graves (Figures 9.52–9.55). Unlike the silicates such as carnelian, for



Figure 9.52 Amazonite bead and pendants from Grave 706 (EDM 88519). Note the "horns" on the third piece from the right. *Photos: UC San Diego Levantine Archaeology Laboratory.*

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Figure 9.53 Other amazonite pendants from Grave 706, hypothetically restrung (EDM 89196).



Figure 9.54 Amazonite beads, alongside a carnelian and an agate bead, from Grave 246 (EDM 80838).



Figure 9.55 Amazonite pendant from Grave 714 (EDM 88605). *Photos: UC San Diego Levantine Archaeology Laboratory.*

example, these large irregular pieces seem designed to make use of as much as the raw material as possible. These stones nevertheless often show signs of careful reuse. "Horns" are present on the tops of some of these stones, where the brittle stone broke through its perforation and a new perforation was drilled immediately below the old perforation (Figure 9.52). In a few cases, the distal end of an amazonite pendant was notched, perhaps for decorative purposes (Figure 9.55).

Unlike the other minerals discussed here, amazonite has distinct and limited sources in the Near East. Two amazonite sources are known in the Eastern Desert of Egypt, one in the region of Jebel Migif and Wadi Higelig, the other at Abu Rushaid. It is also known north of Tibesti in the in Libyan Mountains, although this source may not have been mined in the Iron Age (Aston et al. 2000:15, 46). There may be Persian sources, but this has not been confirmed, and in Mesopotamia, the stone saw little use by comparison to Egypt (Moorey 1994:82–83). Given the relative paucity of Egyptian artifacts in the cemetery, however, and the unlikelihood that such a large quantity of a highly prized stone could be extracted from Egypt, another source is more likely. No amazonite sources have yet been reported for Jordan, but the stone is found in the Arabian Peninsula, including at Wadi Tbeik (Fabiano et al. 2004). The most parsimonious explanation is that the presence of so much amazonite at Wadi Fidan 40 is most likely a sign of connections to Arabia.

An examination of beads per burial shows a great deal of variation within the cemetery (Table 9.8S). Many individuals, even those with no obvious signs of grave robbery, were buried without beads or other surviving personal adornment, while other burials were found with up to 914 beads in association. All of the most richly adorned individuals were women. Although beads were frequently found in grave fill, we found no evidence that this was a deliberate ritual.

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Often beads were left in the fill of robbed graves. There was little evidence that beads were intentionally interred with secondary burials. John D. M. Green (2007) has pointed out that at other Iron Age sites, women were interred with two anklets and certain high-ranking men with one, but no evidence was found of anklets on men at Wadi Fidan 40. When men were buried with beads or pendants, they were single items (Figure 9.56).

Seven of the bone artifacts were spatula-shaped pendants (Grave 95 [B2721], 231 [EDM 80677], 335 [EDM 86855], 507 [EDM 87761, associated with the secondary remains in the cist], 523 [EDM 87758], 706 [EDM 88494], and 707 [EDM 89050]). With the possible exception of Grave 231, which remains to be examined osteologically, all of the artifacts at Wadi Fidan 40 were found with adolescents or young adults, and the two that could be sexed, Graves 523 and 706, were both female (although the spatula in Grave 523 appeared to be associated with the secondary burial in the cist, which was unsexed). Two of these bone spatula pendants were found in situ. One was in Grave 335 (Figure 9.57S; EDM 86855) and the other in Grave 706, and both of these were found in the neck region, apparently serving as pendants. These artifacts bear a strong similarity to the spatulae found at Busayra (Sedman 2002:361–362), which formed "the single largest type of bone items" at Tawilan (Bienkowski 1995d:83), except that the Wadi Fidan 40 examples are rounded on both ends and pierced, while the Busayra examples have points at one end and have no perforation. The artifacts at Wadi Fidan 40, like those at Busayra and Tawilan, were most likely used for weaving on a ground loom. However, the spatulae at Wadi Fidan probably served a symbolic function, denoting young feminine weavers.

Looting is a danger Wadi Fidan 40 faces today (Levy 2003), and disturbance of graves was also dealt with by the population in antiquity. Of the 286 discrete excavated burials, 205 showed evidence of disturbance recently or in antiquity. This ranged from misplaced or missing capstones to, more commonly, partial or complete skeletal disarticulation and even destruction of the human remains. The looted graves were backfilled in antiquity, often filled with stones. Some were then sealed with surface pavements in an apparent reconsecration of the violated grave. Whether these graves were looted in antiquity by external groups or for some reason disturbed by the population using the cemetery cannot be determined.

Wadi Fidan 40 and Edomite Pottery

The limited corpus of pottery found at Wadi Fidan 40 nevertheless allows for some speculation on the



Figure 9.56 The man in Grave 714, with a single amazonite pendant at the neck. This individual was also buried with a carnelian bead, and an amazonite bead was found in the fill of the grave. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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role of ceramics in signifying the identity of these people. At Wadi Fidan 40, only two pottery vessels were found. One, a juglet with a trefoil opening and a globular body (Figures 9.58 and 9.59; EDM 72399), was found in Grave 544 with a semi-flexed adolescent of indeterminate gender (Figure 9.60). In addition to its Cisjordanian parallels cited earlier (Levy et al. 2005:459, 460, 468–469), it has parallels at Tel el-Kheleifeh (Pratico 1985:pl. 31:9) and Tawilan (Hart 1995:257). The other vessel is a pottery bowl, also found with a semi-flexed individual, a child in Grave 345 (Figures 9.29 and 9.61). This bowl has an abnormally thick and misshapen base (Figures 9.62S and 9.63; Levy et al. 2005:468). The offerings found in Grave 345 also included copper earrings, one of the most labor-intensive and therefore prestigious grave goods. Both these graves were also unusual in that their occupants were oriented with heads to the north, while the vast majority of individuals in the cemetery were buried with heads to the south. Neither cist

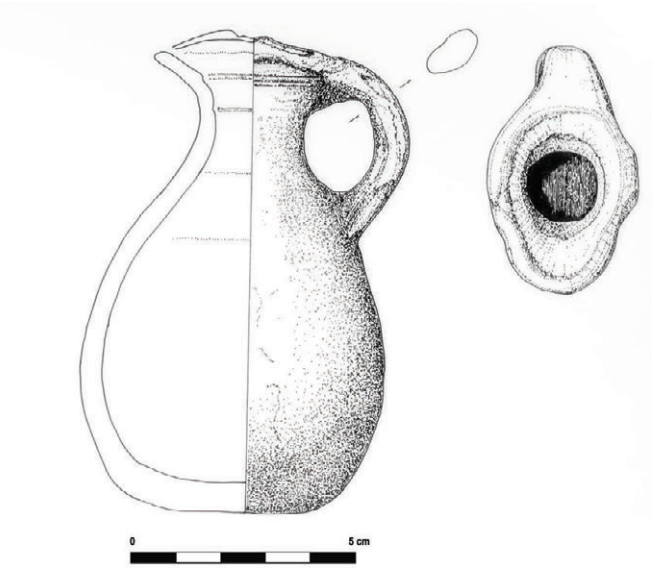

Figure 9.59 The trefoil juglet from Grave 544, L9381, B5308 (EDM 72399).



Figure 9.58 The trefoil juglet from Grave 544 (EDM 72399). *Photo: UC San Diego Levantine Archaeology Laboratory.*



Figure 9.60 The trefoil juglet as found in Grave 544 (EDM 72399). Note that the individual is buried with the head to the north, despite the constrictions the cist places on this. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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Figure 9.61 The ceramic bowl of Grave 345, as found, before the excavation of the postcranial skeleton. The bowl was placed behind the head of the child. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

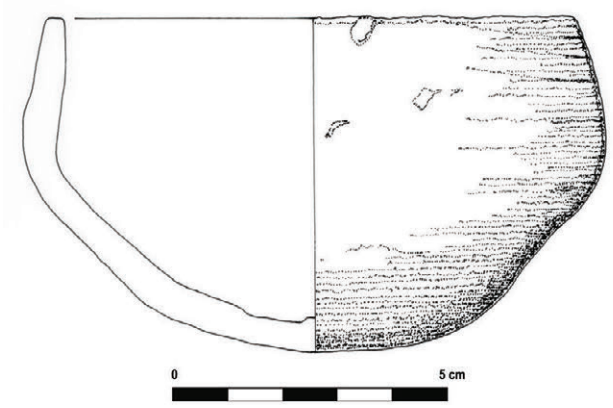

Figure 9.63 The ceramic bowl from Grave 345, L3119, B3051 (EDM 86981). Note the misshapen profile of this vessel.

appeared disturbed, although no surface architecture related to Grave 544 survived.

Despite the problem of preservation that affects wood artifacts, wooden vessels were found much more commonly than ceramic ones, and these vessels show a remarkable variety of forms and crafting. The badly looted Grave 12 included wooden bowl fragments with peg holes along the rim (Figure 9.64S; B2318). A broken wooden bowl was found amid skull fragments in the chest region of the juvenile of Grave 13; more of this bowl was found beneath the left arm, which may have been its original position (B2287). In Grave 22, a large wooden bowl, 24 cm in diameter, was found beside the skull (Figure 9.65). This complete bowl did not survive extraction, but it had a lug handle and holes for pegs were observed along the rim (Figure 9.66S; B2048). In Grave 33, that of a mature adult female, fragments of a poorly preserved, small wooden bowl or cup about 10 cm in diameter was found lying between the hands and face of the deceased (Figure 9.67). Grave 59-2004 included a teapot-like wooden vessel with a spout and a lug handle carved from a single block of wood (Figure 9.69; EDM 86460). This vessel contained four pomegranates and was placed in the chest region of an extended burial (Figure 9.68; Levy et al. 2005:469). A wooden pin, probably used to hold together the shroud or clothing, was also found in the thoracic region of this individual. Grave 92, another wealthy grave (Levy et al. 1999:299), also included the fragmentary remains of a wooden bowl found in the chest region. This bowl also had small pegs that were carefully inserted along its rim (Figures 9.38, 9.70S, and 9.71; B2133). The best-preserved wooden bowl was found in Grave 97, carved from a single piece of wood but with pegs

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Figure 9.65 Grave 22. Note the large wooden bowl placed beside the head. During the excavation, this appeared to be a large wooden basin.



Figure 9.67 The Grave 33 burial of a mature adult female. Note wooden vessel fragments next to left arm.



Figure 9.68 The Grave 59-2004 burial with spouted, teapot-shaped wooden vessel (EDM 86460), formed from a single piece of wood, and pomegranates. Radiocarbon dates for the burial were derived from these pomegranates, which suggest that this mature adult female was buried in late summer to early fall. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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around its circumference (Figure 9.72). Inside was a gazelle bone with a cut mark and numerous seeds (Figure 9.73S; Levy et al. 1999). These were no doubt food offerings placed near the deceased at the time of burial. Wood fragments, most likely the remains of a vessel, were found mixed with the ovicaprid remains beside the skull of Grave 701 (Figure 9.74). Wood fragments that could not be identified were also reported from Graves 29, 54, 102, 110, 240, 258, 516, 522, 535, 544, and 714.

The only other vessel used at Wadi Fidan 40 is marine shell. Marine shell fragments were common finds in fill and looted tombs. In two graves in the west-central portion of the cemetery (Areas B and C), Grave 543 and Grave 706, intact single valves of marine shells were found in situ, lying flat. In Grave 543, that of a middle to old adult female, the shell was found below the mandible and between the wrists (Figure 9.74S; EDM 72412). In Grave 706, that of a female of about 18 years old, a large marine shell was placed at the elbow (Figure 9.42; EDM 88492). In Egypt, bivalve shells, particularly those of the freshwater mussels *Mutela nilotica* and *Aspatharia (Spathopsis) rubens*, were commonly used as palettes to hold kohl or other pigments and were so highly valued that artificial shells were even molded out of stone (Berman and Boha 1999:270). Nothing was found in either shell at Wadi Fidan 40, and no flotation or residue analyses have been conducted.



Figure 9.71 The wooden bowl from Grave 97 (B3619). Note the wooden pegs along the rim. The body of this bowl, like all the surviving wooden vessels, was constructed from a single piece of wood. *Photo: UC San Diego Levantine Archaeology Laboratory.*

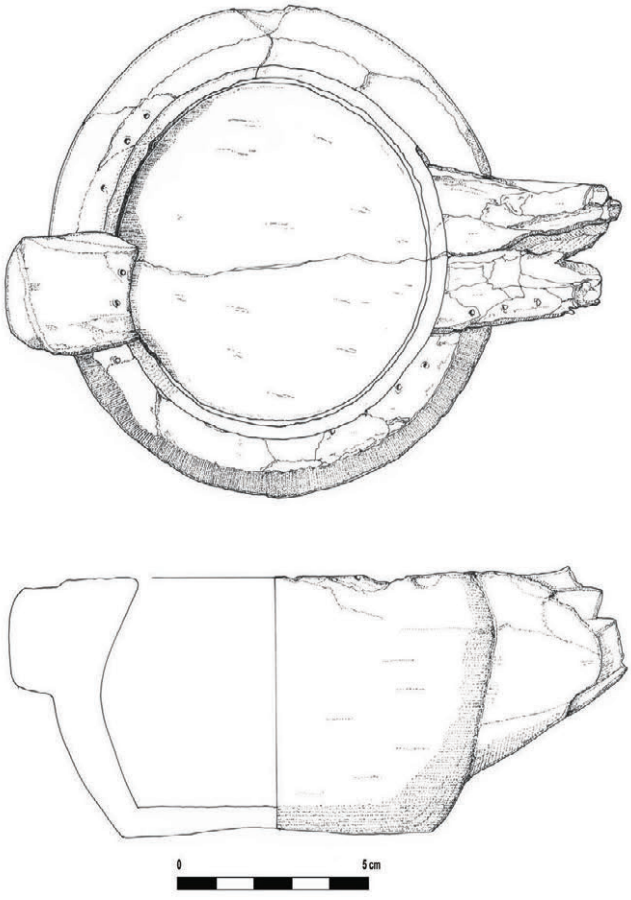

Figure 9.69 The teapot-shaped wooden vessel from Grave 59-2004 (EDM 86460). Note the spout, lug handle, and pegs along the rim. This, like all the surviving wooden vessels, was expertly constructed from a single piece of wood.

The use of wooden bowls rather than pottery is suggestive of a pastoral nomadic group (Levy and Holl 2002:96; Levy et al. 2004:86–87). These pots were also very small and robust—enough to withstand being broken on a journey. Nomadism itself is not an ethnic marker, and ethnographically nomadic groups often consider themselves to be of the same ethnicity as nearby settled peoples (Khazanov 1994). The excavated wooden bowls contained a range of items, from meat to seeds to fruit, and may have contained such perishable offerings as juices. The spouted vessel implies by its form that it was meant to contain liquids, in which the pomegranates might have been floated.

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Figure 9.72 The in situ wooden bowl containing an ungulate bone and seeds, buried with a juvenile in Grave 97 (B3619). See also Figure 9.37. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

Large bowls, a small bowl, a possible cup, and even a spouted vessel were represented in the wooden bowl assemblage. The pegs along the rims of the wooden vessels suggest interlocking lids, but no lids were ever found; thus, these may be part of a decorative device. Each surviving wooded vessel was shaped from a single block of wood, which would have required expert craftsmanship and large pieces of wood likely not available in the immediate area, adding to their expense of manufacture and therefore prestige. The wooden vessels explain the initial misdating of Wadi Fidan 40. The initial surveyors and excavator dated the site primarily on the presence of Early Bronze potsherds (Adams 1991; MacDonald 1992b), which are now known to be unconnected to the graves. Too great a reliance on pottery has no doubt resulted in the misdating of other sites in the region, especially those used by pastoral nomads.

This lack of pottery in the WFD 40 cemetery is especially interesting in contrast to excavated production sites such as Khirbat en-Nahas, the region's largest Iron Age metallurgical site. There, pottery is uncommon compared to other sites in the Levant. However, bowls with black concentric circles painted on their red fabric were proportionally not uncommon among the assemblage (Smith and Levy 2008:80), and Smith and Levy (2008:85) argue that the pottery and the chronological processor assemblage is similar to that of highland Edomite sites. The absence of painted pottery at Wadi Fidan 40 cemetery suggests that, while painted wares may have been an important marker of ethnic identity at sites such as Khirbat en-Nahas, they were not the engine by which those at Wadi Fidan 40 chose to signify themselves. By avoiding ceramics, the individuals interred at Wadi Fidan appear to have signaled a distinction between themselves and groups with ceramics.

Standing Stones and Surface Architecture at Wadi Fidan 40

The most common surface architecture in the Wadi Fidan 40 mortuary site consisted of circles of dolerite cobbles, set upright in the earth. Dolerite cobbles are found in the wadi below the site and eroding out of the hillside; gathering and collecting them from the fill of the graves themselves would have been a simple task. Approximately 160 dolerite grave circles were counted in the excavated portions of the cemetery (Table 9.9S). Double concentric circles were noted in six cases, and three concentric circles were observed over Grave 211. Surface pavements (or remnants thereof) were found within more than 40 of the grave circles. Sometimes, however, more elaborate constructions were made, such as the rectangle of Grave 80, the rectangle-and-circle associated with Grave 703, or the elaborate construction of Grave 712. Adams (1991) and Levy et al. (1999) at one time speculated that these differences in grave construction might be temporal markers, although further evidence to support this has

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not yet materialized. It also cannot be said how much of this surface architecture dates to the original interments and how much built up as the site was revisited over time, reflecting ritual behavior. However, many of the graves featuring elaborate surface architecture were discovered to have been looted in antiquity and were apparently re-consecrated.

Among the finds from WFD 40 that perhaps shed the most light on the site's ritual and ethnic dimensions are its standing stones. These are differentiated from the site's grave circles (which are themselves, of course, rings of standing stones) by being anthropomorphic in shape or by being placed in such a way that there is clear intent to separate them from the circle stones. Strictly aniconic standing stones—that is, standing stones that may be shaped but display no obviously anthropomorphic features—were first observed at the site by Raikes (1980:53); although he does not describe them, they appear in his site sketch map. Aniconic stones were recorded again during the 1997 season (Levy et al. 1999). But it was not until the 2003 emergency expedition (Levy 2003) when anthropomorphic standing stones were first observed. The results of that season have not yet been published, and the data are published here and in Beherec (2011). The 2004 season yielded more such anthropomorphic stones. Some of the data from three of the stones recovered that season were published in the season's preliminary report (Levy et al. 2005:471–474). In addition, one worked chalkstone, which may have been a standing stone, and one incised stone (the latter in association with anthropomorphic stones) were found, both of which will also be discussed in this chapter.

The aniconic and anthropomorphic standing stones, as well as the incised stone, are all made of local dolerite (not *dolomite*, as was previously reported [Levy et al. 2005:471]). This hard, dark gray to black metavolcanic stone erodes out of the conglomerate on the site and can also be found in the wadi below. It is the favored stone in all of the surface architecture at WFD 40 and makes a marked contrast to the buff silt and conglomerate and red sandstones, which are found across the cemetery.

The cemetery's aniconic standing stones are nearly all either unworked or simply smoothed stones that were chosen because they were longer than they were wide. They were all placed in grave circles, in most cases in the middle of the circle (Figures 9.75–9.77). In all 10 cases, the stones were placed in paved areas. These pavements created a uniform surface above which the standing stone rose and on which liquids might be poured. Since aniconic standing stones can only be recognized when in situ, few were recognized and described. Only nine such stones over eight graves were thus recorded (Table 9.10).

One of the more exciting finds of the 2003 and 2004 seasons was the presence of anthropomorphic stones

Table 9.10 The aniconic standing stones from WFD 40.

EDM	Basket	Area	Grave	Locus	Age	Height (cm)	Width (cm)	Thickness (cm)
		A	80	460	Infant	11	Not recorded	Not recorded
		B	39	685	Infant	28	22	12
		C	31A		Unknown	26	12	7
70093	3123	A	359	9164	Infant	20	6	8
88589	6909	C	716	2715	Adult	12	9	5
88706	7014	C	717	2501	Juvenile	30	10	5
88912	7099	C	733	2595	3–5 years	16	7	7
88978		C	735	9613	Juvenile and adult remains collected; unclear which was primary burial	Not recorded	Not recorded	Not recorded
88979		C	735	9613	Juvenile and adult remains collected; unclear which was primary burial	Not recorded	Not recorded	Not recorded

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Figure 9.75 Graves 716 and 717. Standing stones in the center of pavements within grave circle installations. Grave 716 was found to have been looted in antiquity.

in the cemetery. Standing stones of various shape and arrangement have been found throughout the deserts of southern Israel, the Sinai, and Jordan (Avner 1984; Avner and Carmi 2001; Levy et al. 2006). However, the Iron Age anthropomorphic standing stones from WFD 40 are the first assemblage to have been found in southern Jordan and the region of Edom. None were reported in the 1997 season, probably for two reasons. First, they cluster in the eastern portion of the cemetery in Area E rather than in the west in Areas A, B, and C. Indeed, no such stones were found in Area A in any season, and Area E has more such stones than were found in Areas B and C combined in 2004. Second, these stones are extremely difficult to recognize. It is possible that anthropomorphic stones have been discarded without being recognized at other digs in the Near East.

A total of 20 anthropomorphic standing stones were recovered at WFD 40 (Table 9.11). All of these stones, like the aniconic standing stones, were hard dark gray dolerite, the same stone that was most commonly used in grave circles at WFD 40. The stones seem to have been roughly shaped by pecking, and then most of them were finished smooth, likely by rubbing them with some kind of sandstone burnishing stone or perhaps a sand-covered cloth. It is perhaps notable that the lapidary techniques used in creating



Figure 9.77 The Grave 733 standing stone (next to scale). This is the grave of a child, aged three to five years. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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the anthropomorphic stones are similar to those used in bead production but carried out on a larger scale. A variety of shapes and sizes of the stones are seen (Figures 9.78–9.82). The shape of the sculpture seems to have been dictated largely by the shape of the raw stone. This is evidenced especially by such examples as EDM 80552, which has a long scar along one side, which the artist did his best to prevent from being seen (Figures 9.83 and 9.84S). Surface anthropomorphic stones were not recognized until after such artifacts had been found in excavation. Anthropomorphic stones EDM 80553, 80555, and 80556, as well as dubious standing stone EDM 80554, were all collected in a single day from piles of stones removed from the surface after anthropomorphic stones had been found in excavation. Despite being the largest of the finely worked anthropomorphic stones and the second largest anthropomorphic stone overall, EDM 80552 was not recognized when found in the excavation of Grave 223, was discarded, was collected as a surface find, and was reunited with its proper context only when the senior author recognized it in site photographs while writing his dissertation.



Figure 9.79 The same anthropomorphic stones as in Figure 9.78, found east of Area C (EDM 70337), side view. Note the ear or shoulder and the wide, flat nose.



Figure 9.78 One of the anthropomorphic stones found east of Area C (EDM 70337). Note the pronounced ears or shoulders, made by wearing away the stone, and the less visible, wide flat nose.



Figure 9.80 One of the Grave 731 anthropomorphic stones (EDM 88366). Note the pronounced shoulders or ears and the wide, flat nose. This is one of two anthropomorphic stones found in the rocky fill of a looted grave. *Photos: UC San Diego Levantine Archaeology Laboratory.*

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Figure 9.83 The Grave 223 anthropomorphic stone (EDM 80552), the largest finely worked anthropomorphic standing stone, and the second largest overall. Note the pronounced shoulders or ears and the nose. *Photo: UC San Diego Levantine Archaeology Laboratory.*

Of the 20 standing stone samples, 8 were associated with graves. Six graves each had two stones, while a seventh grave (Grave 712) was associated with two anthropomorphic standing stones and the incised stone. Unfortunately, only one stone (EDM 88331) was found associated with a grave whose occupant could be both aged and sexed. This grave, Grave 701, belonged to a middle-aged adult male. Three other graves included adults, while another included a juvenile or adolescent. In addition, one of the adult graves included the intrusive burial of an infant.

The aniconic stones were all placed over primary infant burials or secondary burials or, in one case, a grave that contained both secondary remains and the primary burial of an infant. All four of the primary burials were oriented to the south. Two were placed facing west (Graves 359, 717), one facing east (Grave 39), and one with no recording of which way it faced (Grave 31A).

The aniconic standing stones tended to be placed over graves that required less energy expenditure in their construction than either the graves associated with anthropomorphic stones or even the normal grave at Wadi Fidan 40. Four of the aniconic standing stones were over pit graves. Of the remaining three burials, one (Grave 39) was erected over a cist that was clearly reused, while two were erected over cists that were unusually small and therefore required less labor to construct than other cists (Grave 31A, Grave 80). The remaining cist was violated, with the surface pavement and standing stone apparently a re-consecration akin to a secondary burial (Grave 735). Thus, the one unifying feature of all of these graves is that they belonged to individuals in society who would be expected to have lower rank or undergoing a secondary burial, which may not warrant the energy expenditure of the first. All these graves included pavements, and the many stones used to mark out these graves raised the energy expended in their construction, though not by much.

The anthropomorphic stones obviously required a greater expenditure of time and energy—and therefore resources—than the aniconic standing stones. Those that were found with graves also sometimes correlate with other signs of wealth. Only one anthropomorphic stone was found with an infant burial (Grave 248). This grave was paved at the surface, but not in the orderly fashion within a stone circle as with the graves with non-anthropomorphic stones. The anthropomorphic stone associated with this grave was broken and found in the debris over the pavement; it may or may not have originally stood over the grave, but if it had, this may be an important marker of inherited status (Saxe 1970). Two of the graves each had two stones in association (Grave 712 and Grave 731). One stone was associated with the grave in the complex rectangular stone feature of Area C (Grave 703), and one stone was associated with that area's tumulus and large double circle (Grave 701). Three cists were paved (Grave 235, Grave 260, and Grave 701).

Because of the looting, it is difficult to link anthropomorphic stones to specific grave goods. However, Grave 253, although robbed, did contain a copper bead and a Lambis shell bracelet fragment, both of which are likely signs of high rank.

Only two of the graves associated with anthropomorphic stones were not obviously robbed (Grave 701 and Grave 248). These were also the only two with intact skeletons. One of these individuals lay semi-flexed, with head to the south, on the left side facing west. The other lay in an extended position, with head to the north, facing up. However, this individual lay in an obviously reused cist. The southern end of the cist was removed. The anthropomorphic stone was

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Table 9.11 Contexts and metric data of the anthropomorphic standing stones of WFD 40.

EDM	Area	Grave	Burial Sex	Burial Age	Context	"Nose"?	"Shoulders"?	Length (cm)	Width (cm)	Thickness (cm)
80518	E	203	NA	Adult	Grave fill	Y	Y	42	18	17
80552	E	223	NA	NA	Rocky grave fill	Y	Y	70	28	24
80456	E	235	NA	Adult	Rocky grave fill	Y	Y	50	19	19
80022	E	248	NA	Infant	Rock pile over grave	N	Y	15*	10*	NA
80717	E	253	NA	NA	Grave fill	Y	Y	43	21	17.5
80801	E	260	NA	NA	Grave cist	Y	Y	52	23	17
80553	E	0	NA	NA	Surface (none)	Y	Y	58	17	15
80555	E	0	NA	NA	Surface (none)	Y	Y	47	19	15
80556	E	0	NA	NA	Surface (none)	Y	Y	36.5	16	11
88006	B	0	NA	NA	Surface (none)	Y	Y	13*	14*	8*
88007	B	0	NA	NA	Surface (none)	Y	N	11*	9*	7*
88331	C	701	Male	30–40	Grave fill	N	Y	31.5	15.5	6
88194	C	703	NA	Juvenile/ adolescent	Grave fill	Y	Y	43	28	20
88366	C	731	Female	Young adult	Grave fill	Y	Y	38	25	9
88371	C	731	Female	Young adult	Grave fill	Y	Y	39	24	26.5
88407	C	712	NA	20–50, infant	Surface pavement	N	Y	81	37	16.5
88517	C	712	NA	20–50, infant	Grave fill	Y	N	28	12	8
70337	East of C	0	NA	NA	Surface (none)	Y	Y	41	28	19
86017	East of C	0	NA	NA	Surface (none)	Y	Y	29	23	13

*Indicates measurement of a fragment. NA = not available.

found in the fill and was likely not intended for this particular burial. Grave 701 was that of an adult male, and some infant bones were also recovered from this grave. The remains of an adult female were recovered from Grave 731, and adult remains were also recovered from Grave 203 and Grave 235.

Grave 712 is the only grave that seems to have mortuary architecture intact enough to describe ritual function. Here, an anthropomorphic stone apparently stood beside a paved pit, which itself was constructed over an open and looted cist. As found, the stone had fallen over and stood upside down in the pit (Figure 9.85). The incised stone was directly opposite the anthropomorphic stone. It was incorporated into the stones that ringed the pit, in a place where it would only be seen by one standing directly over the grave (Figures 9.86, 9.87S, and 9.88S). A small standing stone lay face-up in the fill beneath this paved pit (Figure 9.89). It is presumed that libations were poured into the pit, which would then percolate downward, past the smaller anthropomorphic stone, toward the open cist. It is notable that the largest and

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Figure 9.85 Grave 712. Standing stone (EDM no. 88407) as found, upside down, but in situ, atop a pavement. The pavement is recessed, perhaps as an offering place. Note the two concentric stone circles and the fragmentary pavement between.



Figure 9.86 The incised stone of Grave 712 in situ. The stone in the lower left corner is the fallen standing stone. The incisions have an unknown meaning but would have not been easily visible in position. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

the smallest anthropomorphic stones were found associated with this grave, although it is unclear whether there is a tie between this and the fact that this grave also contained both adult and infant bones. All the other anthropomorphic stones found in association with graves were found in the rocky fill of the graves. However, these were not carefully arranged as was the stone in the fill of Grave 712 and appeared to have been tossed into the graves haphazardly during their robberies.

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Figure 9.89 The smallest standing stone uncovered, EDM 88517, found face-down beneath the pavement of Grave 712. The arithmetical mean for complete anthropomorphic stones at Wadi Fidan 40 is 46 cm long; this one is just 29 cm long. *Photo: UC San Diego Levantine Archaeology Laboratory.*

Standing Stones of Edom?

Although standing stones are common in much of the Near East, to date, they have not appeared in Edomite assemblages of the Late Iron Age. The available reports for most Edomite sites make no mention of standing stones. No standing stones were reported at the excavated sites of Tawilan (Bennett and Bieknowski 1995), Barqa el-Hetiye (Fritz 2002), Khirbat al-Megheitah, or Khirbat Ishra (Hart 1987), nor were any reported in the survey and test excavation at the two Ras al-Miyah fortresses (see Chapter 12, this volume; Ben-Yosef et al. 2009). Although a series of "standing stones" were found at Ghrareh, those in Room 1 are obviously wall pillars, and the excavator is no doubt correct in deducing based on their placement that the stones between Rooms 1 and 9 are "to demark space" (Hart 1988:89) between two rooms that would otherwise be open. This is similar to the standing stone wall features discovered in Area W at Khirbat en-Nahas (see Chapter 2, this volume). A possible altar at the site is some distance from either set of stones (Hart 1987). Finally, Hart's published survey reports do not mention standing stones (Hart 1986b; Hart and Falkner 1985).

The reports from Umm el-Ala (Es-Sadeh; Lindner 1992a; Lindner et al. 1988; Lindner et al. 1990), Ba'ja III (Lindner 1992a; Lindner and Farajat 1987), and Khirbat al-Mu'allaq (Lindner, Knauf, and Zeitler 1996) also do not note standing stones, and the surveys of the Sabra district do not even note any Iron Age sites (Lindner 1992b). Although the Dushara-throne in the cave there and the cut niches at Sela' (Lindner 1992a) may have served a similar purpose to standing stones, they are so like those at Petra that one suspects they are attributed to the site's Nabatean inhabitants and therefore are too late to consider here. No true standing stones have yet been reported at Sela' (Hart 1986a; Lindner 1992a). At Jabal al-Qseir, no standing stones were observed, although oddly shaped natural formations, possibly modified, were observed. One of these was labeled a high place (Lindner, Knauf, Zeitler, and Hubl 1996:147). However, these stones are broader than they are tall and were carved into the living rock rather than erected. They may have served as focal points or memorials with similar functions as standing stones, but they are distinct from standing stones.

A few standing stones were reported in the Jabal as-Suffaha district, which includes several Iron II sites, most notably the fortress Deraj III, the "estate" Kutle III, and the settlements Deraj I and Kutle II. However, most "are not of a cultic or sepulchral significance but the remains of stone and brushwood fences" (Lindner et al. 1998:226). Most interestingly, what may be a disturbed tomb, apparently once marked with a standing stone and worked from stone not from the vicinity, was found along the mountain ridge. A single Late Roman sherd was found nearby. Two Iron II sherds of the same vessel were found near another disturbed tomb; it is possible, although unlikely, that the tomb might date to the Iron Age. Both of these tombs were dug into undated house ruins (Lindner et al. 1998:236). The reporters wisely do not attempt to date the tombs, which may belong to any or none of the mountain's three main occupation periods, Iron II, Nabataean to Byzantine, or Late Islamic.

One round, possible, standing stone was noted in the gate of the Stratum 5 fortress of En Hazevah, believed by the excavators to date to the ninth to eighth centuries BCE (Cohen and Yisrael 1995a:229). Stratum 5 dates to a century or more before the possibly Edomite Stratum 4 (ca. seventh to sixth centuries BCE), with its associated structure interpreted by its excavators to be an Edomite shrine. Indeed, the inhabitants of the Stratum 4 city may have been responsible for felling this standing stone.

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At Khirbat en-Nahas, a single standing stone was encountered during ELRAP's 2006 excavations that the excavators suggested may be cultic (see Chapter 2, Area F, this volume). Its morphology and function were different from those in the WFD 40 cemetery. The excavators concede it may instead have a functional purpose. It should also be considered that this stone was found in close proximity to stone collapse, and its placement may therefore be accidental.

Bienkowski argues that the elite residence at Busayra may have imitated Assyrian palaces by exhibiting a standing stone in its courtyard. Citing Turner (1970), Bienkowski (2002:199) claims, "The unplastered niche in the wall of the Busayra 'courtyard/reception room' may have been for the insertion of a stone slab, as in the principal reception suites of Neo-Assyrian residences and palaces." However, Turner's argument is oversimplified. Turner notes the ubiquity of stele in Neo-Assyrian palaces and the suggestions of some scholars that niches like that at Busayra—niches that are not found with standing stones—may have once held these objects. But it is also possible that this is a form of "empty space" iconism. Standing stones are not in fact found within these niches, so the niche may take the place of a standing stone. This method of emphasizing the presence of the god through the absence of a symbol is not uncommon in the ancient Near East (Mettinger 1995). By the Iron IIC, standing stones may have been replaced in Edom by still more aniconic religious features as was common in Nabatean society (Schmid 2008:371–374). Further investigation in Edom, including the excavation of religious architecture, is necessary before firm conclusions can be drawn.

Some standing stones have been found in the Edomite cultic complexes in the Negev. At 'En Hazeva (some 20 km northwest of WFD 40), numerous ashlar stones were recovered that may have functioned as standing stones. These, like all the cult objects, were found buried in a pit alongside deliberately broken vessels. However, the excavators, Cohen and Yisrael (1995b), suggested some may have been erected as standing stones while others were building stones. At Horvat Qitmit, also in the Negev desert, a standing stone, believed to be cultic, was found in Complex B. To its north was a small paved area. Two use phases were noted at Complex B, but the stone was first erected in the first use phase and continued unchanged in the second (Beit-Arieh 1995:20–24). Two other large stones were observed, one in each of the site's low stone circular enclosures. In the southeastern end of the large enclosure (L114), a 1.15-m-long sample and a 0.70-m-long stone were found standing on its long end. The excavator suggested that the stone was broken and may have once stood higher (F91; Beit-Arieh 1995:24). Next to the stone was a 5-m-long stone bench or altar. In the northeastern side of the small circular stone enclosure (L60), a large stone, measuring 1.40 m long and 0.70 m wide, was found next to another stone, 1.00 m long and 0.85 m high, which were both lying flat on their long sides (Beit-Arieh 1995:25). These may have served as dual *masseboth*. At both 'En Hazeva and Horvat Qitmit, these stones were roughly shaped and found in association with much more striking clay anthropomorphic vessels and statuettes.

Anthropomorphic grave markers spread over much of the Levant in the Iron Age. In the Phoenician world, stele, some with stylized human figures and others with baetyls, were often set up in large fields called *tophetim*, where human remains have also been discovered. Some of these steles may date as early as the ninth century, and the practice was clearly in evidence across the Phoenician cultural sphere, from Carthage to Byblos, by the seventh century (Moscati 1988; Ribichini 1988). Ancestral images carved in stone are found at Iron Age burial sites in Arabia. Particularly fine examples were found at the necropolis of Timna in modern Yemen (Cleveland 1965). These are testified to in Jordan at Risqeh, near Wadi Rum, where Diana Kirkbride uncovered a collection of such images—some intricately carved bas-relief figures and others just eyes and noses. The more elaborate carvings were made in sandstone, a medium much easier to work than Wadi Fidan 40's dolerite and therefore subject to fewer limitations. Many of these statues were incorporated into cairns or, like those at Wadi Fidan 40, buried in cist graves, although Kirkbride believed they more properly predate the burials and belong to an older sanctuary (Kirkbride 1969a, 1969b). Dating of the site remains obscure, although Thalmudic inscriptions found in two of the cairns show that at least some of the funerary architecture significantly postdates Wadi Fidan 40. Anthropomorphic grave images appear in both North and South Arabia, at Tayma and Jawf, by about the eighth century BCE and possibly several centuries earlier (Schiettecatte 2010).

It is very likely that both the Arabian ancestor images and those at Wadi Fidan 40 are the result of emulation of Egyptian funerary busts. Evidence for

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Egyptian emulation can be seen in the occasional (albeit rare) deposit of Egyptian artifacts in Wadi Fidan 40 graves, such as the scarab of Grave 92 (Levy et al. 1999:299) and the stamp seal of Grave 91 (Levy et al. 2005:227), in addition to the scarab, bifacial seal, and figurine from across the wadi at Wadi Fidan 4, Tomb 1. Funerary busts are a not uncommon find both at tombs and in domestic contexts in Ramesside Egypt, where they served as a focus for ancestor veneration, including the pouring of libations (Friedman 1994:Fig. 11). The Wadi Fidan 40 anthropomorphic standing stones may have served a similar role.

Thus, no standing stones can be definitively attributed to the Edomites at the large number of reported Iron II sites on both the Edomite plateau and what Lindner and Knauf (1997) call "the rocks," that is, the highly defensible fortresses around Petra. This sample of published sites includes fortress sites, hamlets, villages, an "estate," and even Busayra. Busayra may have been the most important city in the kingdom with its two public buildings, one of which was possibly a temple (Bennett and Bienkowski 1995, but see Bienkowski 1992). These inventories and excavations were conducted by a number of archaeologists, so although sample bias cannot be entirely ruled out, it is likely to be minimal. However, stone ancestor images are found in Arabia and Egypt, which may suggest cultural ties to those areas. For example, beautifully carved anthropomorphic standing stones have been found in the Hijaz region of northwest Arabia (Ghabban 2010:166–169; Gierlichs and Franke 2011:70), but their archaeological context is questionable. The shape of these stone figures is remarkably similar to the Wadi Fidan 40 samples with prominent noses and shoulders. Thus, rather than dating to the fourth millennium, we would suggest a Late Bronze or Iron Age date, tying all these carved standing stones to tribal traditions in northwest Arabia. The Wadi Fidan 40 cemetery produced anthropomorphic standing stones that lack exact parallels in the Near East; however, they may indicate close ties between Arabian culture groups and nascent Edomite identity.

Conclusions

Mortuary archaeology in Iron Age Edom remains in its infancy, primarily due to the lack of excavated cemeteries and published excavated burials. As the only definitive Iron Age cemetery excavated in Edom to date, Wadi Fidan 40 is the greatest source to understand how the people living in tenth-century Edom chose to represent themselves in death. Those "traditional" ethnic markers so far recognized by scholars as indicators of Edomite ethnicity are entirely absent from the graves at Wadi Fidan 40 cemetery and WFD 4 tombs. No evidence of Edomite script was recovered, and the scant pottery is not distinctively "Edomite" in form. While none of the burials catalogued here from ancient Edom are included in Bloch-Smith's study of the practices of Judah and its neighbors, they fit her general pattern of lowland south Levantine burials (Bloch-Smith 1992:144). Like many of those graves, the graves of Edom are in pits or cists and are predominantly for individuals, although the Wadi Fidan 4 tomb contained multiple interments. However, while Bloch-Smith limits scarabs to Judean tombs, they were found at Wadi Fidan 4 and 40 in addition to other types of Egyptian amulets.

Finds at the Wadi Fidan 40 cemetery reflect some social interaction with the Egyptian world during the second millennium BCE. In terms of grave offerings, this includes the presence of scarabs at Wadi Fidan 4 and 40 and of a figurine at Wadi Fidan 4. The form of burial itself—individual interment in pit or cist graves wrapped in shrouds—has been argued to be derived from Egyptian burial practices in the Late Bronze (Gonen 1992; Tubb 1995) and shows an importance attributed to the preservation of the corpse. The anthropomorphic standing stones, with their parallels in Egyptian funerary busts, further suggest Egyptian emulation, although these sculptures also have parallels in Arabia. Interestingly, standing stones are not at present reported from the rest of Edom. These Egyptian and Arabian style customs have, however, been adapted from their original forms. Not unexpectedly, in defining themselves, the Edomites seem to have looked to the southeast and to their powerful neighbors to the southwest, although this may be more an example of elite emulation than biological or ethnic affinity.

Both children and adults are buried in much the same fashion at Wadi Fidan 40. Most were found with few or no grave goods, a combination of the rampant looting in antiquity and apparently of very simple burial furnishings. Children, as young as the newly born and perhaps even stillborn, were found at the cemetery alongside adults, suggesting value and personhood was seen to begin at a very young age. Some of the wealthiest graves found belong to children. This suggests a certain level of ascribed status and inherited rank (Saxe 1970). The great deal of variety at the graves, as well

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as the emphasis on certain ancestors reflected by the anthropomorphic standing stones, suggests competition and rivalry between families—signs of a chiefdom (Earle 1991; Flannery 1999; Peebles and Kus 1977; Stein and Rothman 1994). The large amount of amazonite among the grave goods also shows important trade links to Arabia. Finally, we should point out that every grave in the Wadi Fidan 40 cemetery was disturbed during the Iron Age. This, cultural formation processes have played an adverse role in preserving the integrity of the grave good assemblages at the site.

The future of the archaeological investigation of Edomite ethnicity requires a great deal more research. Greater attention must also be paid to the possibility that different ethnic groups may have shared the same territory—that Edom may have been home to both earlier Horites and Edomites, and perhaps even other groups—before the two merged into a state that may or may not have allowed the continued existence of such ethnic groups. The differences between the material finds at Wadi Fidan 40 and those of Khirbat en-Nahas and the sites of the Edomite plateau may indicate that the people of Wadi Fidan 40 belonged to an ethnic group distinct from that which left the remains traditionally considered signifiers of Edomite ethnicity, although this cannot be assumed based on the present data. These questions can be best answered by taking regional comparative approaches that are sensitive to small differences in the broad spectrum of material culture, and it is hoped that, with more excavations by UCSD ELRAP and others, a clearer picture of the emergence of Edomite ethnicity will be obtained.

Notes

1 YHWH is the tetragrammaton (from Greek, meaning "four letters") that refers to the Hebrew name of God הוהי , transliterated into the Latin letters as YHWH.

2 All artifact drawings are by ELRAP illustrator Dr. Caroline Hebron.

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10 A Picture of the Early and Late Iron Age II in the Lowlands
Preliminary Soundings at Rujm Hamra Ifdan

Neil G. Smith, Mohammad Najjar, and Thomas E. Levy

On March 24, 1934, Nelson Glueck was in the second year of his archaeological survey of eastern Palestine as part of the joint expedition of the American School of Oriental Research in Jerusalem (now the W. F. Albright Institute of Archaeological Research) and the Transjordan Department of Antiquities (now the Department of Antiquities of Jordan). Glueck was especially interested in the Late Bronze and Iron Age archaeology of Transjordanian Edom because of its links to the Hebrew Bible. In his report (Glueck 1934:1), Glueck notes that the historical sources for Edom in this period came from Egyptian documents from the time of Merneptah and Rameses III that mention plundering the tents of the people of Se'ir (Edom) and that the Hebrew Bible was the primary source of data concerning the many fortresses, towns, villages, and ancient highways for the region. Employing five riding and two pack camels, Glueck's team arrived on the Wadi Fidan that spring day to find the site reported on here.

By noon, Glueck (1934:20) arrived at a "small ruined watch-tower, measuring 6.20 metres square, and is oriented north south." He refers to the site as Rujm Hamra Ifdan and suggested it may have been a Nabatean watchtower on the way between Bir Madhkur and el-Hosb (modern Hatzeva in Israel) or et-Telah.

In 2004, as part of an emergency excavation when the Jordan Valley authority had planned to build a dam across the Wadi Fidan, Rujm Hamra Ifdan was sampled by the University of California, San Diego (UCSD)–Department of Antiquities of Jordan (DOAJ) team to gain a more refined understanding of the Iron Age occupation in the lowlands of Edom. By acquiring radiocarbon samples and ceramics associated with controlled stratigraphic excavations, the soundings shed light on both the Early and Late IA II occupation in the lowlands of Edom. Rujm Hamra Ifdan is especially important because it is the only site excavated in Edom (highland and lowlands) thus far that provides both early and late components of the Iron Age sequence in stratified contexts with deposits that span the tenth through seventh centuries BCE.

Opposite: ELRAP excavation team at work, Rujm Hamra Ifdan, Jordan. Calibrated radiocarbon dates show that this part of the site, near the summit and watchtower, dates to the tenth century BCE. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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Introduction

This site was first identified by Nelson Glueck (Glueck 1934:20) as Rujm Hamra Ifdan, a Nabatean watchtower that helped control the trade route between Bir Madhkur and el-Hosb (modern Hatzeva in Israel) or et-Telah. In his 1935 publication, Glueck wrote that it was on the south bank of the Wadi Fidan, resulting in some confusion between this site and Khirbat Hamrat Ifdan (Adams 1992). Part of the problem is that the site is on the north bank of the Wadi Fidan. However, the presence of a secondary drainage to the north of the site may have led to this confusion when he wrote up his notes following the expedition. Glueck dated the watchtower to the Iron Age I to II, according to the ceramics collected on the site surface; however, when he refers to this structure in the 1935 paper, there is confusion over its location being at Rujm Hamra Ifdan or Khirbat Hamra Ifdan—the large (ca. 3 ha) Early Bronze Age site situated in the middle of the Wadi Fidan some 1.2 km to the southeast. Glueck identified traces of a watchtower at the top of the site on a small isolated inselberg consisting of monzogranite basement rock capped with Pleistocene gravel and associated with a lower retaining wall on a wadi terrace located on the northern end of the site. This description rules out the much larger Khirbat Hamra Ifdan (KHI) site. Later surveys and reconnaissance revealed that the actual KHI dating to the Early Bronze period was located approximately 800 m upstream in the Wadi Fidan (Adams 1992; Levy et al. 2003). Ceramic evidence from Glueck's Khirbat Hamra Ifdan, however, appeared to confirm his dating of the site to the Iron Age when it was surveyed by the SIGNAS project (MacDonald 1992) and later by the Jabal Hamrat Fidan (JHF) 1999 survey (Levy et al. 2001). Since this site had no local name in the literature besides "Glueck's Khirbet Hamra Ifdan" (Adams 1992) and the original Nabatean Rujm Hamra Ifdan never materialized in future surveys, the name Rujm Hamra Ifdan was selected to identify this site.[1]

Rujm Hamra Ifdan is located around 5 km southwest of Khirbat en-Nahas (30.671867 and 35.390019 degrees, ca. 25 m above sea level; see Figures 10.1, 10.2) as the crow flies, on the northern bank of Wadi Fidan at the entrance of the southern approach to Wadi al-Ghuwayba. The site is located at the junction of a small secondary drainage called the Wadi Umm Tha'hor that provides a natural route northward around the western side of Jabal Madsus mountain and into the Wadi al-Ghuwayba—the second largest drainage that flows east–west in the Faynan region. The peak of the Rujm Hamra Ifdan site is situated on a tiny fragment of the Pleistocene conglomerate that rises above the wadi bed and stands as a small island on the edge of the wadi, making it an ideal control point for the Wadi Fidan (cf. Figure 10.2). The surface of the northern face of the hill is densely strewn with Iron Age pottery and architectural features, indicating that the site was occupied for a considerable duration.



Figure 10.1 Overview of 2004 excavations at Rujm Hamra Ifdan (RHI): (*a*) the northern slope (southeast) showing the summit of the site where Glueck found the remains of a watchtower. (*b*) The UCSD–DOAJ team excavating a rock shelter (Sounding A) directly below the summit. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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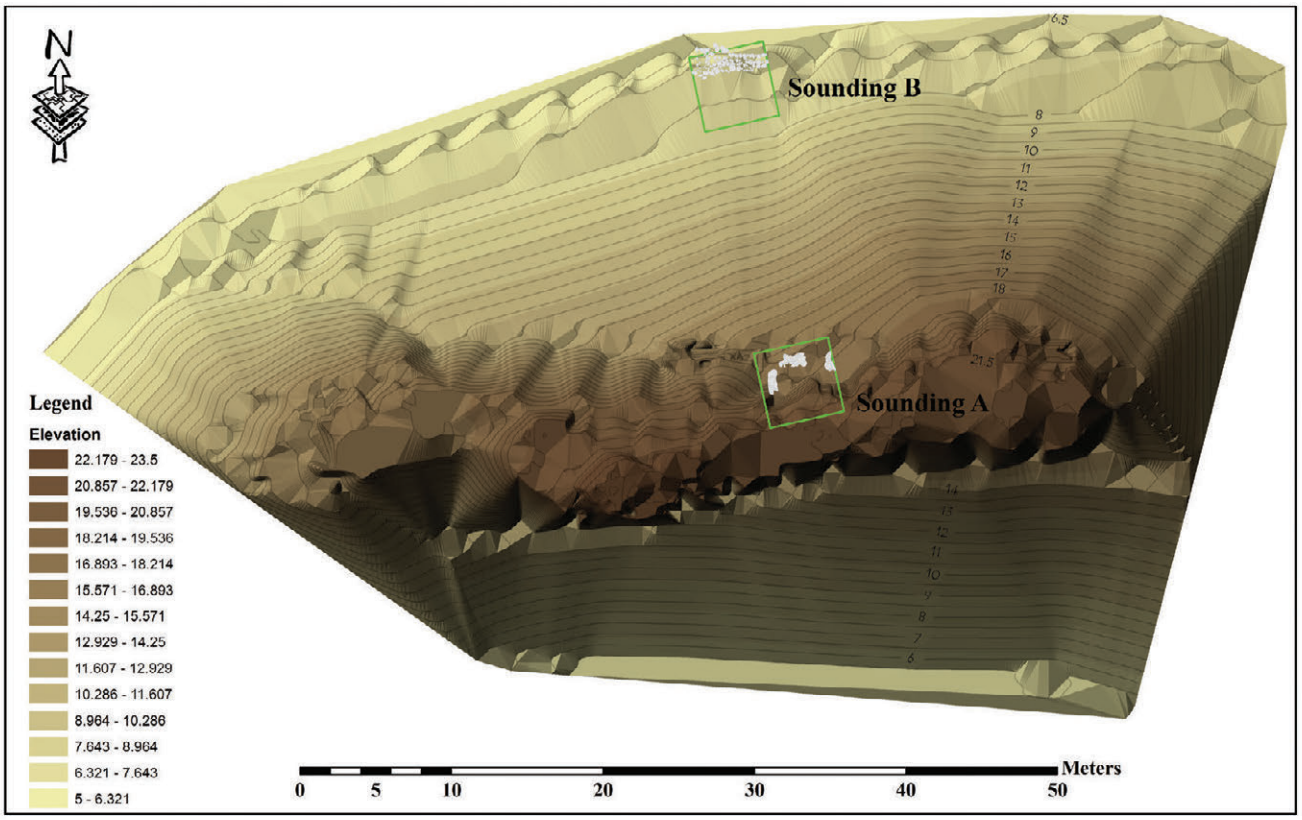

Figure 10.2 Topographic map of Rujm Hamra Ifdan showing the location of Soundings A and B with excavation squares.

The site no longer preserves the well-defined architectural features that Nelson Glueck identified as the watchtower, but its location at the entrance to the main southern approach to the copper mines of the Wadi Ghuwayba and Wadi al-Jariya and the route to Khirbat Faynan would have made it an ideal watchtower or small habitation area to alert the settlements near the copper mines of encroaching enemies. In the conclusion of this chapter, we apply a GIS Viewshed analysis of Rujm Hamra Ifdan (RHI) to better understand its function as a watchtower in the Iron Age landscape.

Excavation Methodology

To sample the range of occupation areas at Rujm Hamra Ifdan, two distinct areas were investigated at the site (Figure 10.3). To test Glueck's hypothesis that the summit of RHI did indeed have a strategic component, we placed a 5 x 5–m excavation unit as close to the apex as possible and labeled it "Area A" (Figure 10.4). To sample the lower component of the site, a sounding was also made there (Figure 10.8). Consequently, two 5 x 5–m probes were excavated to bedrock on the northern slope of RHI (Sounding A close to the summit and Sounding B near a large wall that encircles the site and is embedded in a natural terrace that surrounds the site; see Figures 10.2–10.9). In addition, to determine whether the slope of the site was terraced, the topsoil and first approximately 20 cm of rock collapse and other debris were excavated from the 5-m transect connecting Sounding A to B over a distance of around 25 m. The stratigraphy, pottery, and radiocarbon dates all support an interpretation that the soundings represent spatially segregated single occupations of two different periods, Iron Age IIA and Iron Age IIB/C. Overall, the soundings were successful, achieving the goal to collect a sample of ceramics and material culture data substantial enough to understand Rujm Hamra Ifdan's relation to Khirbat en-Nahas and the Iron Age sites in the highlands. Over 300 kg of pottery was collected and approximately 1,000 diagnostics sherds were found (see Chapter 4 for discussion of pottery found at the RHI soundings). Moreover, evidence of

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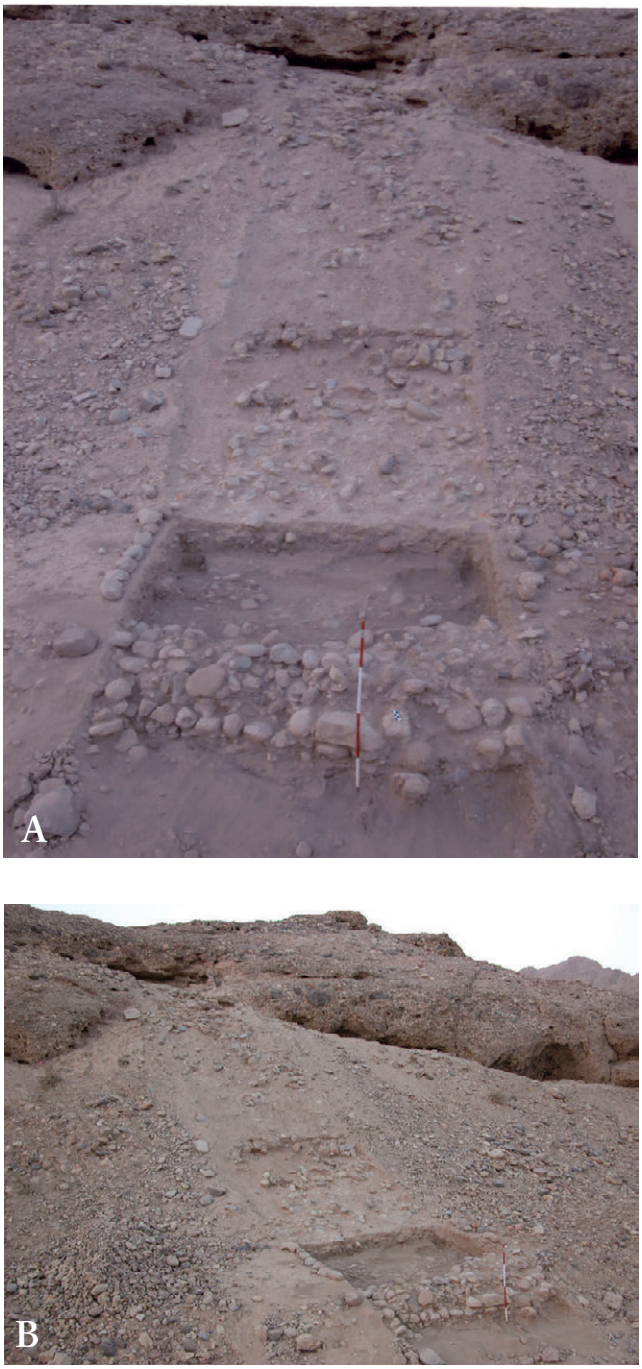

Figure 10.3 Relation of Sounding A to Sounding B at Rujm Hamra Ifdan, 2004: (*a*) upper (A) and lower (B) detail vertical view of the trenches established at RHI to sample the upper and lower limits of the site. (*b*) Oblique view with area between the upper (Sounding A) and lower (Sounding B) with topsoil and first 10 cm excavated. *Photo:s T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

small-scale copper production was found in Sounding A near the site summit, along with copper artifacts and crafted beads similar to those found at Wadi Fidan (WFD) 40. The following presents an overview of both of the soundings carried out at RHI.

Sounding A: Square H6 (see Figures 10.4–10.7)

In the Edom Lowlands Regional Archaeology Project (ELRAP) survey of RHI, architectural features and high concentrations of pottery were primarily found on the northern face of the hillock (Levy et al. 2001). On the summit of the small hilltop (Glueck's tower), a possible watchtower may have existed, but it was highly eroded, leaving behind only building stones that had rolled down from the top into the lower crevices of the conglomerate hill. At the ledge of the northern face of the hill was a natural overhang made of Pleistocene conglomerate that created a small rock shelter. This conglomerate overhang extends from east to west, following the northern face of the hill for around 28.6 m. Cultural deposits and pottery were found on the surface underneath the overhang. The eastern end of the rock shelter was selected for sounding. This area (10 x 5 m) was enclosed by a wall running north–south and another possible wall running east–west. A 5 x 5–m sounding was conducted in this area, allowing the remaining eastern half of the enclosure to be used as a balk to control for stratigraphy.

The excavations followed the natural stratigraphy of the shelter that sloped downward from the interior of the shelter to the exterior. To control for stratigraphy, the sounding was excavated in 10-cm increments starting from the inside of the shelter, which was at a higher elevation. At 10 cm below the surface of excavation, an accumulation of powdery, light gray ashy sediment was found throughout the probe and continued the depth of the excavation until reaching at its bottom either a plaster surface or the conglomerate bedrock. The initial height and depth of this fill varied (ca. 10–30 cm) according to the natural slope of the conglomerate bedrock (see Figure 10.7 for section drawing). This accumulation was mixed with a high quantity of handmade pottery and a smaller amount of wheel-made pottery (see Chapter 4, this volume, for further discussion). After the removal of the accumulation, it became clear that the bedrock under the shelter overhang created a natural smooth bench for sitting and working, which was shaded

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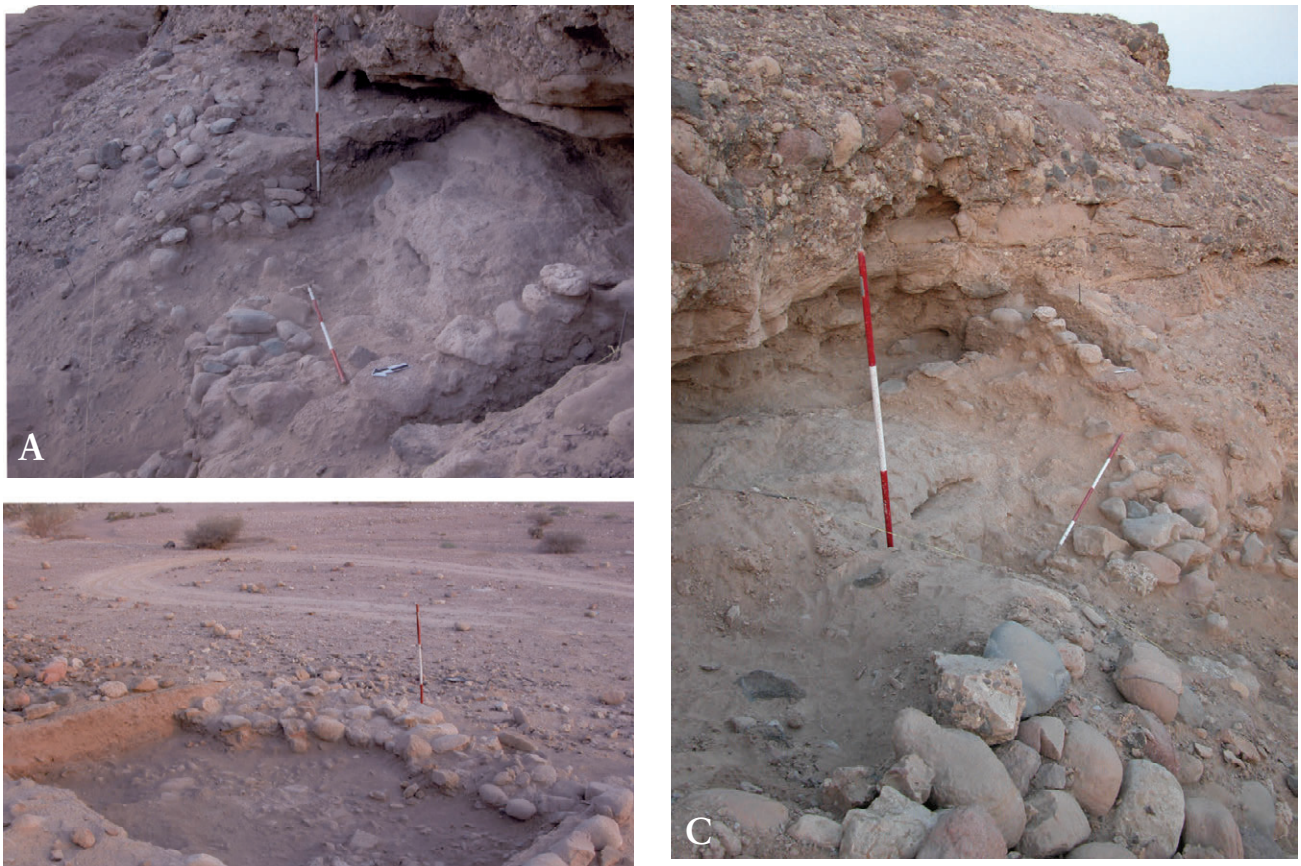

Figure 10.4 Sounding A excavated to final surfaces: (*a*) upper Sounding A in rock shelter, (*b*) Sounding A view looking southeast, and (*c*) view northwest of tenth-century BCE surface exposed in association with the rock shelter in the upper Sounding A. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

by the conglomerate roof. As one moves north, no longer shaded by the overhang, the slope of the natural bedrock appears to be leveled out by a mud plaster surface found 5 cm above the original conglomerate bedrock. The mud plaster had a similar composition to that found to reinforce the north–south stone wall. This surface continues until it abuts the east–west wall sealing the room (see Figure 10.4b). The total dimensions of the excavated room in Sounding A from the north–south wall to the balk is around 4 m, and the conglomerate to the east–west wall is around 3.7 m.

A hearth consisting of a dark ashy sediment (20 cm in depth) filled with charcoal, charred bone, and ostrich eggshell and filled with cooking stones (L501) was found adjacent to the southeastern corner of the sounding. In addition, iron metal, copper metal, prills, and a small (5- to 7-cm) globular piece of slag were found in the hearth (see Figures 10.12–10.14). Minor smelting or remelting activities possibly occurred in the hearth alongside domestic cooking. The pottery found inside the hearth consisted primarily of hand-made slag-rich pottery hinting at an Early Iron Age date (see Chapter 5, this volume, Ware A2). The occurrence of metallurgical activities in close proximity to food preparation is puzzling. The only other locale in the Faynan study area where small-scale ephemeral Iron Age smelting activities have been documented is at WFD 58, where numerous small smelting installations associated with camping sites were identified (Levy et al. 2001:175). No radiometric dates were recovered at WFD 58, so it is difficult to link these activities with RHI with certitude. This material context is not comparable to any of the larger industrial activities documented at other Faynan sites during the Iron Age.

Excavations in the upper portion of the sounding confirmed the presence of a three-course-high wall (L513; Figure 10.5) built northwest to southeast

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Figure 10.5 Sounding A, north–south wall: (*a*) southeast view showing wall and collapsed mud plaster and (*b*) south view with gap between wall and western balk.





Figure 10.6 Sounding A, east–west wall: (*a*) southeast view highlighting wall and circular installation and (*b*) south view showing relation of east–west wall to north–south wall. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

made of large rounded stones (from the wadi) and mud plaster. When this wall was at its original height, it most likely touched the ceiling of the conglomerate roof. To the east of the wall, a dense concentration of mud plaster and stones (possibly all related to the collapse of the upper courses of the wall) was found (see mud plaster abutting the wall in Figure 10.4c). A perpendicular wall (L526; Figure 10.6), preserved at its foundations only to two courses, was installed at the northern end of the room. It also may have provided entry into the building on the western side, as seen in Figure 10.6b, where there is an opening and then continuation of the wall into the balk, but the absence of the wall here may also be due to erosion down the slope. The material remains suggest Sounding A was a domestic habitation area connected to the strategic function of the site, where its occupants also carried out small-scale part-time copper metallurgical activities.

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Sounding B: Square H2 (see Figures 10.8–10.11)

Sounding B was selected at the flat terrace at the base of the conglomerate hill adjacent to a large enclosure wall (cf. Figures 10.2, 10.3). As RHI is located at the confluence of the main Wadi Fidan and the secondary Wadi Umm Zahur, this natural terrace accumulated sometime before the Iron Age occupation of the site. As will be seen below, the terrace played an important role in the function of RHI during its Late Iron Age II occupation that was quite different from the martial activities associated with the upper portion of the site. Based on the distribution of surface pottery, wall

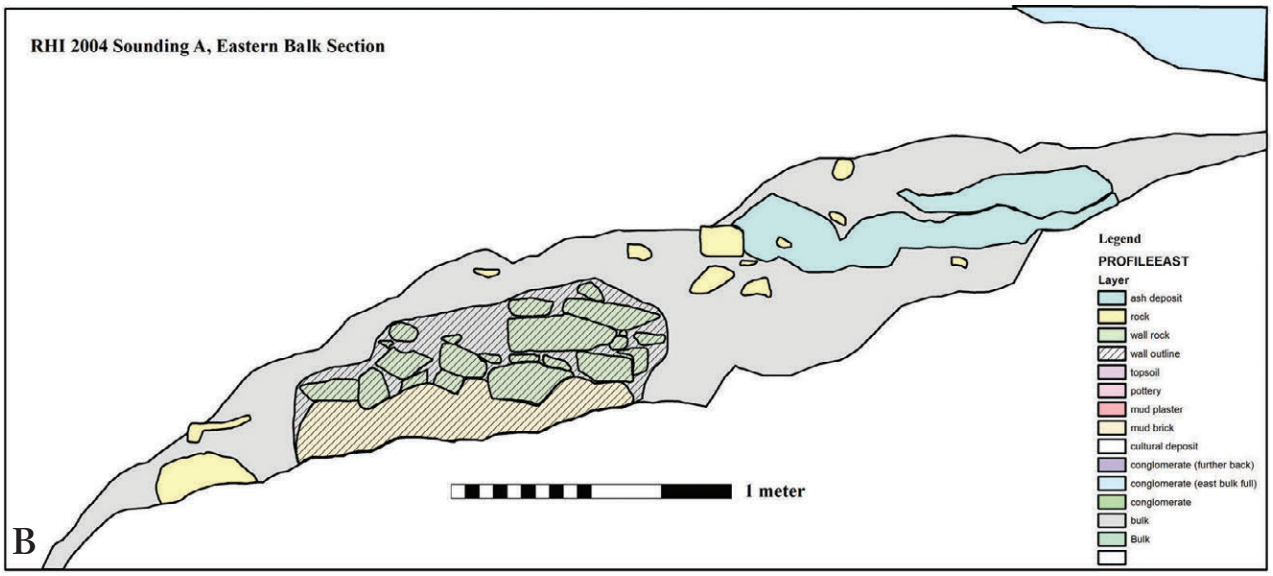

Figure 10.7 Sounding A section drawing and photograph: *(a)* south view with eastern balk and *(b)* profile drawing of eastern balk section. *Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

features, and other remains, Sounding B was excavated to investigate the more extensive occupation of the lower area in relation to the rock shelter in Sounding A. Although Soundings A and B represented different elevations and locations of the site, it was assumed that they would belong to the same occupation period. Therefore, instead of assigning it a new area, it was differentiated as a separate square (H2), and the initial loci assigned to it were subsequent numbers following the first probe (i.e., L531 to L539).

The excavation of Sounding B was of a completely different nature from Sounding A. A massive amount of wheel-made pottery (10 times the amount found in Sounding A, > 100 kg), ground stone artifacts, and brown clayey charcoal-rich sediment filled this probe until reaching bedrock (see Figures 10.12–10.14 for special finds). A compacted level earthen surface was reached around 1 m below the excavation surface adjacent to the enclosure wall (Figure 10.9). Resting on the floor were many ground stone artifacts and more pottery sherds (see Figure 10.10). A radiocarbon sample was taken from the inside of an upper portion of a broken jug found resting on the compacted surface (see Figure 10.10b). No installations or additional architectural evidence besides the northern enclosure wall was found in this probe. Due to time constraints, the eastern half of the compacted surface (L534) was sectioned and excavated another 20 cm to bedrock

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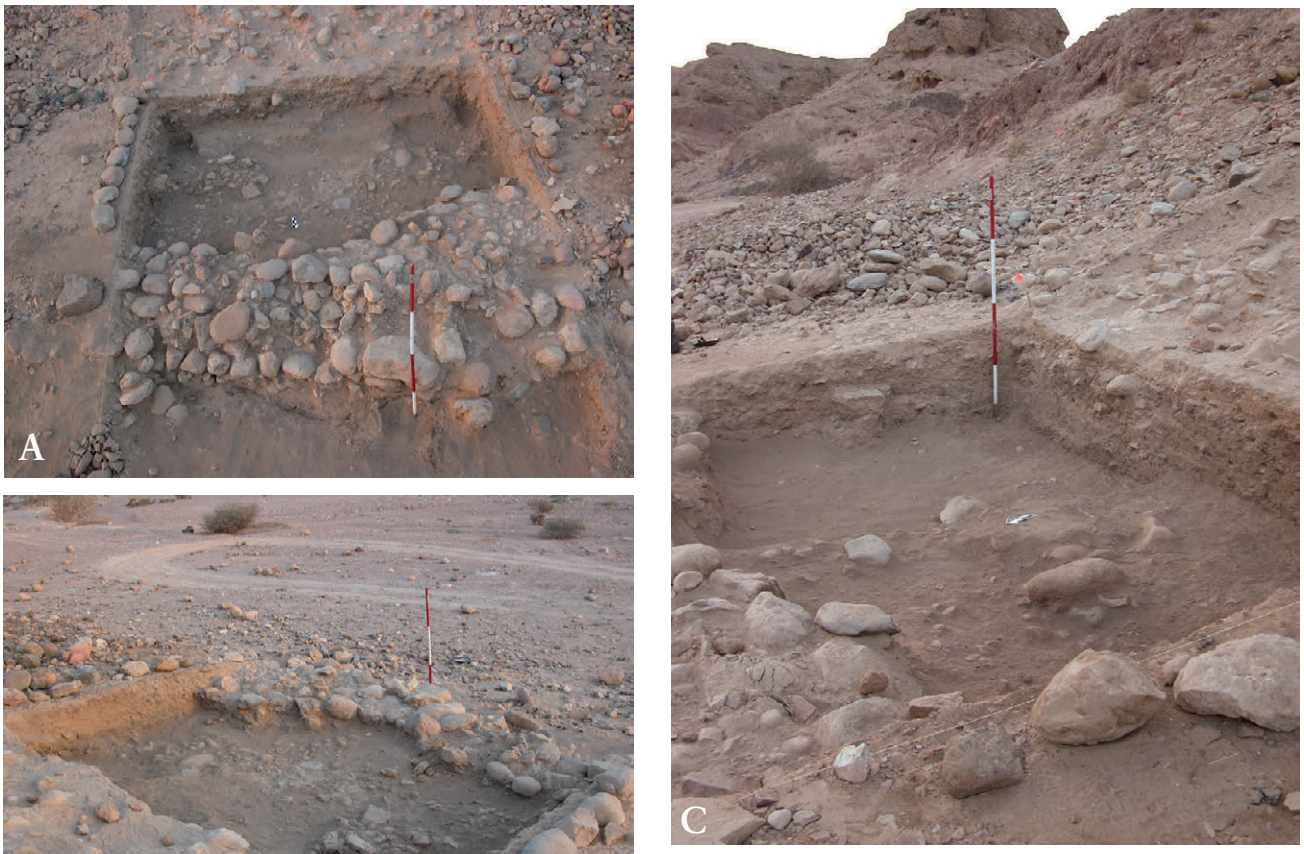

Figure 10.8 RHI 2004 Sounding B lower probe: (*a*) south (direct) view, (*b*) northwest view, and (*c*) southeast view. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

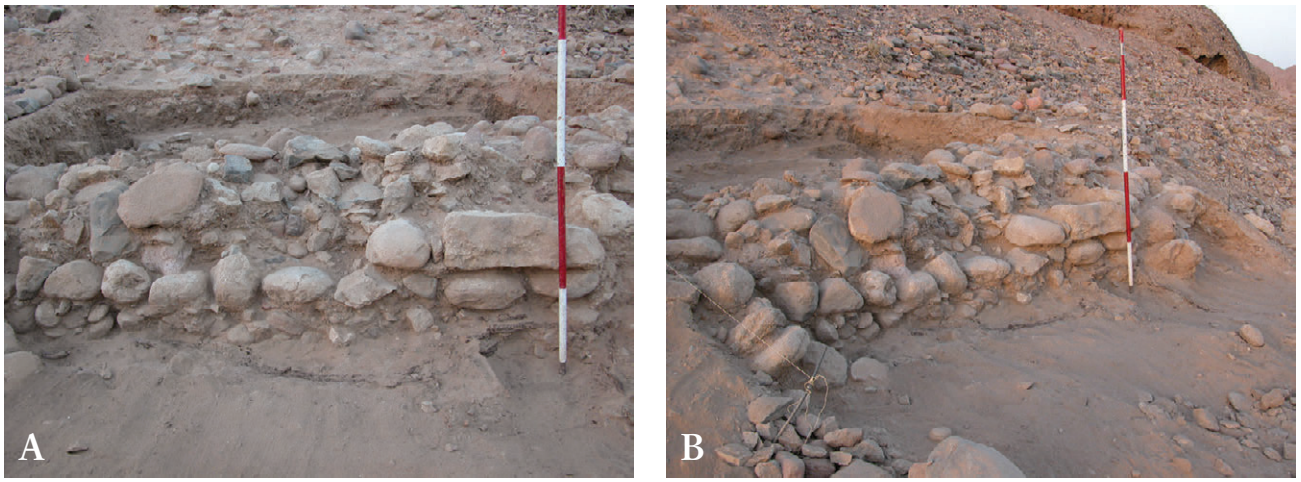

Figure 10.9 Sounding B terrace wall: (*a*) south view and (*b*) southwest view. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

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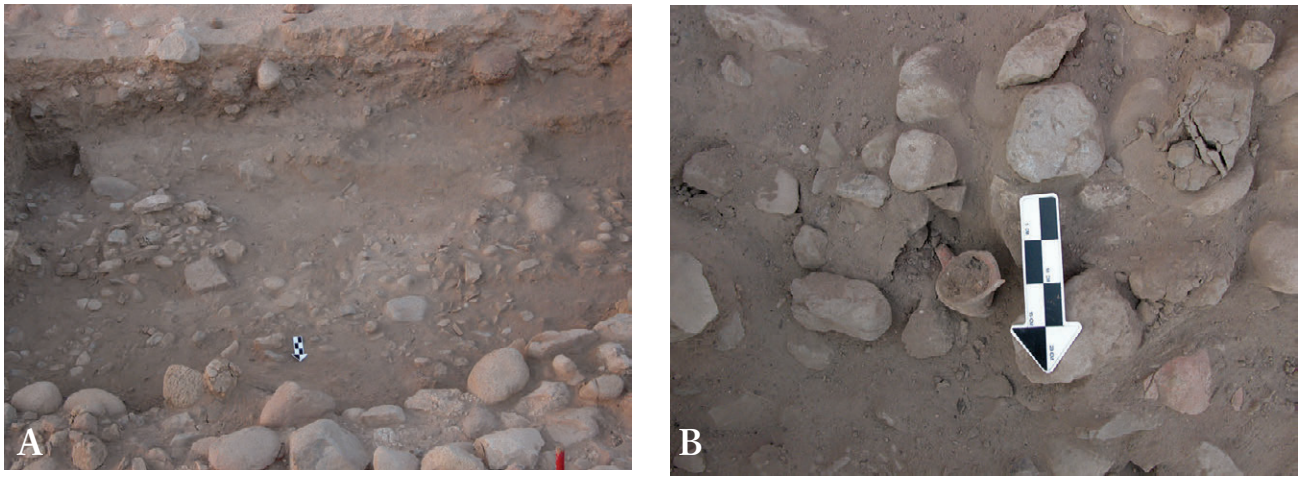

Figure 10.10 Sounding B, in situ groundstones, and pottery found on compacted surface layer: (*a*) full view of probe area and (*b*) close-up of L4001 where a jug with radiocarbon (seventh to sixth centuries BCE) was found. *Photos: T.E. Levy, UC San Diego Levantine Archaeology Laboratory.*

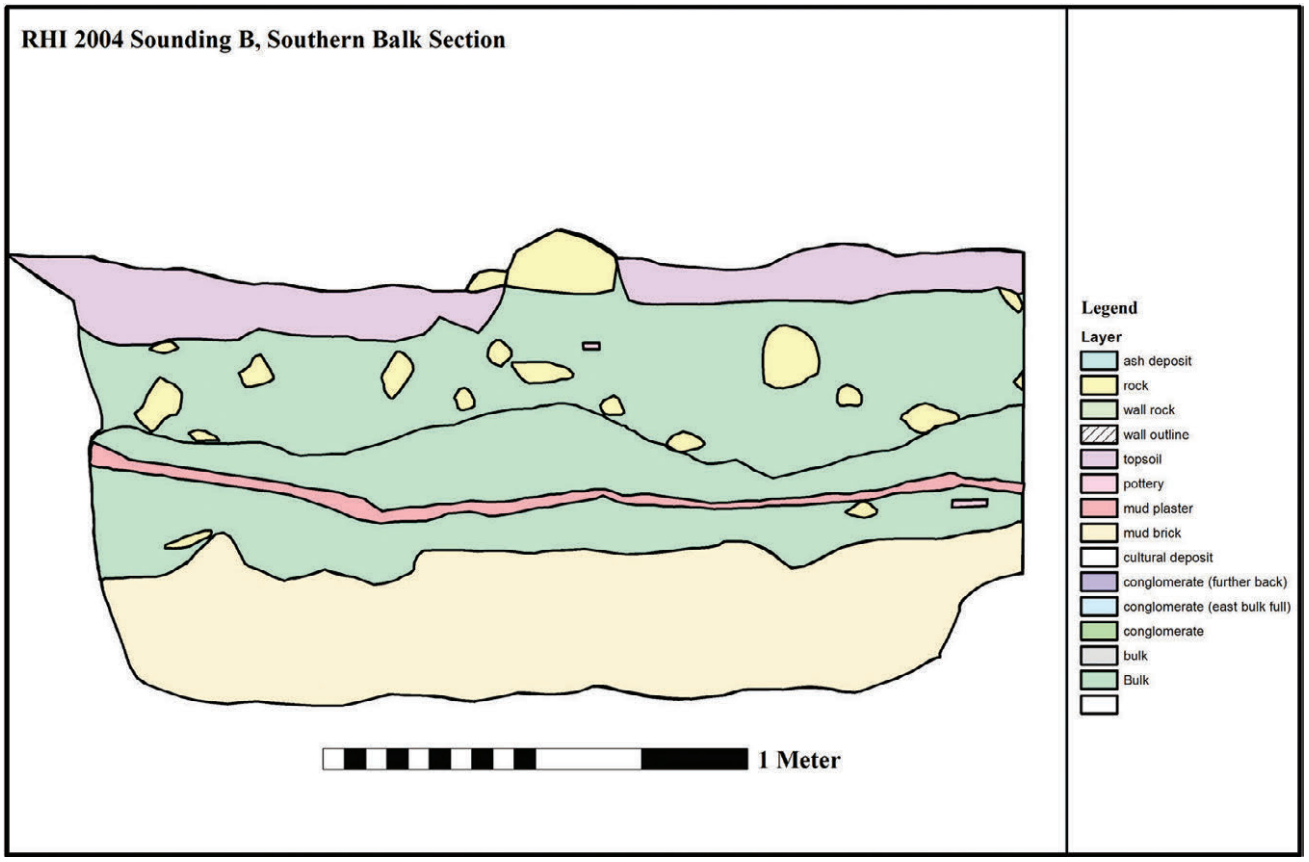

Figure 10.11 Sounding B section of southern balk.

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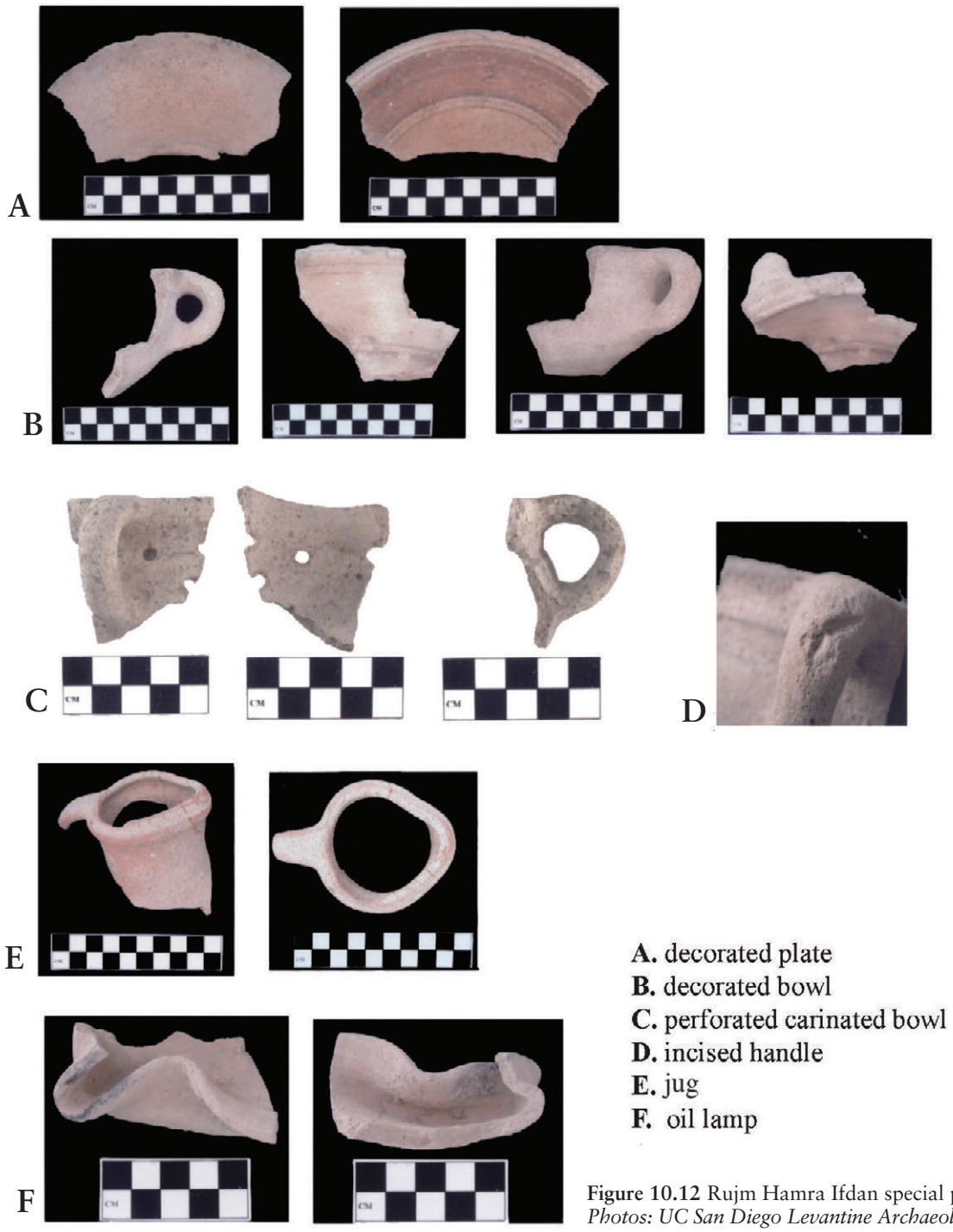

Figure 10.12 Rujm Hamra Ifdan special pottery.
Photos: UC San Diego Levantine Archaeology Laboratory.

(L536). The southern portion of L536 remained sterile, while the northern half, abutting the terrace wall (L532), had a small depression above bedrock. The depression contained soft ashy brown sediment, several ceramic sherds, charcoal, and half of a broken painted ceramic platter bowl (Figure 10.12:A; see also Chapter 4, this volume, BL2). It is assumed that Sounding B penetrated a rubbish deposit near the enclosure wall where pottery, discarded ground stone artifacts, and other waste associated with the later occupation at RHI were deposited (see discussion of radiocarbon dates below).

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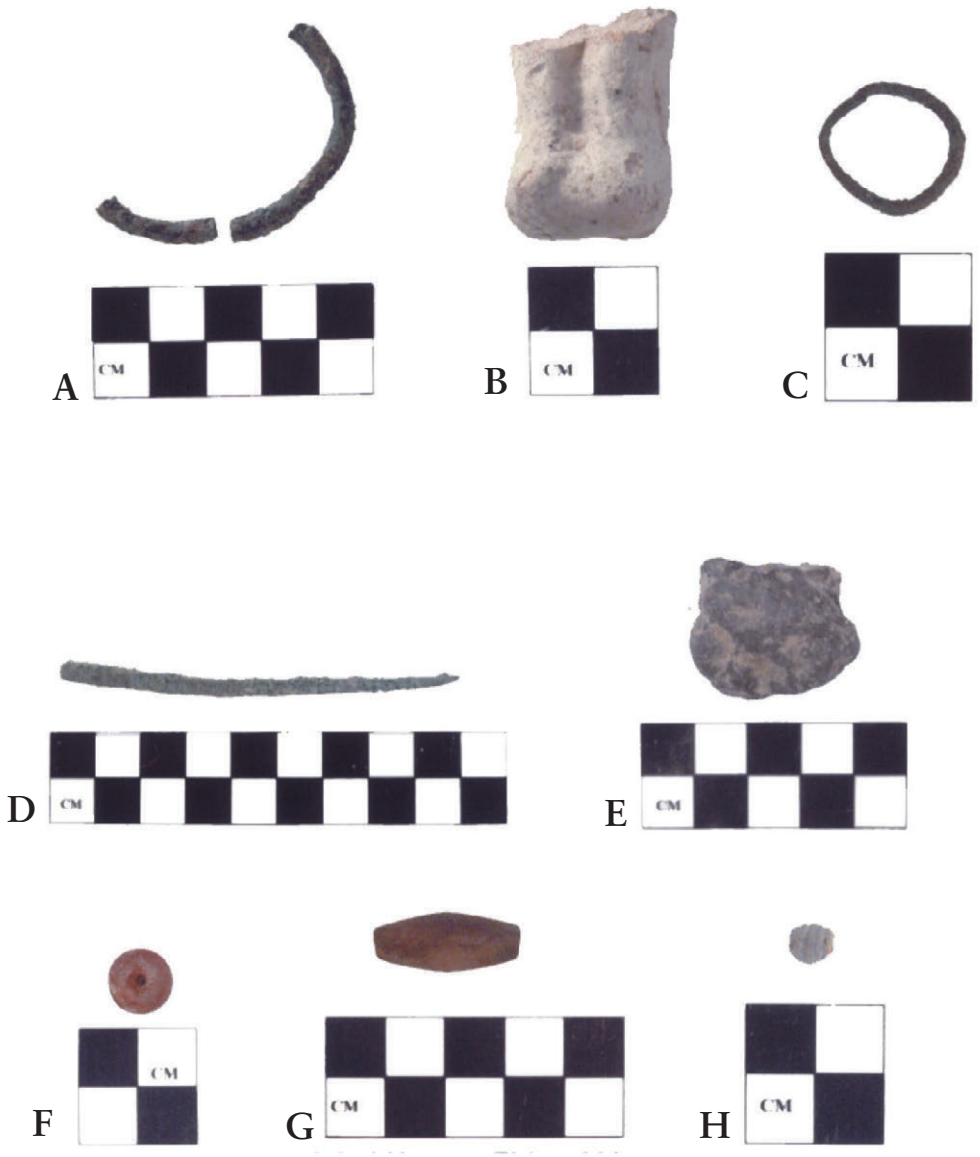

A. copper bracelet (EDM.89040 L.503)
B. figurine (EDM. 10307)
C. copper ring (EDM. 89046 L.507)
D. copper pin (EDM. 10161 L.520)
E. slag (EDM. 10057 L.5501)
F. bead (B.10089 L.3022)
G. bead (B.10269 L.3038)
H. bead (B.10230 L.3033)

Figure 10.13 Rujm Hamra Ifdan special finds. *Photos: UC San Diego Levantine Archaeology Laboratory.*

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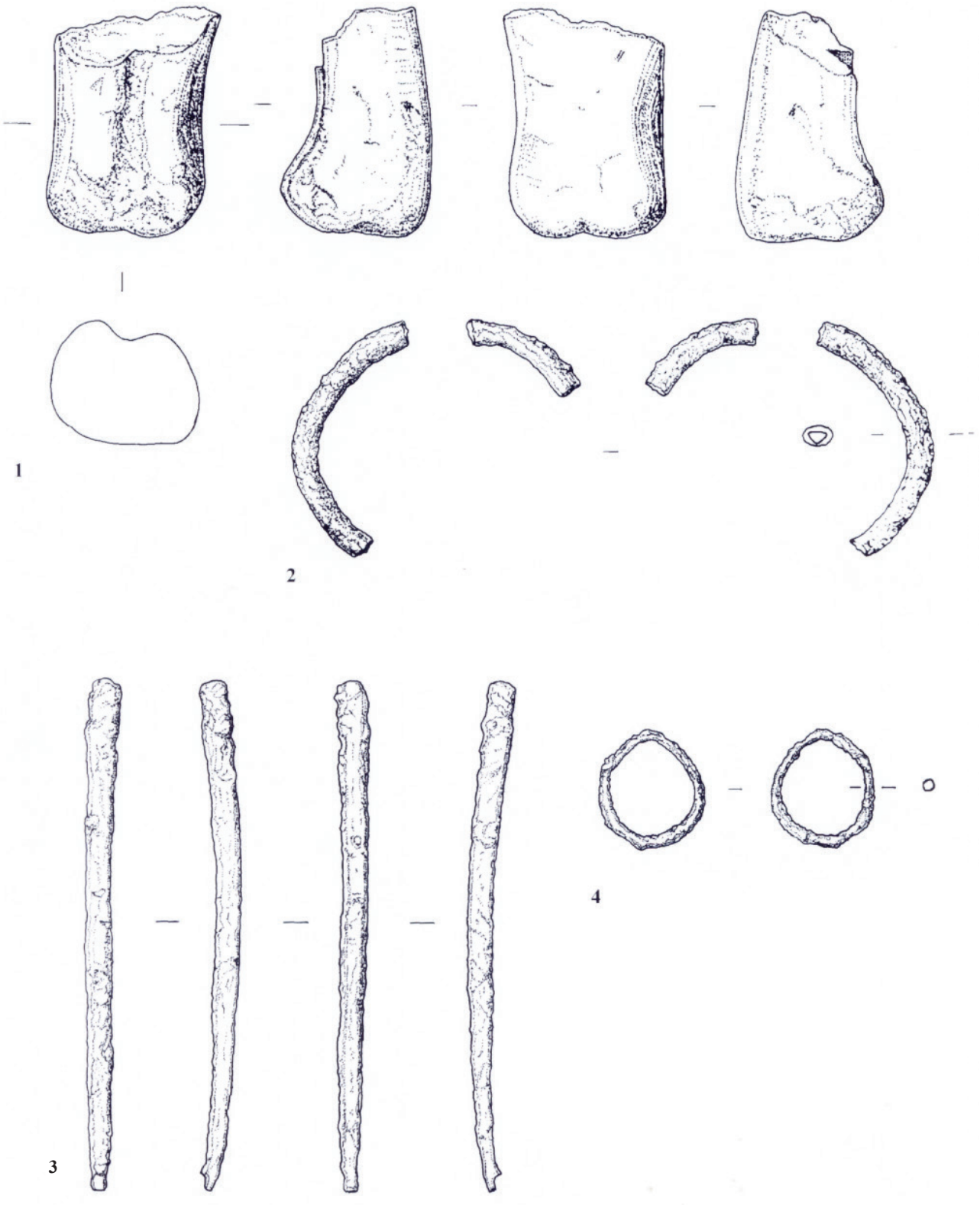

Figure 10.14 Rujm Hamra Ifdan, illustrated finds: 1) broken clay anthropomorphic figurine; 2) copper bracelet; 3) copper pin; 4) copper ring

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Radiocarbon Dating Results

A series of radiocarbon samples were submitted for absolute dating of the two soundings. For a detailed description of the methodology used here, see Levy et al. (2004), Higham et al. (2005), and Levy et al. (2005). From Sounding A, two charred date seeds (*Phoenix dactylifera*) were submitted for radiocarbon dating. One was taken from the hearth (L501; OxA-14849) and the other from a slightly lower light ashy sediment above the conglomerate bedrock (L509; OxA-14850; see Table 10.1). According to the radiocarbon results, this occupation dates to the tenth to ninth centuries BCE (see Figure 10.15). From Sounding B, three charcoal samples (*Tamarix* species) were submitted from L533 (OxA-14851), L534 (OxA-14852), and L536 (OxA-14853). Like all charcoal samples used for dating ELRAP projects, the outer rings closest to the sapwood were extracted by Professor Mark Robinson following his identification of the wood species. Despite the inherent problems in the calibration curve for the Late Iron Age II, all of these dates fall within the seventh to sixth centuries BCE (see Figure 10.15). These results were exciting because RHI is now the first Iron Age site in the lowlands of Edom where two important Iron Age II phases are found at a single site: the tenth to ninth centuries BCE and the seventh to sixth centuries BCE.

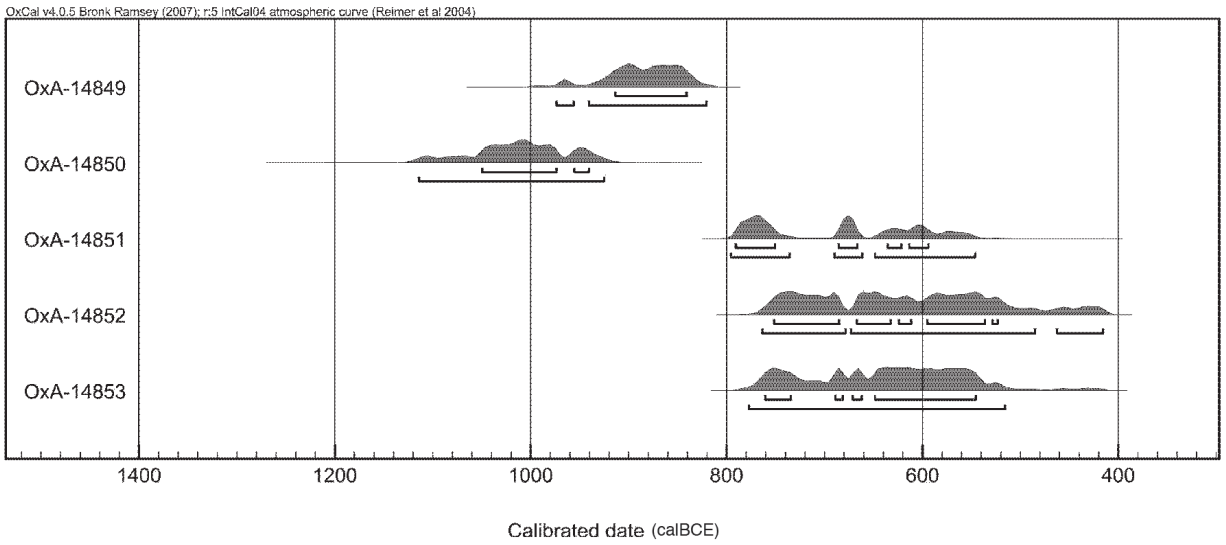

Figure 10.15 Calibrated radiocarbon dates from the Iron Age excavations at Rujm Hamra Ifdan, Faynan district, Jordan.

Radiocarbon Dates from Rujm Hamra Ifdan 2004 Season, UCSD - Department of Antiquities of Jordan Excavations

LAB NO.	SITE & LOCUS	BASKET	SQUARE	EDM	d13C	14C date BP	CalBCE 1 sigma	CalBCE 2 sigma
OxA-14849	WFD77 L501	54	H6	10045	-20.6	2747 ± 28	915BC (68.2%) 840BCE	980BCE (4.5%) 950BCE 940 (90.9%) 820BCE
OxA-14850	WFD77 L509	96	H6	10092	-21.2	2849 ± 28	1050BCE (58.9%) 970BCE 960BCE (9.3%) 940BCE	1120BCE(95.4%) 920BCE
OxA-14851	WFD77 L533	207	H2	10238	-26.7	2537 ± 27	800BCE (33.8%) 750BCE 690BCE (16.4%) 660BCE 640BCE (18.1%) 590BCE	800BCE(38.3%) 730BCE 690BCE(18.6%) 660BCE 650BCE(38.5%) 540BCE
OxA-14852	WFD77 L534	258	H2	10295	-24.7	2473 ± 28	760BCE (25.7%) 680BCE 670BCE (17.8%) 610BCE 600BCE (24.7%) 520BCE	770BCE (89.4%) 480BCE 470BCE (6.0%) 410BCE
OxA-14853	WFD77 L536	265	H2	10305	-25.6	2495 + 28	770BCE (11.9%) 730BCE 690BCE (7.1%) 660BCE 650BCE (49.3%) 540BCE	780BCE(95.4%) 510BCE

Table 10.1 Radiocarbon determinations from Rujm Hamra Ifdan, Jordan.

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Conclusions: Contrast Between Early and Late Iron Age II Occupation at RHI

Sounding A revealed a portion of the tenth-century BCE small habitation area possibly linked to the watchtower described by Nelson Glueck. This excavation also demonstrates that small-scale metallurgical activities took place here at the same time that industrial-scale work was being carried out at Khirbat en-Nahas (KEN) and its surroundings. This is in contrast to Sounding B, which was a rubbish deposit area of a much larger domestic settlement that may have served as an animal enclosure linked to seventh- to sixth-century BCE pastoralism, possibly agriculture, trade, and/or some other as yet undefined activities. The metallurgical deposits and abundant handmade pottery found in Sounding A and KEN were absent in Sounding B, suggesting in the later Iron Age II sequence a shift toward greater dependence on sedentary domestic production with the decline of metallurgical activities in the Faynan region. Sounding A's naturally shaded conglomerate shelter would have been a prime habitation area during the heat of the day. The evidence of the construction of walls to enclose the shelter suggests that this site was an important strategic locale that was repeatedly occupied whenever regional metal production was in full swing at nearby KEN. The north–south wall may have also served as a support of a roof for an extension of the site's natural shade to block the sun during later parts of the day as well as enclose the rock shelter, making it a useful room feature. The evidence of a hearth suggests frequent cooking activities. It should also be noted that this hearth may have been used for small-scale metallurgical processing. Some evidence of remelting of copper is seen by the occurrence of copper bits. The inhabitants may have acquired the copper metal from KEN or nearby sites and attempted to refine it for personal use or very small-scale trade. The primary activity of the inhabitants cannot be fully clarified through the sounding.

Glueck's original observation that RHI served as an Iron Age watchtower can still be considered a possibility with a few qualifications. From the projected roof of this room just below the site summit, the southern

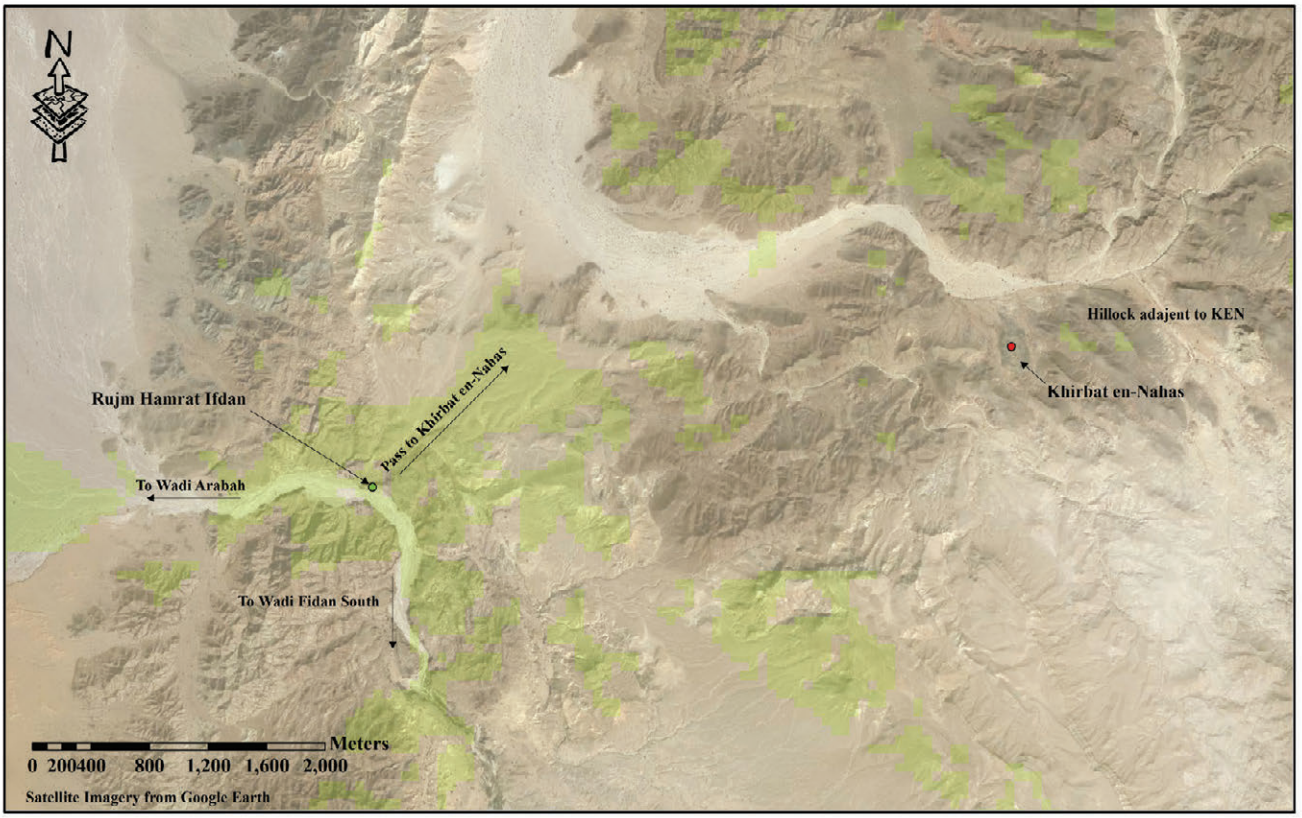

Figure 10.16 Viewshed map of RHI's relation to known Iron Age copper smelting sites, trade routes, and local springs.

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approach to the Wadi Ghuwayba is in full view. This was also the easiest place to climb to the summit of the site. Once on top, a clear view is possible of the other side of the Wadi Arabah and the main routes heading toward KEN and Khirbat Faynan. To help better understand this aspect of the function of RHI, a GIS viewshed analysis is presented in Figure 10.16. A viewshed represents the visible area that can be seen by the human eye from a fixed vantage point. The use of GIS to construct viewsheds for archaeological purposes has been conducted by a number of scholars (Jones 2006; Lake et al. 1998; Llobera 2003; Ogburn 2006; Tschan 2000; Wheatley 1995; Wheatley and Gillings 2000, 2002). The viewshed in Figure 10.16 shows in yellow that from the vantage point of RHI, all the main entrances into Wadi Fidan can be observed. RHI's elevation and location in the center of the Wadi enable a clear line of site in every direction. Although the Wadi al-Ghuwayba cannot be seen, the main route to the wadi is fully visible. It is also important to note that the hillock adjacent to Khirbat en-Nahas can be seen from RHI, which means that it was possible to signal to Khirbat en-Nahas from RHI. In this light, the idea that the room discovered in Sounding A was the habitation area for individuals in charge of keeping a lookout is not unreasonable. However, no archaeological evidence suggests that the inhabitants belonged to some form of military group or that defensive measures were made to defend the site as was connoted by Glueck's description. Taken together with the evidence of a contemporary large fortress at Khirbat en-Nahas, it is safe to assume RHI was indeed an ideal location for a small defensive lookout that was part of a defensive system, if not informally, to protect the lucrative copper production in the area.

However, the function of RHI changed in the later Iron Age, during the seventh to sixth centuries BCE. Clarification of the functional and temporal differences between the upper and lower portions of RHI came to light in Sounding B. Sounding B was located at the bottom of the hillock, adjacent to the circumvallation wall just above the wadi bed in full exposure to the sun. Although Sounding B revealed an exterior wall and compacted floor surface, there is no clear indication that this was a room. The general character of deposition reflects an intensive dumping area for pottery and other rubbish brought from around the site. The enclosure wall may have served as protection against seasonal flooding, support for adjacent buildings, and a formidable corral for keeping herd animals. Since the foot of RHI is adjacent to the wadi bed, the full extent of the architecture cannot be determined due to erosion and covering by fluvial sediment, even though sporadic wall lines can be identified on the terrace surface throughout the area. Accordingly, it is highly likely that extensive architectural remains throughout the terrace area could be excavated in the future or mapped using newer geophysical methods than those applied back in 2000 to other sites in the Jabal Hamra Fidan region (Witten et al. 2000). To the east of RHI, a large enclosure was found possibly for controlling water runoff coming from the east or as a corral for pastoralism (cf. MacDonald 1992). The Late Iron Age II RHI occupation resembles the open agricultural-type villages found on the plateau during this period (e.g. Tawilan and the Lowland to Highlands of Edom Project [L2HE] sites; see Chapter 3, this volume). Moreover, the majority of all the ceramics have direct morphological parallels with the plateau sites (see Chapter 4, this volume, for further discussion). The intensity of pottery use at RHI during this Late Iron Age period highlights and the domestic architecture reflects a trend in the Late Iron Age II of more permanent occupation and greater demand for domestic products. While the perennial Wadi Fidan spring is located around 1 km upstream from RHI today, it is possible that stream flow was stronger during the Iron Age and that water was readily available throughout the Iron Age sequence, adding another important variable for understanding the long-term use of RHI during the Iron Age. In sum, occupation in the lowlands continued into the later Iron Age II and perhaps flourished in conjunction with the highlands as areas once only sparsely occupied now changed function to become small- or medium-size open villages.

Accordingly, Soundings A and B at Rujm Hamra Ifdan present an important case study for comparing ceramic traditions in Edom from the tenth- to ninth-century BCE phase with that of the seventh to sixth centuries BCE. The significant temporal contrast between these two soundings reflects the dating discrepancies we originally noticed between KEN (tenth to ninth centuries BCE) and the plateau sites (seventh to sixth centuries BCE) (cf. Levy et al. 2003; Levy et al. 2004; Levy et al. 2005; Smith and Levy 2009). As we approached the excavation of RHI and all our Iron Age sites without preconceived chronological assumptions, on receiving Early Iron Age radiocarbon dates

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(pre–eighth century BCE) for all the occupation strata at KEN, it was clear that there was a much longer Iron Age sequence than the pioneer excavators of Iron Age sites in the highlands of Edom had assumed (Bienkowski 1990, 1992, 2001; Bienkowski and van der Steen 2001). The inability to grapple with the rapidly increasing number of radiocarbon dates produced from our excavations at Khirbat en-Nahas from 2002 to 2009 has led to the failure of Finkelstein et al. to understand the local evolution of Iron Age pottery from Edom beginning in the eleventh and perhaps as early as the twelfth century BCE in the lowlands (Finkelstein 2005; Finkelstein and Piasetzky 2006, 2008; Finkelstein and Singer-Avitz 2009), to the "classical" Late Iron Age forms commonly known from the highland sites of Busayra, Tawilan, Umm al-Biyara, and others. However, the radiocarbon dating of RHI continues to corroborate our findings at KEN and explain the discrepancies in ceramic form and archaeological materials found at the two soundings. Now with this comparison of the archaeological remains and ceramics recovered from controlled stratigraphic excavations at KEN and Sounding A to Sounding B and the L2HE sites, we are able to present clearly the differences in morphology and production of the Iron Age ceramic assemblages chronologically.

In short, RHI is the first locale in lowlands Edom where it is possible to study virtually the full Iron Age II sequence of Edom at one site and observe the local evolution of Iron Age ceramics from the tenth to sixth centuries BCE. The soundings at RHI further corroborate the archaeological evidence discovered for both the early and later periods of the Iron Age II in Edom. RHI represents the first excavated lowland site to represent the Late Iron Age II but is one of many sites representing this period in the highlands. It is hoped through future excavations at RHI and other sites located in the Faynan regions that the social evolutionary processes connecting these two periods will be more clearly delineated.

Notes

1 This site is also referred to as WF77 by the JHF project (Levy et al. 2001) and WFD20 by MacDonald (1992).

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11 The Iron Age Egyptian Amulet Assemblage

Stefan Münger and Thomas E. Levy

The assemblage of glyptic objects, which include scarabs and other amulet types, sheds light on the vivid interaction between the people living in Iron Age Edom and Egypt during the twenty-first and the beginning of the twenty-second Egyptian dynasty (ca. 1070–850 BCE).

Given the peripheral location of the investigated area, far off from regular transport axes, and the industrial nature of the investigated copper sites, the number of Egyptian stamp seals and amulets is astonishing, especially during a period when contacts with Egypt were normally observed on the Mediterranean coast and along transregional trade routes.

However, while some of the Egyptian goods unearthed in tombs may be the result of the nomadizing Shasu tribes' social interaction with neighboring groups, the presence of these items within Edomite copper production centers could reflect commercial and/or cultural interconnections of the local population with the Egyptian realm at the close of the second and at the beginning of the first millennium BCE.

This chapter summarizes the entire corpus (n = 16) of Egyptian amulets found in the surveys and excavations of the Edom Lowlands Regional Archaeology Project in Jordan's Faynan district. The majority (n = 10) come from the stratified excavations at the Khirbat en-Nahas copper production center located on the Wadi Ghuwayba. Three items are from an Iron Age tomb from Wadi Fidan 4, two from the large Iron Age cemetery at Wadi Fidan 40, and one found on the surface of Khirbat Hamra Ifdan, also on the Wadi Fidan. This assemblage contributes to understanding the nature of Egyptian interaction with this important southern Levantine copper production zone.

Opposite: Collection of Egyptian amulets from the UC San Diego-Department of Antiquities of Jordan Edom Lowlands Regional Archaeology Project. (Images not to scale)

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Introduction

The small but significant assemblage of Egyptian amulets found during the course of excavations and surveys carried out by the University of California, San Diego (UCSD)–Department of Antiquities of Jordan (DOAJ) Edom Lowlands Regional Archaeology Project (ELRAP) shed important light on the nature of Egyptian–Levantine interaction during second and first millennium BCE. The amulets were found primarily in stratigraphic excavations at the copper production site of Khirbat en-Nahas and the contemporary Wadi Fidan 40 cemetery that the ELRAP team links to the Shasu nomads referenced in ancient Egyptian texts such as the Harris Papyrus and the Papyri Anastasi (Giveon 1971; Levy, Adams, and Muniz 2004; Ward 1972). While no definitive conclusions can be made about what role the Third Intermediate Period Egyptians had in the Faynan copper ore district, the data demonstrate important social interaction that can be factored into different models and interpretations discussed throughout this volume.

In terms of the study presented here, a number of qualifications need to be outlined. The glyptic expert (Münger) could not inspect the objects in person, and all observations were made by means of photographs. Equally, measurements were taken according to the photographs rather than from the actual objects.

A capital letter followed by a number (e.g., H6) refers to the "List of Hieroglyphic Signs" in Gardiner (1957:438–548).

Parallels marked with * are of unknown stratigraphic attribution, or altogether have none; (*) indicates an uncertain stratigraphic attribution or find context; and ° designates a surface find. A superscript "?" signals a tentative interpretation or a hesitant attribution.

Analogous objects in the "Parallels" section have been included only if corresponding examples from authorized excavations are available (comparanda kept in museums or private collections are cited only if essential to the discussion). No comprehensive presentation of parallels was attempted.

This study follows the nomenclature and chronology of the southern Levant according to Stern (1993) (except for the absolute dating of the Iron Age I, cf. Münger 2003, 2005; for the dates of the Egyptian dynasties, cf. von Beckerath 1999).

In what follows, the context of each amulet is presented, followed by a detailed description of the object, a discussion of its meaning, parallels in the scholarly literature, and finally its date. When taken together, in the conclusion, it is possible to make some preliminary observations concerning the nature of Egyptian interaction with Faynan, especially during the tenth century BCE.

Cat. No. 1: Scarab—Amun-Re (Figure 11.1)

Registration Details and Context: Wadi Fidan وادي الفيدان 4 (WFD 4), Area H, Season 2003, Tomb 1, Locus 758, Basket 1948, EDM 40046/50208. Wadi Fidan 4 (WFD 4) is primarily an Early Bronze I site located west of the Wadi Fidan gorge that cuts through the Jabal Hamrat Fidan (Adams and Genz 1995) and situated southeast, across from the Wadi Fidan 40 cemetery on the south bank of the wadi. While the UCSD-DOAJ ELRAP team was excavating WFD 4, a series of tumuli were identified along the northern edge of the site, overlooking the wadi. Two of these tumuli were sampled as they were in danger of looting. The tomb was made up of a 25-m^2 rock cairn that covered a cist grave identical to those found in the Wadi Fidan 40 cemetery across the wadi (see Chapter 9, this volume; Levy, Adams, and Muniz 2004). Unlike the WFD 40 cemetery, the isolated Iron Age tombs at WFD 4 and the newly excavated Iron Age tomb on the summit of Wadi Fidan 61, these outlier tombs contain unusually large numbers of buried individuals. Thus, Tomb 1 at Wadi Fidan 4, with eight buried individuals (see Chapter 9, this volume), played a different role in Iron Age mortuary rituals in Faynan. While no radiocarbon dates have been obtained, at the end of this chapter, an assessment is made of its dating based on the assemblage of Egyptian amulets found there and discussed in this chapter.

Object: Scarab; typologically belonging to Group B of the Early Iron Age Mass-Produced Series (EIAMS; cf. Münger 2005:394 with examples; see also Cat. No. 10, below).[1]

Condition: Small chip on plinth is broken off; there is slight damage near the drilling on the scarab's rear. *Engraving*: Bold linear and hollowed-out engraving. *Material*: Enstatite.[2] *Color*: Yellowish brown. *Dimensions*: 11.7 × 9.5 × 6.0 mm.

Base: The base is vertically arranged and shows several degenerated hieroglyphs. The vertical line on the right-hand side may represent a *j* (M17 or alternatively *šwt*, H6; cf. Keel 1995:§456.461). The sign *mn* (Y5; Keel 1995:§457) is clearly visible in the center. The horizontal line above might be an *n* (N35; Keel 1995:§458).[3] The two short horizontal strokes below the *mn* should be

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interpreted as two *r*ʿ (N5; Keel 1995:§461). The first sign on top corresponds to the hieroglyph *ḫ*ʿ*(j)* (N28; Keel 1995:§453).

Discussion: The hieroglyphs in the lower two-thirds of the plinth combine to form the name of the god *Jmn R*ʿ «Amun-Re». The top most sign, however, should not be interpreted as *ḫ* ʿ*(j)*[4] but as a space filler (as first suggested by Brandl 1993a:135–136, No. 10, for somewhat earlier but graphically similar motifs), which occasionally occurs in connection with the name of Amun-Re (for parallels from the southern Levant and Egypt, see Brandl 1993a and Keel 1997:684–685, No. 62; see also Cape Gelidonya: Brandl 2003:Pl. 1, SC 2). Brandl (1993a:136) dates this peculiar space filler to the nineteenth Egyptian dynasty.

Parallels: Although the written name of Amun-Re is quite frequently found in the corpus of the EIAMS,[5] only one item shows a similar arrangement. It comes from Grid 33 at Ashkelon and was found in an Iron Age III context (cf. Keel 1997:716–717, No. 75 = Münger 2011:154) (catalogue entry Aškelon 3).

Dating: As object EDM 51101 typologically clearly belongs to the EIAMS, it should be dated accordingly, from around 960 to 900/880 BCE or somewhat later (corresponding to the final years of the twenty-first and the beginning of the twenty-second Egyptian dynasty; cf. Münger 2003, 2005). In view of the degenerated, yet almost illegible rendering of the originally nineteenth Egyptian dynasty motif, a late production date during this time span may be assumed (see also the poorly engraved items from later contexts at Tell el-Farʿah South; Münger 2005:Figure 23.1).

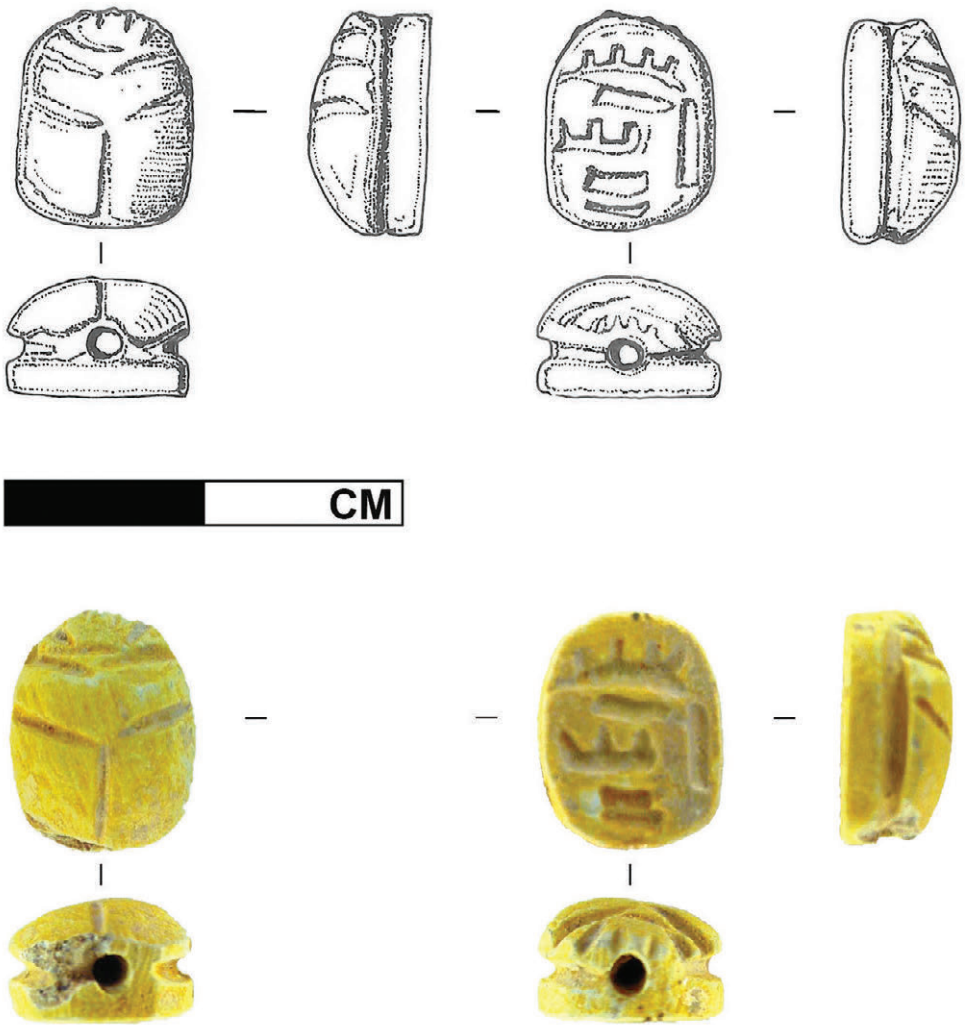

Figure 11.1 Scarab of Amun-Re found in Tomb 1, Wadi Fidan 4, EDM 51101, L758, B1948.

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Cat. No. 2: Figurine Amulet—Standing Female (Figure 11.2)

Registration Details and Context: Wadi Fidan وادي الفيدان 4 (WFD 4), Season 2003, Area H, Tomb 1, Locus 701, B1613, EDM 50700. This item was found in the Tomb 1 multiple burial in a cist grave, beneath the rock cairn at Wadi Fidan 4 in association with a semi-flexed adult who had copper (possibly bronze) anklets—one on each leg, along with a number of beads and cowrie shells. Unfortunately, the sex of this individual has not yet been determined (see Chapter 9, this volume).

Object: Figurine amulet of a standing female figure with a high (double) crown. The arms are hanging down along the body, and one leg seems to be placed slightly ahead of the other, which gives the impression that the figure is advancing. The right leg is damaged; otherwise, the item is complete but very worn. Hardly any details of the head are visible except for eyes, nose, and mouth. Traces on the chest could be the remains of an original necklace; below, the belly button is visible. The back is plain; there is a suspension hole at the height of the figure's ears. *Measurements*: 2.1 (H) × 0.8 (max. W) × 0.6 (max. D).

Material and Production Technique: Whitish composition, no remaining traces of glaze; mold-made (see also Cat. No. 9, below).

Parallels: This type of figurine corresponds to Herrmann's type 1.10.B ("Gestalt mit Doppelkrone, schreitend"; cf. Herrmann 1994:209–210). A comparable amulet comes from an Iron Age IB or early IIA context at Tell Abu Hawam, Stratum IV: Hamilton (1934:34 with Pl. 35,213; for the dating of the context, cf. Balensi et al. 1993:10–11).

Date: On the basis of the parallel from Tell Abu Hawam, an Iron Age IB/Early Iron Age IIA date, roughly corresponding to the twenty-first Egyptian dynasty (1070/69–946/45 BCE), is suggested.

Cat. No. 3: Rectangular Piece—"Amun Is My Lord" (Figure 11.3)

Registration Details and Context: Wadi Fidan وادي الفيدان 4 (WFD 4), Season 2003, Area H, Tomb 1, Locus 720, Basket 1775, EDM 50809. Tomb 1 at Wadi Fidan 4 was exceptionally rich in imported Egyptian amulets. Preliminary analyses of the fragmentary human remains suggest that this was an adult age 20 to 50+ years of undetermined sex. Even though this

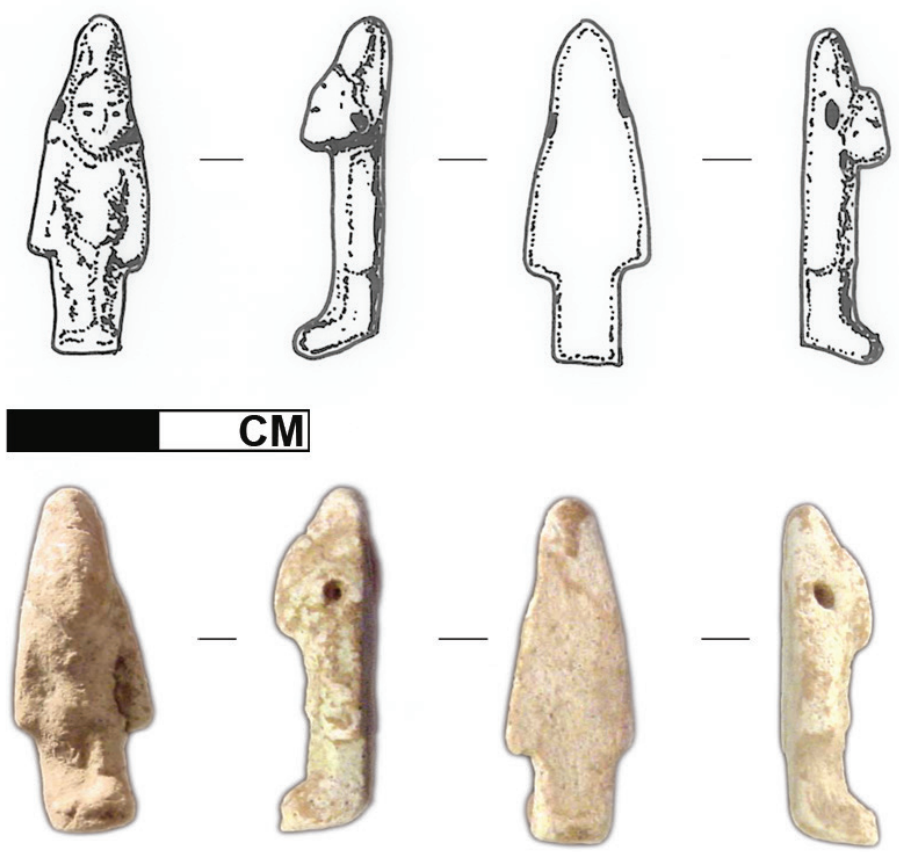

Figure 11.2 Standing female figurine amulet, Tomb 1, Wadi Fidan 4, EDM 50700, L701, B1612.

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tomb was robbed in antiquity, it still contained a rich assemblage of Egyptian imports, suggesting that this adult was a prestigious individual.

Object: Bifacial rectangular piece, type II (Keel 1995:§§220–224), perforated lengthwise. *Condition*: Fully preserved. *Engraving*: Bold linear and hollowed-out engraving. *Material*: Enstatite. *Color*: Beige. *Dimensions*: 11.1 × 9.2 × 5.4 mm.

Side A: Vertically arranged scene—framed by a simple line—showing a falcon-headed deity with one arm raised and the other arm hanging down along the body. Above the deity's head is a sun disk. To its right is a rearing uraeus (cobra) with a long tail (*j'rt*; I12/13; cf. Keel 1995:§522).

Side B: Horizontally organized hieroglyphs (from right to left): *j* (M17; Keel 1995:§456), *mn* (Y5; Keel 1995:§457) with a complementary *n* (N35; Keel 1995:§458) below (for a similarly executed *n*,[6] cf., e.g., an item from (*)Ashkelon: Keel 1997:726–727, No. 103), and three short vertical lines that should be viewed as determinative strokes.[7] On the far left is a vertically arranged *nb* (V30; Keel 1995:§458).

Discussion: Side B reads *Jmn nb<j>* «Amun is my Lord», as it is, for example, found on an item from Tell el-'Ajjul, Tomb 1035 (Keel 1997:176–177, No. 216; see also Tell el-Far'ah South, Tomb 960C: Keel 2010b:336–337, No. 725 [without determinative strokes]). Note that there is a plethora of parallels to this formula, which usually reads «Amun-*Re* is my Lord» (cf., e.g., Beth Shean, Level VI: Keel 2010a:116–117, No. 42 with many parallels).

The falcon-headed deity spreading its wing(s) protectively over a uraeus is a common motif in the glyptic art of the New Kingdom. A strikingly similar parallel for Side A comes from an Iron Age IIA context at Kadesh Barnea, Stratum 4B, which equally features on its reverse side the name of Amun, though cryptographically written (Münger 2007:No. 1 with further explanations and comparanda[8] [add, e.g., the oval piece with sheaf-shaped handle found at Ekron, Stratum VIA: Keel 2010a:548–549, No. 69, with additional parallels]).

Parallels: A very fine—although unfortunately stratigraphically unclear—comparandum comes from Area A at (*)Tell el-Fukhar (Acco); cf. Keel (1997:628–629, No. 274; for a bifacial rectangular piece with the name of Amun-Re that was found in Transjordan at Tell es-Sa'idiyeh, Tomb 90, see Eggler and Keel 2006:376–377, No. 19). While the item from Tell el-Fukhar (Acco) is much larger in size than the item from Wadi Fidan, it similarly has a falcon-headed deity with a uraeus on one and the name of Amun(-Re) on the other side. Keel (1997:628) dated this item to the late nineteenth and the twentieth dynasties (ca. 1250–1075 BCE).

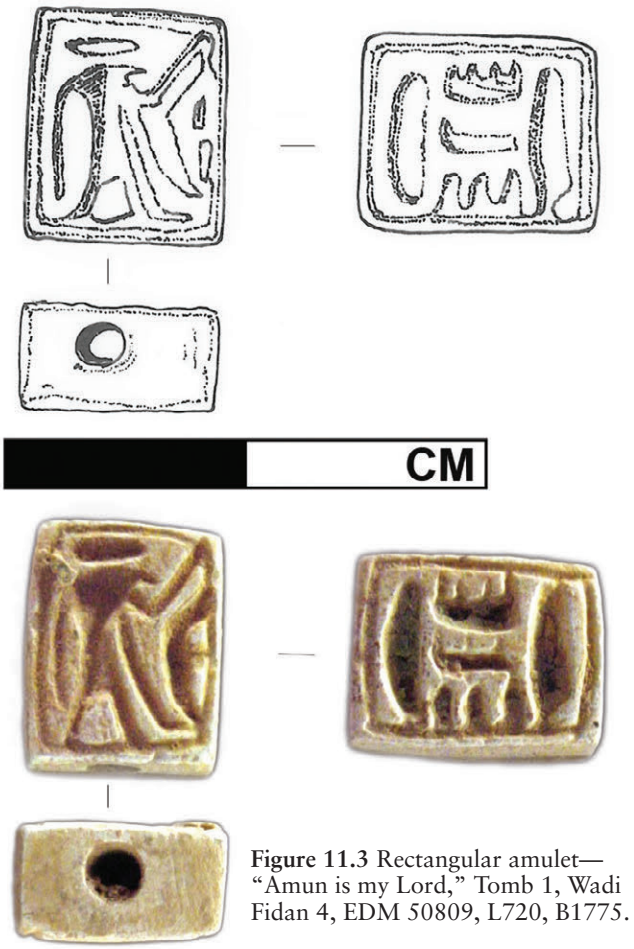

Figure 11.3 Rectangular amulet—"Amun is my Lord," Tomb 1, Wadi Fidan 4, EDM 50809, L720, B1775.

Dating: Bifacial rectangular pieces of type II clearly had their heyday during the Ramesside period (ca. 1292–1070/1069 BCE). After the Late Bronze Age IIB, they are much less frequent but still might have been produced (Keel 1995:§222 and 224). In view of the mentioned parallel from Tell el-Fukhar (Acco), a Late Bronze Age IIB/Early Iron Age I date is suggested.

Cat. No. 4: Scarab—Crowned Uraeus (Figure 11.4)

Registration Details and Context: Wadi Fidan وادي الفيدان 40 (WFD 40), Season 1997, Area A, Grave 92, Locus 531, Basket 2152. Grave 92 was one of the first systematically excavated tombs in the Wadi Fidan 40 cemetery (Levy et al. 1999). Like most of the graves,

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this one was disturbed in antiquity, as evidenced by the removal of one of the capstones covering the rectangular cist. However, this grave was also relatively rich in burial offerings, including a well-preserved wooden bowl with spout that was filled with pomegranates. The interred was an adult female oriented north and facing west. This woman was also buried with an iron bracelet on her left arm, copper anklets on each leg, two copper rings (one on a toe from each foot), a necklace made of beads accompanied by the scarab described below, and other objects. The first radiocarbon dates from the Wadi Fidan 40 cemetery were taken from desiccated pomegranates found with this individual (see Chapter 9, this volume). The calibrated (1 sigma) date from this short-life sample is 1015 to 845 BCE. As the scarab described below dates to the MB IIB period, we assume that this was an heirloom that reflects Egypt–Edom interaction during the Hyksos period. As will be noted in the conclusion, this find is important in that it may illustrate kind of interaction alluded to in Egyptian papyri and other inscriptions from the fifteenth to tenth centuries BCE (Giveon 1969–1970, 1971; Levy, Adams, and Muniz 2004).

Object: Scarab; type D5 (head), 0 (back), e9 (side) according to Tufnell (1984). *Condition*: Chipped along the border of the plinth. *Engraving*: Linear engraving with hatching. *Material*: Enstatite. *Color*: Dark reddish brown. *Dimensions*: 18.5 × 12.4 × 11.2 mm (measurements after Eggler and Keel 2006:484).

Base: The center of the vertically arranged plinth is dominated by an upraising uraeus (Keel 1995:§529) with a red crown (Keel 1995:§452) flanked on each side by a *z3* «protection» (V16; Keel 1995:§465) atop of a *nfr* «good, perfect» (F35; Keel 1995:§459).

Discussion: The motif on the plinth belongs to Tufnell's design class 3A3 (Tufnell 1984:Pl. 8a,b) and is typical for an early Middle Bronze Age II scarab group dubbed by Daphna Ben-Tor's "Early Palestinian Series" (Ben-Tor 2007:126); for crowned uraei in central position, which are flanked by various signs, compare with, for example, (*)Rishon Leziyyon, transitional MBIIA to MBIIB tomb (Ben-Tor 2007:Pl. 51,23; for the context, cf. Ben-Tor 1997:162–163; Levy 1993); Tell el-'Ajjul, Tomb 1337 (Keel 1997:434–435, No. 974); and Lachish, Tombs 153 and 6027 (Tufnell 1958:Pl. 32,76.118).[9] It is probable that the seal was locally produced.

Parallels: Close parallels of the scarab's type and the motif on its plinth come from Tel el- Dab'a, Tomb 5 A/II-1/14 = Stratum E/1, which is dated to 1620 to 1590

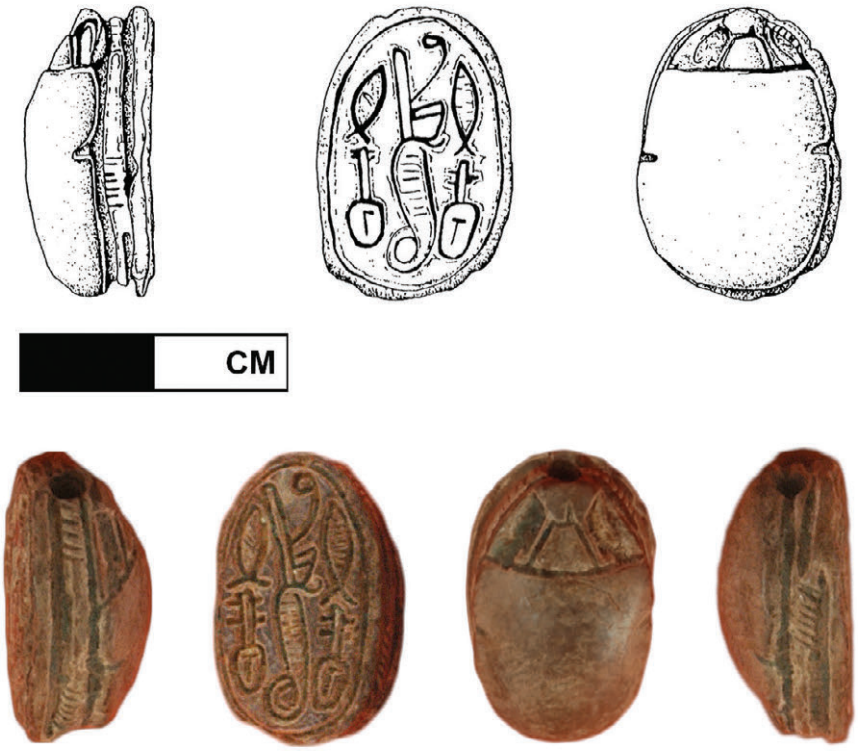

Figure 11.4 Scarab—crowned uraeus from the Middle Bronze IIB, Wadi Fidan 40 cemetery, Grave 92, EDM 86873, L3050, B2983.

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BCE, that is, to the first part of the Hyksos's rule in Lower Egypt (Mlinar 2004:129), and from Megiddo, Tomb 24 (Guy 1938:Pl. 105,14). Note, however, that on the base of each of these examples, the uraeus is flanked by two vertically positioned *z3* to each side (instead of a *z3* and atop a *nfr*).

Dating: Middle Bronze Age IIB (ca. 1700–1630 BCE; cf. Ben-Tor 2007:119).

Bibliography: Levy et al. (1999:299–300 with Figure 6) and Eggler and Keel (2006: Wadi al-Feidan Friedhof 40, No. 1).

Cat. No. 5: Rectangular Seal with Sheaf Shaped Handle (Figure 11.5)

Registration Details and Context: Wadi Fidan وادي الفيدان 40 (WFD 40), Season 2004, Area A, Grave 91, Locus 3050, Basket 2983, EDM 86873. This tomb may represent a reuse of the original cist structure associated with the burial monument. The removal of the southern slab of the cist to accommodate this extended burial points to this interpretation. As suggested by Beherec et al. in Chapter 9 (this volume), the rectangular stamp seal and the other Egyptian artifacts found in the Wadi Fidan 40 cemetery and other tombs in the region were relatively rare finds. While they are quite common at Levantine sites around the southern Levant, their rarity in Faynan may indicate individuals of high status. Thus, the interred individual, or some closely related family member, may have used the stamp seal found in Grave 91. The reuse of the tomb suggests that a number of generations living in Faynan made use of the cemetery.

Object: Almost rectangular "piece with sheaf shaped handle" (Keel 1995:§210.212–213 [type II]). Keel catalogued well over 20 items from Israel/Palestine (in Keel et al. 1990:355–360, updated in Keel 1995:§212; further see Ashkelon, Iron Age II context: Keel 1997:728–729, No. 108) to which, for example, the following from Cis- and Transjordan should be added: Beth Shean, Stratum II-I (Keel 2010a:166–167, No. 155); Ekron, Stratum VIA (Keel 2010a:548–549, No. 69); Sahab, Tomb C (Eggler and Keel 2006:258–259, No. 1); and Tell es-Sa'idiyeh, Tomb 354 (Eggler and Keel 2006:380–381, No. 29).

Contrary to other seals of this type, which normally tend to be more oval, the plinth of the present item from Wadi Fidan 40, Grave 91 is almost rectangular; similar in shape are Tell Abu Hawam, Stratum IIIB (Keel 1997:6–7, No. 7); Tell el-Far'ah South, Tombs 133 and 524[10] (Keel 2010b:120–121, No. 217 and 128–129, No. 233); or Gezer, Tomb 96 (= Stratum VIII; cf. Dever 1974:4; Macalister 1912: III: Pl. 90,30).[11]

Condition: The seal is somewhat worn; its plinth is slightly damaged (the upper part of the fourth vertical stroke is apparently broken along the outer edge and some smaller parts are chipped off, especially in the center of the plinth). *Engraving*: Bold linear engraving. *Material*: According to the excavators, the seal is made of limestone. This is very unusual since "oval/rectangular pieces with sheaf shaped handles" are almost exclusively made of composition (Keel 1995:§394–395) with a greenish or bluish glaze (but cf., e.g., Basel: Museum für Völkerkunde: Hornung and Staehelin 1976:Nos. 17–18, where the material "Steatite" is indicated—although with a question mark). *Color*: Yellowish brown. *Dimensions*: 14.5 × 10.5 × 8.0 mm; with these measurements, the seal is among the smallest of its type (a seal with similar dimensions is, e.g., the seal from Tomb 133 at Tell el-Far'ah South mentioned above).

Base: The base should most probably be viewed horizontally. It shows four vertical strokes flanking—two on each side—an endwise-vertical rectangle, which is horizontally divided by two additional lines into three segments.

Discussion: The decoration on the seal's base is uncommon, and no exact parallel can be found. However, on the basis of comparative material, it might be suggested that this geometric pattern imitates or alludes to the divine name *Jmn* «Amun», similar to seals of the same type bearing debased renderings of the name of this Egyptian deity, although to a lesser extent.

Parallels: The closest parallel to the engraving on the seal's base is an unstratified item from *Gezer: Macalister (1912: II: 322, No. 217 and III: Pl. 207,30). Other "pieces with sheaf shaped handles" bearing the defectively (vertically arranged) written name of Amun are, for example, items from Tell Abu Hawam, Stratum IIIB (cited above); Tell el-Far'ah South, Tomb 643 (Keel 2010b:156–157, No. 295) and "Stratum" Y (Keel 2010b:378–379, No. 830); and Timna South, Site 200 (Hathor sanctuary), Locus 107 (Schulman in Rothenberg 1988: Eg.Cat. 189, p. 138 with Fig. 46,9 and Pl. 123,6).

Dating: Insofar as none of the seals in question bears a datable inscription (i.e., a pharaonic name that is likely to be contemporaneous with the seals' production),[12] it is appropriate to give a relative date. Among the earliest

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find spots is the one from Sahab (see above) where a "rectangular/oval piece with sheaf shaped handle" was found in a tomb chamber that mainly contained LBI-II material (Dajani 1970:30). However, it cannot be ruled out that this seal was deposited at a later time, since Tomb C at Sahab was in use until the Iron Age IIB.[13] Another case is the seal found in the Hathor sanctuary at Timna South (see above) that is dated to the nineteenth to twentieth dynasties (1292–1075 BCE).[14] Nevertheless, all other stratified items from Cis- and Transjordan were found in contexts dating to the Iron Age IB or later. In view of the debased engraving on its base and the unusual material used (which might point to a local production), a date for this seal from Grave 91 at the end of the twentieth to the twenty-first Egyptian dynasty (ca. 1100–950 BCE) is suggested (see also Keel 1995:§213 with earlier literature).

Bibliography: Levy, Najjar, Muniz, et al. (2005:470–471) and Eggler and Keel (2006: Wadi al-Feidan Friedhof 40, No. 2).

Cat. No. 6: Scarab—Sheshonq I (Figure 11.6)

Registration Details and Context: Khirbat Hamra Ifdan خربة حمرة إفدان (WFD 120), Season 2006, Surface, EDM 12189. This scarab is the most significant Iron Age Egyptian artifact found to date in southern Jordan. The scarab was discovered by UCSD graduate student Ben Volta during a field trip to the Early Bronze Age copper production site of Khirbat en-Nahas led by T. E. Levy. Volta was walking around the site while the undergraduate students were being given a tour. The site is situated on an isolated, naturally defended mesa or inselberg situated in the middle of the Wadi Fidan. Approximately 100 m south of the northernmost point of the plateau site, Volta found the Sheshonq I scarab on the surface. There is an absence of architectural remains that date to the Iron Age at Khirbat Hamra Ifdan. However, a well-preserved Iron Age slag mound is situated in the southern aspect of the site that was probed by the UCSD team in 2007. A radiocarbon date from the 2000 excavations in Area L at the site



Figure 11.5 Rectangular seal with sheaf-shaped handle, Wadi Fidan 40, Grave 91, EDM 86873, L3050, B2983.

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confirms that Iron Age copper production activities took place at the site (2910 + 41 BP: 1192–1021 BCE with a 68.2 percent probability and 1261–995 with a 95.1 percent probability; see Levy et al. 2012:207–208), as does the technological artifacts found at the site (see Chapter 13, this volume). In an earlier publication, Levy et al. (2008) suggested that the disruption of copper production at Khirbat en-Nahas observed in the slag mound in Area M (see Chapter 2, this volume) may have been attributed to the military activities of Sheshonq I's army during their campaign in the southern Levant. This is discussed in greater detail in the conclusion below.

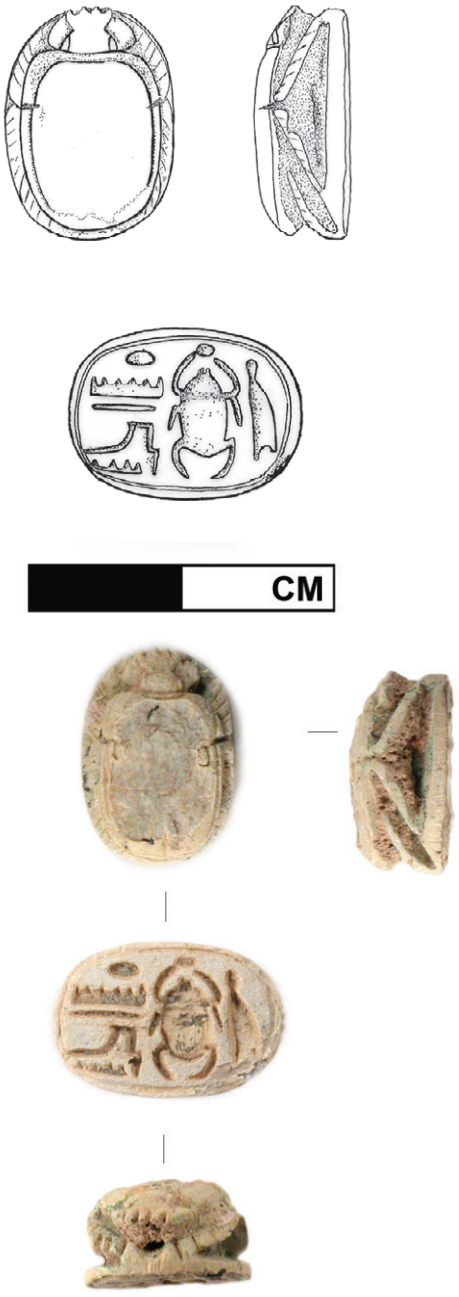

Figure 11.6 Scarab—Sheshonq I, Khirbat Hamra Ifdan, Wadi Fidan, Jordan.

Object: Scarab. *Condition*: The back is chipped and the border of the plinth slightly damaged along the right side. *Engraving*: hollowed-out and linear engraving.

Material: Enstatite. *Color*: Light brown with traces of green glaze in the recesses. *Dimensions*: 12.7 × 9.2 × *5.5 mm.

Base: The plinth is horizontally arranged and bordered by a thin line. The enclosed hieroglyphs read (from right to left): *ḥḏt* (S1; Keel 1995:§453) and *ḫpr* (L1; Keel 1995:§454) with a small *r*ʿ (N5; Keel 1995:§461) between the scarab beetle's forelegs, followed to the left by *stp* (U21) atop an *n* (N35; Keel 1995:§458); above these two signs are again a *r*ʿ, a *mn* (Y5; Keel 1995:§457) and a second *n*.

Discussion: The hieroglyphic sequence *ḥḏ-ḫpr-R*ʿ *stp.n-(J)mn-R*ʿ «bright is the manifestation of Re, chosen of Amun/Re» corresponds to the throne name of the founder of the twenty-second Egyptian dynasty, Sheshonq I (946/45–925/924 BCE; cf. von Beckerath 1997:191; see also Shortland 2005).[15] If this attribution is accepted, this is—apart from the well-known stele found in a dump at Megiddo (Fischer 1929:12–16; Kitchen 1986:299; Ritner 2009:218–219; Schipper 1999:129–132)—the second epigraphic evidence for pharaoh Sheshonq I unearthed in Cis- and Transjordan to date.[16]

Parallels: Closest to the scarab's inscription comes a museum item from Cairo: Inv.-No. CG 36297, which is featuring *ḥḏ-ḫpr-(R*ʿ*) stp.n-(J)mn-R*ʿ along with the prenomen and epithet *šš(nq) mrj Jmn-R*ʿ «Sheshonq beloved of Amun-Re» on its base (Petrie 1889:Pl. 56, 1775 = Newberry 1907:Pl. 5,36297).[17]

Dating: A production date during the reign of Sheshonq I (946/45–925/924 BCE) may be assumed.

Cat. No. 7: Scarab—Walking Sphinx or Griffin (Figure 11.7)

Registration Details and Context: Khirbat en-Nahas خربة النحاس, Season 2002, Area S, Locus 330, Basket 6974, EDM 71241. During the first large-scale excavations at Khirbat en-Nahas in 2002, a number of Egyptian amulets were discovered in a small building in Area S, situated near the center of the site. The small four-room structure (see Chapter 2, this volume) was

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dedicated to processing slag with the aim of crushing this viscous material to retrieve any copper prills left in the slag from smelting activities. Ethnoarchaeological data related to recycling procedures in association with traditional metal production are described by Levy et al. (2008:83–95). The scarab described here was found in the western site of Room 4 in the lower level fill that was sieved. It is interesting that a small building with no evidence of prestigious occupants was associated with an imported Egyptian amulet (Levy, Adams, and Muniz 2004; Levy, Najjar, van der Plicht, et al. 2005).

Object: Scarab. *Condition*: The item is very worn, and the upper third of the plinth is broken off. *Engraving*: Hollowed-out engraving. *Material*: Enstatite. *Color*: Creamy light brown. *Dimensions*: 12.9 × 9.6 × 6.6 mm.

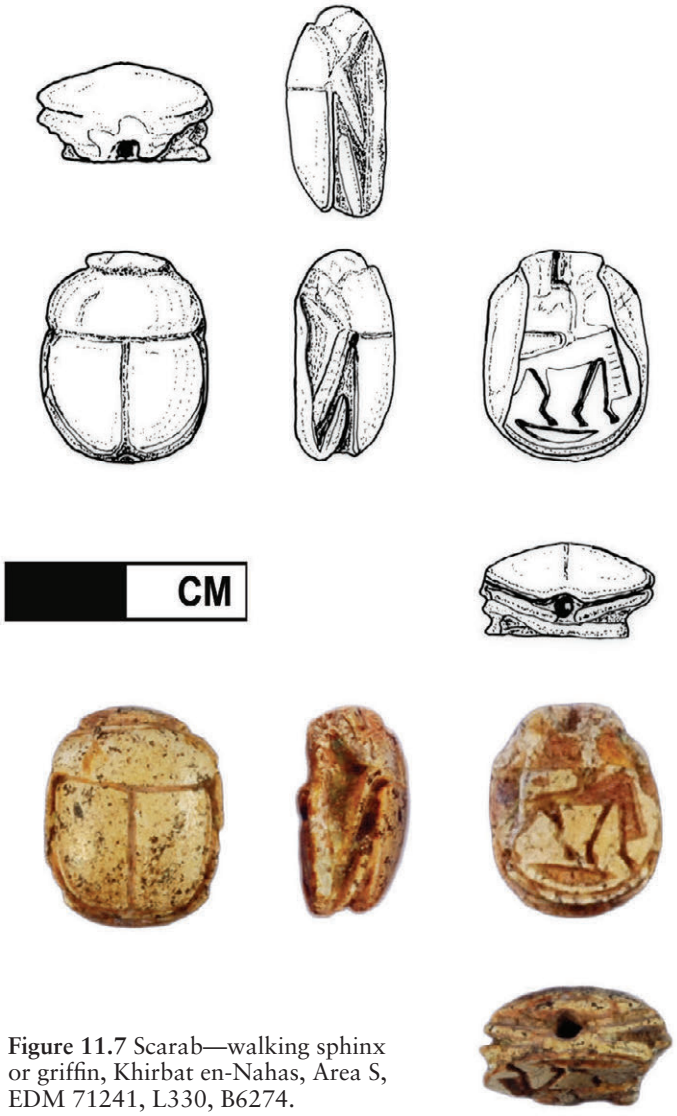

Figure 11.7 Scarab—walking sphinx or griffin, Khirbat en-Nahas, Area S, EDM 71241, L330, B6274.

Base: Sphinx or griffin[18] (Keel 1995:§543–552) dressed in a kilt striding to the right above a *nb* (V30; Keel 1995:§458) that serves as an exergue.

Discussion: Sphinxes or griffins are a common—normally horizontally arranged—motif in the Late Bronze Age iconographic repertoire (cf. Lalkin 2008:Nos. 343–403). Eggler and Keel rightly note that—if vertically arranged on a seal's base—these heraldic beasts regularly stride above an enemy stretched on the floor.[19] Furthermore, they add that the present item from Khirbat en-Nahas is stylistically closer to epigraphic seals from the Iron Age II (Eggler and Keel 2006:126 with many references; for an anepigraphic item dating to the Iron Age II, see, e.g., Achsib, Tomb 69: Keel 1997:68–69, No. 140).

Parallels: A sphinx *passant* above a *nb* is found in vertical arrangement on the base of a scarab in the British Museum (Hall 1913:97, No. 998) and on an item from the former Matouk collection in the Bible+Orient Museum in Fribourg/Switzerland (Matouk 1977:384, No. 587).[20]

Dating: Eighteenth to nineteenth Egyptian dynasty (1539/30–1190 BCE) or later.

Bibliography: (Levy, Adams, Najjar, et al. 2004:874–875) and Eggler and Keel (2006: Chirbat an-Nuhas No. 2).

Cat. No. 8: Scarab—Hunting Scene (Figure 11.8)

Registration Details and Context: Khirbat en-Nahas خربة النحاس, Season 2002, Area S, Locus 316, Basket 6438, EDM 10243. This scarab was also discovered during sieving activities carried out for Room 4 in the Area S building at Khirbat en-Nahas. Unlike the other scarab (No. 7 above), this one was found in the upper levels of the room, suggesting that the entire room was disturbed in antiquity, perhaps by the final users of this part of Khirbat en-Nahas who used the last vestiges of this building as an animal pen.

Object: Scarab; typologically belonging to Group C of the EIAMS (cf. Münger 2005:394 with examples). *Condition*: The item is worn and damaged along the right flange of the plinth. *Engraving*: Bold linear and hollowed-out engraving. *Material*: Enstatite. *Color*: Yellowish light brown with traces of yellowish golden glaze. *Dimensions*: 16.1 × 12.2 × 9.2 mm.

Base: The base is horizontally arranged with an archer standing to the right aiming toward a resting ibex (above; for the identification, cf. Keel in Keel et

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al. 1990:280–282) and a pacing lion (below). To the far right is a hardly visible standing human figure, probably facing toward the beholder.

Discussion: This hunting scene with a hunter chasing wild animals and attacking enemies[21] is a typical motif within the EIAMS iconographic repertoire (motif group HS2a; cf. Münger 2011:137 with parallels from Egypt and Greater Syria in notes xvii and xviii), whose origins go back to the Ramesside iconography of the nineteenth and twentieth Egyptian dynasties (ca. 1292–1070/1069 BCE; for an outline of the long tradition of this motif, cf. Keel in Keel et al. 1990:288–291 with Figure 0130).

Parallels: Nearly identical items have been found in the southern Levant in contexts such as Beth Shean, Lower V (Keel 2010a:128–129, No. 66) and Tell el-Far'ah South, Tombs 133 and 506 (Keel 2010b:120–121, No. 216 and 136–137, No. 250). One item has been found on the surface at °Tell el-Fukhar (Acco): Keel (1997:560–561, No. 87); see also *Tell el-Far'ah South (Keel 2010b:190–191, No. 378) *Gezer (Münger 2011:165) (catalogue entry Gezer 3 [previously unpublished]), and *Tell Jemmeh (Münger 2005:Pl. 23.7,40).

Dating: Around 960–900/880 BCE (see Cat. No. 1, above).

Bibliography: Levy et al. (Levy, Adams, Najjar, et al. 2004:874–875); Eggler and Keel (2006: Chirbat an-Nuhas No. 1); Levy and Najjar (2006:35); Levy et al. (2007:20–21 with Fig. 5); and Münger (2011:173 [catalogue entry Khirbat en-Nahas 1] with Pl. 47,1).

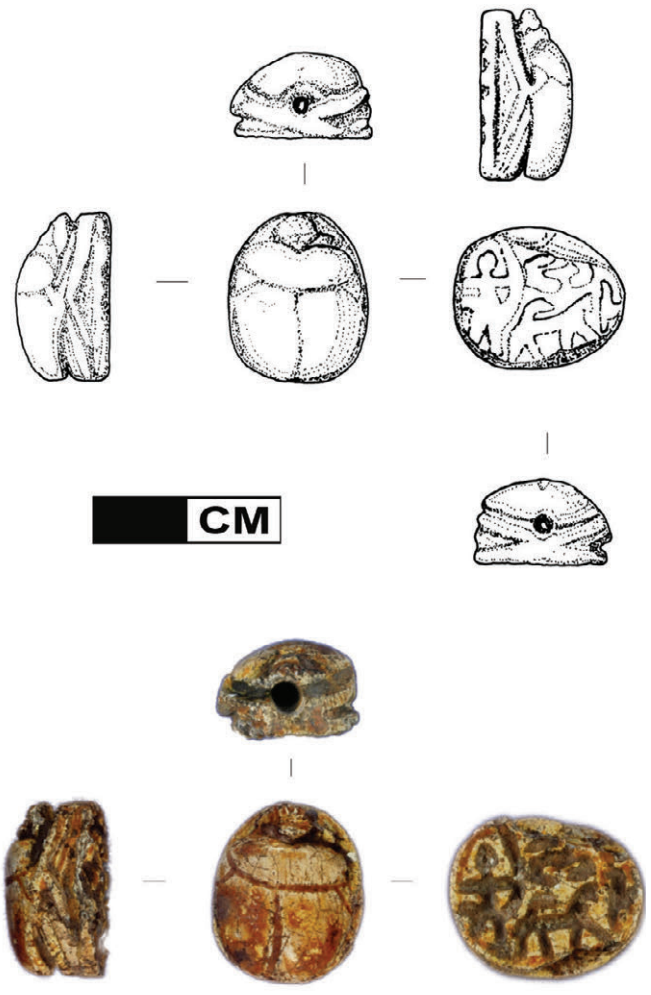

Figure 11.8 Scarab—hunting scene, Khirbat en-Nahas, Area S, EDM 10243, L316, B6438.

Cat. No. 9: Aegis Amulet (Figure 11.9)

Registration Details and Context: Khirbat en-Nahas خربة النحاس, Season 2006, Area M, Locus 635, Basket 9306, EDM 90464. The aegis amulet was found in Room 1 located in Area M at Khirbat en-Nahas. The room is part of four-room building complex constructed at the end of the tenth to the beginning of the ninth century BCE. A series of four rooms surround a courtyard (labeled "Room 3" in Figure 2.66). Room 1 is located in the most southerly aspect of the building complex. The fourth room was not excavated and is embedded in the eastern section of the Area M excavation. During the course of the excavation, Room 1 was dismantled so that excavations could be carried out to virgin soil in the area. The aegis amulet described below was found embedded in a beaten earth floor in Layer M2b along with many date seeds. One date seed was analyzed with radiocarbon dating, which yielded a date of 1020 to 911 BCE (2 sigma; Table 2.9 in Chapter 2, this volume).

Object: Aegis (amulet with broad collar, usually with a lion's head identifying the figure as Bastet or Sachmet); compare with Petrie (1914:42 with Pl. 35.195a–n) and Herrmann (1994:188–196, 219–222). The object is very worn. A high, possibly two-storied "hat" with a "button-shaped" top (usually interpreted as a double crown) is visible. The facial features are not visible anymore. The coiffure is barely traceable. It might be a wig with two braids. The broad collar—originally decorated with rows of small globules[2] and possibly other geometric motifs (representing pendants and beads)—is most characteristic for this type of amulet. *Measurements*: 2.8 cm (H) × 2.0 cm (max. W). This is slightly larger than the average size of such amulets.

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Material and Production Technique: According to the literature, the material used is usually composition (for a definition of the various types, see Keel 1995:§392–402 and, more specifically, regarding amulets and including manufacturing technology, see Herrmann 1994:26–28, 2006:3–5). Amulets of this kind are generally made in a mold (cf., e.g., the model depicted in Herrmann 1985:No. 140).

Parallels: Comparanda come from contexts dating to the Iron Age IB through Iron Age IIB, including Tel el-Far'a South, Tomb 201 (Petrie 1930:Pl. 36,201 and Pl. 41,259 = Herrmann 1994:No. 173). Herrmann dates the item to the Iron Age IB (because of its porous material, the plain and unworked back, and for the reason that the drill-hole pierces the object itself, i.e., there is no suspension device; see also Herrmann's [1994] dating criteria on pp. 34–35). The find context is problematic, since the item comes from a mostly unstratified common grave with at least 122 individuals (Petrie 1930:11–13, Pls. 40–41.67; see also the overview in Laemmel 2003:48–49). *Gezer: Macalister (1912:332 with Pl. 210,56 = Herrmann 1994:No. 176). Herrmann dates the item to the Iron Age IIA at the latest. Megiddo, Stratum V (Lamon and Shipton 1939:Pl. 74,23 = Herrmann 1994:No. 175). The item was found together with a fragment of the same type of amulet (Lamon and Shipton 1939:Pl. 74,22 = Hermann 1994:No. 182). Unfortunately, from paved room L318 (in which the two items were found), nothing besides a bead (Lamon and Shipton 1939:Pl. 90,37) was published. The locus, however, seems to be well embedded into Stratum VA-IVB architecture (Lamon and Shipton 1939:Figure 6). Herrmann (1994:220) forgoes to date the two items. °Megiddo: Herrmann (1994:No. 178). This, according to Herrmann, is an Iron Age IIB specimen, since it is made of a solid composition material and the suspension device is constructed as a discrete element; *Megiddo:

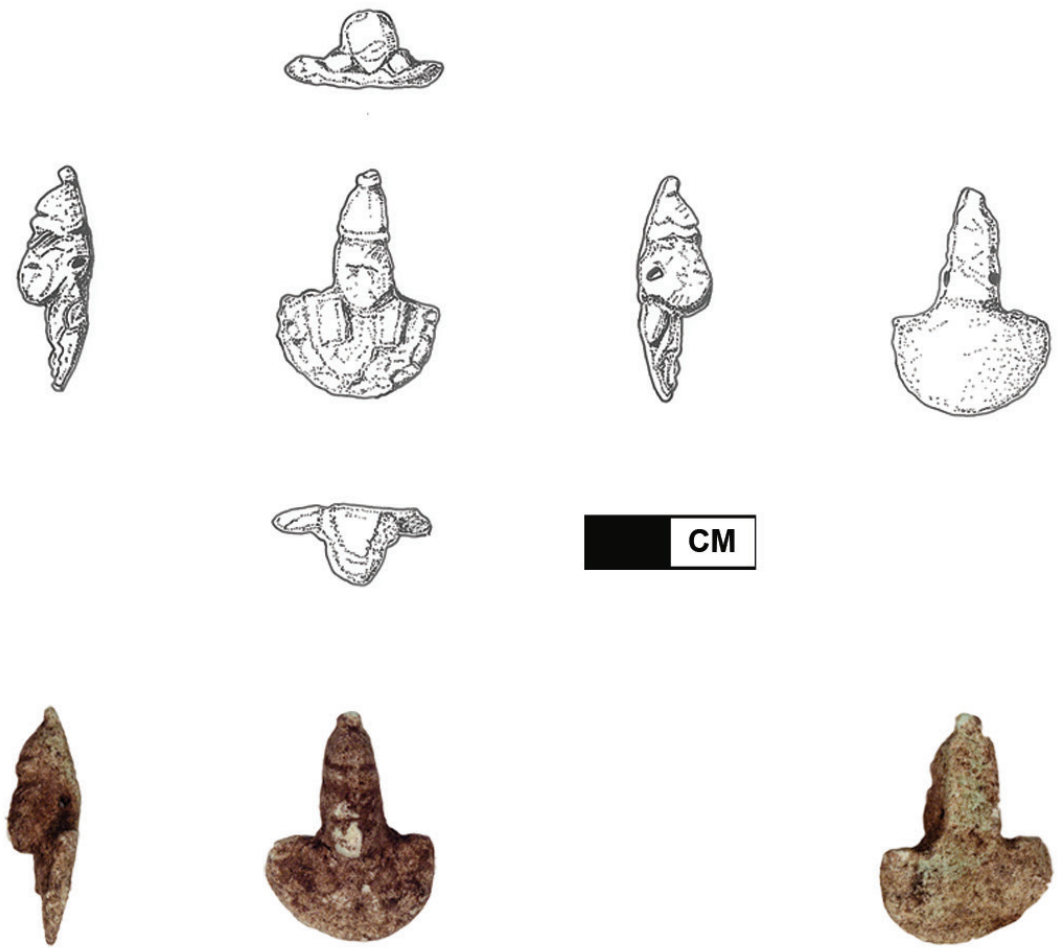

Figure 11.9 Aegis amulet, Khirbat en-Nahas, Area M, EDM 90464, L631, B9306.

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Lamon and Shipton (1939:Pl. 74,28 = Herrmann 1994:No. 174). Herrmann could not date the amulet more precisely than to the Iron Age IB to IIB.[22]

Three unfortunately unprovenanced objects, kept in the Bible+Orient Museum at Fribourg/Switzerland, are very similar in style to the item discussed here. They were published by Herrmann in 2003 as catalogue Nos. 213 to 215 and dated by him to the New Kingdom (1550–1070/69 BCE). These human-faced specimens are identified by Herrmann (2003:12) as representing the Egyptian goddess Mut.

Date: Petrie (1914) dated such objects to the twenty-second to twenty-fifth Egyptian dynasty (946/45—ca. 655 BCE). The dates attributed by Herrmann (1994) to this type of amulet range from the Iron Age I to the Iron Age IIB. However, given how the amulet was suspended and because the material used is rather porous, it is likely that, based on the aforementioned parallels, the amulet was produced sometime during the Iron Age IB or IIA.

Cat. No. 10: Scarab—Striding Animal (Figure 11.10)

Registration Details and Context: Khirbat en-Nahas خربة النحاس , Season 2006, Area M, Locus 707, Basket 10118, EDM 91464. The "striding animal" scarab was found in Area M, also in the area of the four-room building. The locus (L707, Layer M2a) where this amulet was found was also dated with a date seed to 970 to 838 BCE (see Table 2.9 in Chapter 2, this volume). Found at a higher elevation than the aegis amulet (No. 9, above) on a metallurgical working layer, there seems little doubt that this object was in use (worn as an ornament or as a seal) when Room 1 was occupied. The four-room building was closely linked to smelting activities carried out in Area M. This is evidenced by the continuous buildup of slag on the outside of the building, so much so that the doorway from Room 1 to the courtyard was intentionally blocked, suggesting that when metal production was carried out at an intensified scale, this room could no longer be occupied due to the extreme heat.

Object: Scarab; typologically belonging to Group B of the EIAMS (cf. Münger 2005:394 with examples; see also Cat. No. 1, above). *Condition*: Heavily worn; the plinth is damaged on the right-hand side. *Engraving*: Hollowed-out and bold linear engraving. *Material*: Enstatite. *Color*: Spotted reddish yellow. *Dimensions*: 13.1 × 10.6 × 7.1 mm.

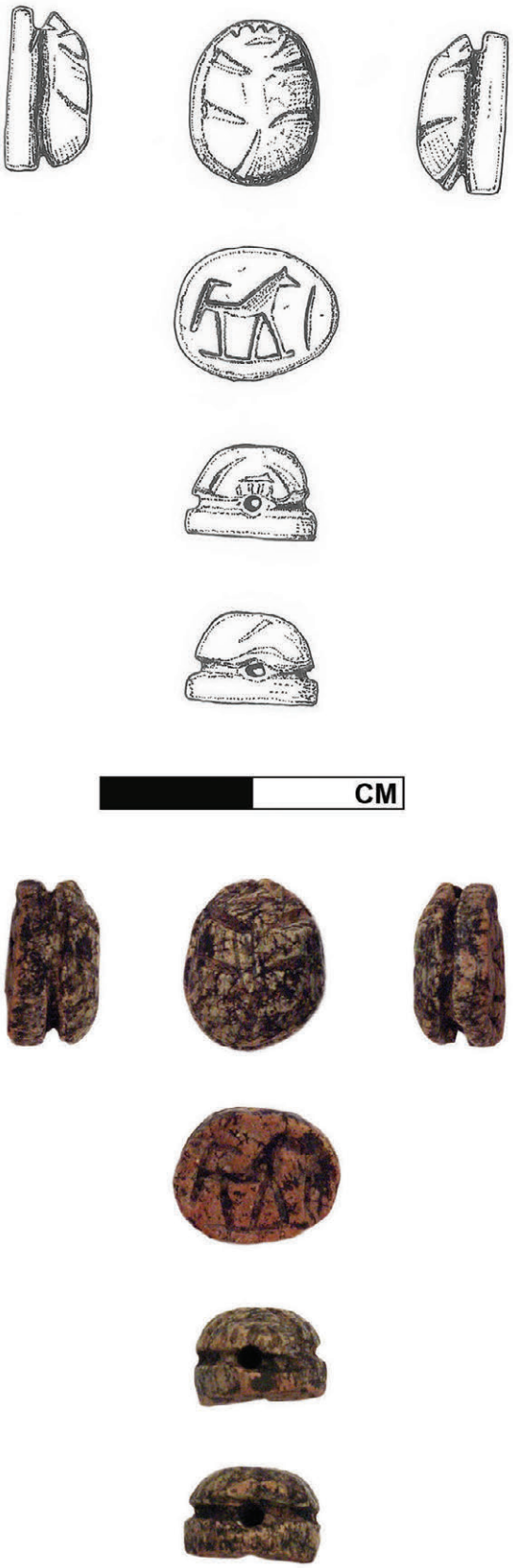

Figure 11.10 Scarab—striding animal, Khirbat en-Nahas, Area M, EDM 91464, L707, B10118.

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Base: The horizontally arranged plinth displays a quadruped with a raised and bent tail prancing on a vertical baseline to the right. In front of it is a vertical element.

Discussion: Striding animals like the one on the seal from Khirbat en-Nahas are usually interpreted as lions.[23] Lions appear as the main motif on scarab bases already in the MB IIA and continue to be an important motif until the Persian period (Keel 1995:§536–537 and references therein). The graphic style of the lion on this Khirbat en-Nahas scarab, however, is very typical for the EIAMS, where it is one of the main iconemes in the following motif groups: single lion striding to the right, lion walking over a human figure stretched out on the ground, or one or two lions (one atop the other) hunting prey and—in turn—being targeted by a human in various hunting scenes (Münger 2005:395 with Pl. 23.6 and 23.7 and 2011:137–139 with many references to parallels in Egypt, the Mediterranean, and Greater Syria).[24] The vertical line to the right of the animal should be interpreted as a floral element or a branch. This is quite often the sole secondary element in single striding lion scenes beginning in the Middle and Late Bronze Age (Keel 1995:§537; see also Münger 2011:138 motif groups LS1a–c).

Parallels: Single striding lions (often accompanied by a branch) occur in the EIAMS assemblage of the southern Levant well over 20 times.[25] Well-stratified parallels were retrieved, for example, at Achzib, Tomb ZR1 (Keel 1997:26–27, No. 15 = Münger 2011: Achzib 1); Beth Shemesh, Tomb 1 (Keel 2010b:222–223, No. 12 = Münger 2011: Beth Šemeš 2); Tel Gerisa, Iron Age IIA context (Giveon 1988:68–69, No. 73 = Münger 2011: Tel Gerisa 2); and Tell es-Sa'idiyeh, Tomb 65 (see Eggler and Keel 2006:374–375, No. 18 and Münger 2011: Tell es-Sa'idiyeh 9).

Dating: Around 960 to 900/880 BCE (see Cat. No. 1, above).

Bibliography: Levy et al. (2008:16462 and supporting information [SI] Fig. S1) and Münger (2011:173 [catalogue entry Khirbet en-Nahas 2] with Pl. 47,2).

Cat. No. 11: Scarab—Flanking Red Crowns (Figure 11.11)

Registration Details and Context: Khirbat en-Nahas خربة النحاس, Season 2009, Area R, Locus R09L053, Basket R09B0380, EDM R09F0475. The "flanking red crowns" scarab was found in the monumental building in Area R at Khirbat en-Nahas. The structure is the second largest building at the site (the fortress gatehouse is slightly larger). Situated in the center of the site, this tenth-century BCE building was contemporary with the fortress and probably served as an elite residence at Khirbat en-Nahas. As described in Chapter 2 (this volume), like many of the buildings at the site, the Area R building has rooms built around a central courtyard. One of these six rooms (the northwest one) contains a large stairwell that leads to a second floor. The presence of a "throne" or dais attached to the exterior of building, surrounded by a courtyard, along with numerous iron, ceramic, and trade items, points to the elite nature of this structure.

Object: Scarab; the simple back with the elytra indicated by single lines, the minimalist design of the head and the basic rendering of the legs point to a Late Bronze or even later date. *Condition*: Slightly chipped along the border of the plinth. *Engraving*: Crude linear and hollowed-out engraving. *Material*: Enstatite. *Color*: Creamy brown. *Dimensions*: 16.3 × 11.6 × 7.9 mm.

Base: The plinth—with a framing line—is horizontally arranged and graphically separated into three vertical "panels": two schematically engraved red crowns (*dšrt*; S3; Keel 1995:§452) are facing to the outside. In the

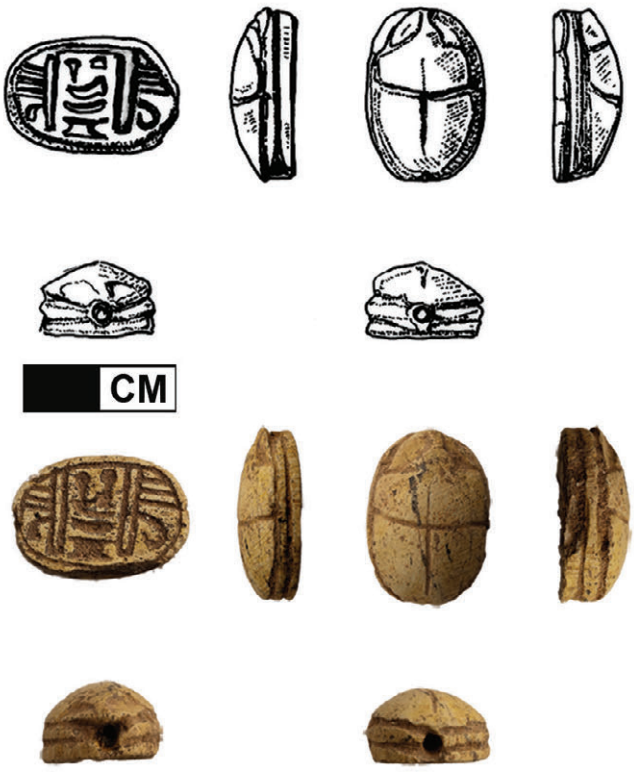

Figure 11.11 Scarab—flanking red crowns, Khirbat en-Nahas, EDM R09F0475, LR09L053, BR09B0380.

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center of the plinth are five almost undecipherable hieroglyphs in a row. They are (from top to bottom): *mrj* (N36; Keel 1995:§457), *t* (X1; Keel 1995:§ 463), *n* (N35; Keel 1995:§458), and *nṯr nfr* (R8 and F35; Keel 1995:§460 and 459).

Discussion: Similarly arranged addorsed red crowns flanking hieroglyphs are frequent during the Middle[26] and the Late Bronze Age.[27] The concept, however, reappears during the twenty-second Egyptian dynasty on very similarly executed scarabs, which are—like the present item—engraved in an archaizing linear style (cf., e.g., °Beth Shean: Keel 2010b:180–181, No. 187; see also *Tell Jemmeh: Petrie 1928:Pl. 19,10).[28]

As for the hieroglyphs in the central panel, one may cautiously propose the reading *mrj.t-n-nṯr-nfr* «beloved by the good god» (note that in this case, the original owner would have been a woman due to the feminine determinative).

A graphically comparable arrangement of the plinth—but with completely different signs—is, for example, an also stylistically analogous item from Tell el-Far'ah South, Tomb 936 (Keel 2010b:328–329, No. 702) (with the name of the god Ptah).

Parallels: Identically stylized red crowns, also with three vertical strokes but flanking a solitary *nfr* can be seen on an item from *Ashkelon (Keel 1997:722–723, No. 87),[29] which is in all aspects (including the shape of the amulet itself) very similar to the present item from Khirbat en-Nahas and dated by Keel to the twenty-second Egyptian dynasty (i.e., 946/945—ca. 735 BCE).

Dating: Due to the lack of well-stratified parallels, only a broad time frame can be proposed, that is, nineteenth to twenty-second Egyptian dynasties (1292–713 BCE), with a tendency toward the tenth and ninth centuries BCE.

Cat. No. 12: Scarab—Winged Sun Disks (Figure 11.12)

Registration Details and Context: Khirbat en-Nahas خربة النحاس, Season 2009, Area R, Locus R09L101, Basket R09B1308, EDM R09F1635. The scarab with "winged sun disks" is the second Egyptian scarab found in the Area R building. It was discovered in sediments between the entrances to Rooms 5 and 8, while sieving. A tiny chalk votive vessel was found in Room 5. There was also a paucity of artifacts in Room 8, but it was associated with a well-crafted stone lintel. This scarab may be more securely dated by a suite of radiocarbon dates from inside the building (Table 2.19). A full discussion of the radiocarbon analysis is presented in Chapter 2 (this volume). Taking into consideration the problem of old wood, when the six calibrated radiocarbon dates are modeled with Bayesian analyses, the start date is between 1157 and 933 BCE (66.6 percent probability). While the winged sun disk scarabs range in date throughout the twenty-second Egyptian dynasty (946/945—ca. 735 BCE), the radiocarbon dating evidence helps place the sample described here more securely in the mid-tenth century BCE. These remarks apply equally to Cat. No. 11 described above.

Object: Scarab. *Condition*: Worn; the plinth is partly damaged. *Engraving*: Linear and hollowed-out engraving. *Material*: Enstatite. *Color*: Yellowish brown with green glaze in the recesses. *Dimensions*: 14.5 × 10.8 × 5.9 mm.

Base: Two confronted schematized winged sun disks (Keel 1995:§450)—each with two uraei hanging down—flanking an oval inscribed with *mn-ḫpr-r'*, the throne name of Thutmose III (1479–1425 BCE; cf. Keel 1995:§634.650.663).

Discussion: The well-known motif on the scarab's base (Jaeger 1982:§346) is one of the many examples of posthumous veneration of the legendary Egyptian pharaoh of the eighteenth dynasty.



Figure 11.12 Scarab—winged sun disks, Khirbat en-Nahas, Area R, EDM R09F1635, LR09L101, BR09B1308.

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Parallels: The following items from the southern Levant feature the same base engraving: °Tell el-Fukhar (Acco) (Keel 1997:548–549, Nos. 51 and 52); Ashdod, Byzantine refuse pit (Keel 1997:686–687, No. 66); Beth Shean (Keel 2010a:180–181, No. 187); Tel Ḥalif, Iron Age II burial cave (Giveon in Biran and Gophna 1970:168 Pl. 38C (1)); and *Samaria (Reisner et al. 1924:Pl. 56,e3).

Dating: Twenty-second Egyptian dynasty (946/945—ca. 735 BCE).

Cat. No. 13: Scarab—Standing Falcon with "Ankh Sign" (Figure 11.13)

Registration Details and Context: Khirbat en-Nahas خربة النحاس, Season 2009, Area W, Locus W09L098, Basket W09B0522, EDM W09F0875. Four Egyptian amulets were found in Area W, located in the southernmost occupation area at Khirbat en-Nahas. Area W consists of three room complexes comprising a total of 18 rooms (see Chapter 2, this volume). A variety of activities took place in these building complexes, including storage, ritual, and domestic. The scarab with "standing falcon with ankh sign" was found while sieving material from L98, a Stratum W1b locus in Courtyard 1 of Area W. Stratum W1b was identified as a "post-abandonment" phase, just beneath topsoil and wall collapse, primarily representing sporadic reuse in the Classical, Late Antique, or Islamic period. This locus in particular seems to contain fairly mixed material, including pottery (Iron Age bowl, BL35 Type 2) that has been identified as being potentially tenth century (see Chapter 4, this volume). Thus, this scarab seems to be in this locus as a result of post–Iron Age mixing of material from the earlier, stratified Iron Age deposits in this area.

Object: Scarab. *Condition*: The abraded plinth is especially damaged along the ridge; the back is partially chipped off. *Engraving*: Linear and hollowed-out engraving. *Material*: Enstatite. *Color*: Yellowish brown. *Dimensions*: 17.3 × 12.9 × *6.2 mm.

Base: The plinth is horizontally arranged and bordered by an only partially preserved line. It is dominated by a falcon (G6; Keel 1995:§442.450.556) facing to the right. To its right is a quite elaborately engraved *ʿnḫ*, the symbol of life (S34; Keel 1995:§449). Above the falcon's back is a short inscription with a *ḏ* (I10)—a wriggling cobra partly framing the other signs—and a *t* (X1; Keel 1995:§463). Below the *t* is a short horizontal line (a *nb*[?]), followed by a *rʿ* (N5; Keel 1995:§461) with three determinative strokes (Z2). At the bottom might be a *nb* (Keel 1995:§458).

Discussion: An ankh sign in front of a standing falcon is not unusual on Late Bronze Age scarabs (but the elements above its back differ and do not normally follow a standard iconographic pattern).[30]

Parallels: A very close parallel was found on the surface of °Tell el-Fukhar (Acco) (Keel 1997:552–553, No. 66; see parallels from Egypt and museum collections there). It features (although vertically arranged) most of the iconographic elements mentioned above, and the base can similarly be read as «Re-Harachte, who lives eternally, my Lord». This may be a later variant of the original epithet *dj ʿnḫ ḏt* (D37, I10, S34), meaning «gifted of life in eternity», which is also found on Late Bronze Age items from *Tell el-ʿAjjul (Keel 1997:No. 202) (together with the throne name of Amenophis II, 1428–1397 BCE) and Lachish, Fosse Temple (Tufnell et al. 1940:Pl. 32A/B,3) (together with the throne name of Amenophis III, 1388–1351 BCE); Tomb 4004 (Tufnell 1958:Pl. 37/38,284); and another one found on the surface (Keel 2004:No. 24) (both together with the throne name of Thutmose IV, 1497–1388 BCE).[31]

Dating: In view of the scarab type, the engraving style, and the aforementioned parallels, the item should be



Figure 11.13 Scarab—Standing Falcon with ankh-sign, Khirbat en-Nahas, Area W, W09F0875, LW09L098, BW09B0522.

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dated to the Ramesside period, that is, the nineteenth and twentieth Egyptian dynasties (ca. 1292–1070/1069 BCE).

Cat. No. 14: Pataikos (Figure 11.14)

Registration Details and Context: Khirbat en-Nahas خربة النحاس, Season 2009, Area W, Locus W09L124, Basket W09B1045, EDM W09F1370. The Pataikos amulet described below was found in Structure 2, Room 8. In nearby Room 7, a large standing stone was erected in the middle of two large pillars (see Chapter 2, this volume), suggesting ritual space was created here. The Pataikos was found in the upper levels of Room 8 in a W2AI fill. In addition to this amulet, beads and a pithos (type 5) storage vessel was found here (see Chapter 5, this volume, for a discussion of the ceramics).

Object: Torso of a three-dimensionally modeled pataikos (see, e.g., Arav and Bernett 1997 for an overview on this type of amulet). The well-fed naked figure has a short penis; the arms are resting on the belly. *Measurements*: *1.6 (H) × 1.1 (max. W) × 0.8 cm (max. D).

Material and Production Technique: Whitish composition; coated with light bluish green glaze; mold-made (see also Cat. No. 9, above).

Parallels: A very similar pataikos has been unearthed at Tel Dalhamiya in an Iron Age II context (Herrmann 2006:No. 164), which is dated by Herrmann (2006:129) to the Iron Age IIB.

Date: On the basis of the parallel from Tel Dalhamiya, an Iron Age IIB date is suggested.

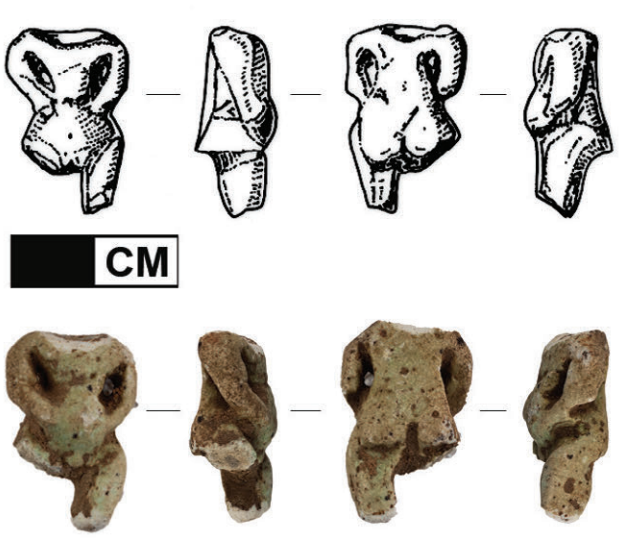

Figure 11.14 Pataikos, figurine Khirbat en-Nahas, Area W, EDM W09F1370, LW09L124, BW09B1045.



Figure 11.15 Cowroid², Khirbat en-Nahas, Area W, EDM W09F1837, LW09L178, BW09B1472.

Cat. No. 15: Cowroid² (Figure 11.15)

Registration Details and Context: Khirbat en-Nahas خربة النحاس, Season 2009, Area W, Locus W09L178, Basket W09B1472, EDM W09F1837. The third Egyptian amulet found in Area W is a broken cowroid. It was found in the courtyard of Structure 2, where Room 8 borders its northern side. This structure has been interpreted as having had some ritual function (see Chapter 2, this volume).

Object: Cowroid², that is, a Egyptian seal type imitating a cowrie shell (type I; Keel 1995:§184–188).

Condition: The stamp-seal amulet is broken along the drilling, and less than 50 percent of the original item is preserved. *Engraving*: Bold linear engraving.

Material: Enstatite (field ID). *Color*: Medium brown with reddish brown coating (field ID). *Dimensions*: 14.4 × *5.6 × 6.4 mm.

Base: The base is undecipherable. However, it should be noted that cowroids were—due to their resemblance to female genitalia—symbolically connected to female fertility (Keel 1995:§184).

Dating: According to the proportions of the presumed seal type, a Late Bronze Age date is suggested (ca. 1500–1300 BCE).

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Cat. No. 16: Scarab (Figure 11.16)

Registration Details and Context: Khirbat en-Nahas خربة النحاس, Season 2009, Area W, Locus W09L187, Basket W09B1860, EDM W09F2254. The fourth Egyptian amulet from Area W is a chipped scarab found in Room 13 of Structure 3—the most western complex. It was found in a W2AI fill along with Midianite ware, a bowl, jug, and krater (see Chapter 5, for ceramic discussion). The location of this room near other domestic facilities suggests that the Structure 3 complex was a residence. The fact that four Egyptian amulet imports were found in Area W suggests that the residents were more than simple workers at the site and retained some higher social status.

Object: Scarab. *Condition*: The back has several large chips, and the base is damaged along the right edge of the plinth; worn. *Engraving*: Bold linear and hollowed-out engraving. *Material*: Enstatite. *Color*: Light to medium brown. *Dimensions*: 16.3 × 11.6 × 7.9 mm.

Base: The plinth is vertically arranged. It displays in the lower part two antithetic uraei (Keel 1995:§522–523) flanking a *ḏd*-pillar (Keel 1995:§451). The upper part of the plinth is engraved with a lying lion (Keel 1995:§536–537) facing to the right; above its back is a roundish/oval element (*r* ᶜ?N5; Keel 1995:§461) and a vertical stroke (*n*?; N35; Keel 1995:§458).

Discussion: The combination of *ḏd*-pillar flanked by two uraei as the sole motif is found on an early New Kingdom item at Lachish, Fosse Temple (Tufnell et al. 1940:Pl. 32,23) and combined with *mn-ḫpr-r*ᶜ, the throne name of Thutmose III (1479–1425 BCE), at *Gurob (Brunton and Engelbach 1927:Pl. 25,25) (see also an item kept at Cairo: Newberry 1907:Pl. 2,36108) and Gezer, Tomb 56 (= Strata XVII-XIV, cf. Dever 1974:4) (Macalister 1912:Pl. 80,26), which are equally dated to the eighteenth Egyptian dynasty (cf. Jaeger 1982:§1001–1003). In combination with other signs, the motif group is found, for example, on later items dated to the nineteenth Egyptian dynasty from Tell el-Farᶜah South, Tomb 981 (Keel 2010b:348–349, No. 756) (combined with a bark and a moon sign above; see also another item from this site with unknown context, which is combined with a Tilapia fish: Keel 2010b:376–377, No. 824); °Shiloh (Brandl 1993b:215, No. 13) (combined with a winged sun disk and an *mn*); and Tell es-Saᶜidiyeh, Tomb 240 (Eggler and Keel 2006:376–377, No. 22) (combined with two *nb*).

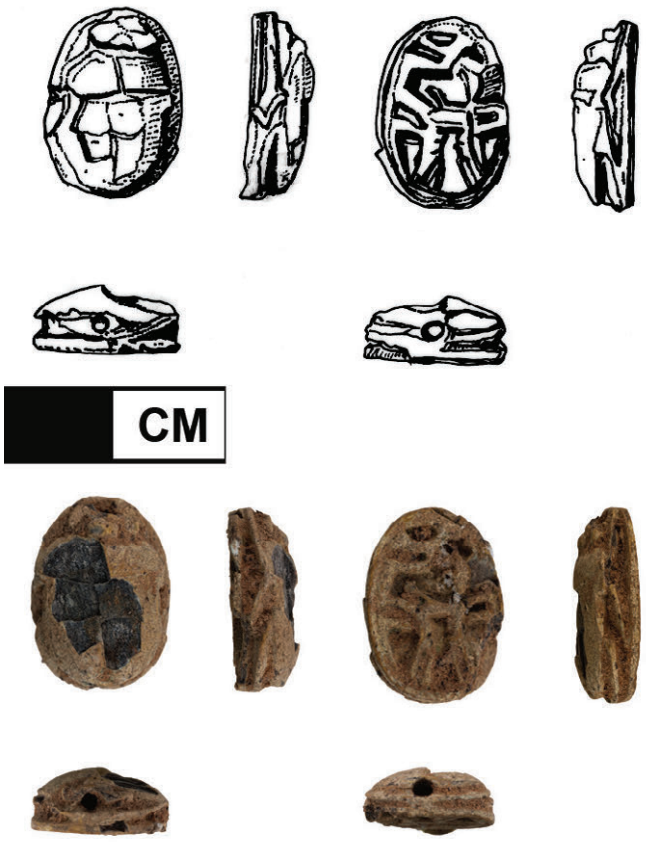

Figure 11.16 Scarab, Khirbat en-Nahas, EDM W09F2254, LW09L187, BW09B1860.

The reclining lion[32] in combination with *nb* and *r*ᶜ is, for example, found on a Late Bronze Age item found at °Tell el-Fukhar (Acco) (Keel 1997:558–559, No. 78) (with further parallels; see also Tell el-Farᶜah South, Tomb 984: Keel 2010b:372–373 and 408–409, No. 909, for an item without context). Lion, *nb*, and sun disk can be read as the divine name Amun-Rᶜ (Jaeger 1982:294, note 218; Keel 1995:§642–443).

Parallels: No exact parallels could be found, but see above for comparable base engravings.

Dating: Nineteenth to twentieth Egyptian dynasties (1292–1070/69 BCE).

Conclusions

The small assemblage of Egyptian amulets found at four different Iron Age sites investigated by the UCSD-DOAJ ELRAP team provides a small but important window on the nature of Egyptian–Edom interaction during this period. All but one of these finds came from stratified excavations. The exception is actually the most important Egyptian discovery made to date in

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southern Jordan and perhaps in the southern Levant for the Third Intermediate period. This is a scarab bearing the name of Shoshonq I found on the surface of the mostly Early Bronze III to IV copper production site of Khirbat Hamra Ifdan. As noted above, while there is no evidence of Iron Age buildings at the site, there are important remains of tenth-century BCE copper smelting activities (Ben-Yosef et al. 2010; Levy et al. 2012). The disruption of metallurgical activities at Khirbat en-Nahas recorded in a deep sounding at one of the slag mounds at the site was attributed by Levy et al. (2008) to agents from the Shoshenq I campaign in the southern Levant, around 925 BCE. According to Kitchen (2003:470), a "flying column" from Shoshenq I's forces made their way across the northern Negev, to the south end of the Dead Sea and south through the Wadi Arabah. The "gateway" to the Faynan copper ore region from the west is through the Wadi Fidan, which cuts through the Jabal Hamrat Fidan where Khirbat Hamra Ifdan (KHI) is situated. It is possible that someone carrying the Shoshenq I scarab seal dropped it at the site during this march.

About 1 km to the north of KHI, the Iron Age cemetery of Wadi Fidan 40 is situated. Here two Egyptian amulets were found that attest to social interaction between the nomadic population buried there and Egypt from the Middle Bronze IIB through the Iron IIB periods. The earliest stamp-seal amulet in the present assemblage dates to the early MB IIB period and was found in an Iron Age tomb at Wadi Fidan Cemetery 40 (Cat. No. 4). It may be considered an heirloom or an indicator for later import of Egyptian goods, indicating exchange between the local population and Egypt, perhaps reaching back many centuries before its final deposition at this burial place.

However, the bulk of amulets date to the close of the Iron Age I and the beginning of the Iron Age IIA (Cat. Nos. 2, 5–6, and 8–12). Other items that belong to the immediate preceding period complement this evidence, which is the norm (Cat Nos. 3, 7, 13, and 15–16).[33] Only one item may be chronologically positioned in the Iron Age IIB (Cat. No. 14); later seal and amulet types are missing. This not only reflects a peak of activity during the Iron Age I and the Iron Age IIA in the area but also indicates intensive contacts between, for example, the copper production center at Khirbat en-Nahas, where most of the material comes from (n = 10), and the Egyptian realm. These links are especially well illustrated by the presence of items belonging to the EIAMS, which were most probably produced during the reigns of pharaohs Siamun and Sheshonq I and somewhat thereafter (ca. 980–900 BCE) in the Eastern Delta in Lower Egypt (Münger 2003, 2005) and are further corroborated by the presence of typical Egyptian amulet types like an aegis (Cat. No. 9) found well embedded in a context relating to melting processes at Khirbat en-Nahas.

Some Egyptian involvement in the mining activities in the Faynan region during the middle years of the tenth century BCE may further be cautiously claimed on the basis of the highly important find of a scarab bearing the throne name Sheshonq I (946/45–925/924 BCE). Although found on the surface of Khirbat Hamra Ifdan, where Iron Age IIA smelting activities did take place (Levy et al. 2012; see Chapter 13, this volume), it nevertheless provides the second material reference ever found in Cis- and Transjordan to this pharaoh, well known from Egyptian sources (Jansen-Winkeln 2007:1–37; Ritner 2009:173–228) and biblical texts (1 Kings 11:40, 14:25–26 and 2 Chronicles 12:2–9). The first came from the University of Chicago's excavations at Megiddo, where part of a monumental stele was found bearing Sheshonq I's birth and throne name (Fischer 1929:12–16). At this point in our research, it is difficult to clarify the exact nature of Egyptian involvement in tenth-century BCE mining and metallurgy activities in Faynan. However, this find and others from the Third Intermediate period add weight to the earlier suggestion that metal production was disrupted by Sheshonq I's forces at Khirbat en-Nahas (see Levy et al. 2008:16465) and that they were present in the Faynan region for some period. What exactly happened in sociopolitical terms after copper production was disrupted in the early tenth century BCE remains an open question.

Acknowledgments

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Notes

1 The head type of Group B corresponds to Type E2 of Eggler and Keel (2006:XVI).

2 Enstatite denominates steatite—a silicate mineral that is foreign to the southern Levant—transformed and considerably hardened through heat (Keel 1995:§383–390).

3 The horizontal line does not form a perpendicular angle with the vertical stroke to the right, like, for example, on an item allegedly found at *Tel Deir el-Balaḫ (Keel 2010a:438–439, No. 95); for an explanation of this phenomenon, see Keel (2010a:418, No. 43).

4 To the best of this writer's knowledge, *ḥ'(j)* never occurs together with the written name of Amun on scarab bases, even if it is strongly connected to the sun god (Hornung and Staehelin 1976:169).

5 Compare with Münger (2011:137) with additional examples from Egypt in note ix and catalogue entries °Acco [Tell el-Fukhar] 24, el-Aḫwat 1 [main phase], °Aphek 3, Aškelon 5–6 [Iron Age II contexts], Dor 4 and 6 [local strata G-7a and G-6/5], Tell el-Far'ah (S) 20 and 22 [Tombs 210 and 510], and °Megiddo 21.

6 Note that it could also be a secondary *mn*.

7 Note that at least one *r'* would be expected at this position.

8 Note that the objections of Singer-Avitz (2008:76–77) toward the dating of the Kadesh Barnea seals lack any sound basis and are the result of a truncated rendering of citations; see also (Münger 2009:124, note 40).

9 Furthermore, a similar composition with a uraeus flanked by two *nfr* is, for example, found on the lower part of the plinth of a scarab unearthed at Tell el-'Ajjul, Tomb 1410B (Keel 1997:206–207, No. 309) (in the upper part of the plinth, a red crown is flanked by two *m3't* feathers; for a comparable iconography see also Tell el-Far'ah South, Tomb 574: Keel 2010b:104–105, No. 176).

10 Listed by Petrie as coming from Tomb 504; for a correction of this attribution, see Braunstein (1998:506).

11 An equally "rectangular piece with a sheaf shaped handle" bearing a somewhat similar base engraving is Basel: von Bissing collection (Hornung and Staehelin 1976:No. 588).

12 For a dismissal of hitherto proposed readings of Pharaonic names on such seals' bases, compare with Jaeger (1982:§1048) and Keel (1995:§212).

13 For a critique of the early dating of the Early Iron Age cemeteries and the corresponding Stratum XII at Tell es-Sa'idiyeh, compare with Münger (2003:75 with further references). An item from Megiddo (Loud 1948:146 with Pl. 162,9) was associated by its excavators with Stratum VII. Yet, they did not rule out a somewhat later date of the find spot. For another outlier from Tell Jemmeh, compare with Keel (1995:§213).

14 But see Ben-Yosef (2010:571–575).

15 Alternatively, one might consider an identification with Smendes, the founder of the twenty-first Egyptian dynasty (1070/1069–1044/43 BCE); Takelot I (ca. 890–877 BCE); Sheshonq IIIa (ca. 798–785? BCE); or Takelot II (841–816 BCE). This is less likely, since for these rulers, only the throne name *ḥḏ-ḫpr-R' stp.n-R'* is attested (von Beckerath 1999:178–179, 186–187, 190–193) and only for Sheshonq I is either *ḥḏ-ḫpr-R' stp.n-R'* or *ḥḏ-ḫpr-R' stp.n-(J)mn* documented (Jansen-Winkeln 2007:1–29; but see Dodson 1993 for the possibility that *ḥḏ-ḫpr-R' stp.n-(J)mn* is attested for Sheshonq IIIa as well). Furthermore, it should be noted that the combination of *(J)mn and R'* together with *ḥḏ-ḫpr-R'*, like on the present item, is currently not attested in the available epigraphic corpus.

16 Note that Keel speculates about an allusion to Sheshonq's throne name on a scarab found at Achsib, Tomb ZR 28 (Keel 1997:34–35, No. 37); for the hypothesis that Sheshonq's name is preserved on Middle Iron Age bone seals, compare with Keel and Uehlinger (1998:536–537).

17 For the peculiar position of the sun disk, compare with, for example, Petrie (1889:Nos. 1764, 1767–1768, 1773).

18 Due to the damage to the plinth, no differentiation can be made.

19 They give as examples Tell el-Ajjul, Tomb 1116 (Keel 1997:192–193, No. 266) (= Lalkin 2008:No. 389) and Lachish, Tomb 4004 (Tufnell 1958:Pl. 35/36,219) (= Lalkin 2008:No. 399), but see, for example, the Bible+Orient Museum, Fribourg/Switzerland (Matouk 1971:211, No. 361).

20 These parallels were already mentioned by B. Brandl in Levy et al. (Levy, Adams, Najjar, Hauptmann, Anderson, Brandl, Robinson, and Higham 2004:874).

21 Alternatively, the standing human figure to the right may be interpreted as a beater.

22 See also the item from Tel Jemmeh (Herrmann 1994:No. 177), where the assumed collar is broken off and two fragmentary collars from Megiddo, Stratum V (Herrmann 1994:No. 182) and Tel Jemmeh (Herrmann 1994:No. 183). All three items were found in Iron Age II contexts.

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23 For example, Hornung and Staehelin (1976:126–127) with some examples or Shuval in Keel et al. (1990:Nos. 2–3, 11–17, 49–52).

24 Note that the lion is also present in these series serving as the mount for the god Baal or as the animal accompanying the healing god Reshef or the so-called lord of the crocodiles (cf. Münger 2005:Pl. 23.3, 15–18).

25 Note that only items from legal excavations are accounted for; compare with Münger (2011): catalogue entries Acco [Tell el-Fukhar] °13–°14; Achzib 1.°3; Arad 1; Beth Šean 3.6; Beth Šemeš 1.2; Tell el-Far'ah (S) 5.*39; Tel Gerisa °1–2; Kinneret °2; Lachiš 2.5; Mefallesim °1; Megiddo 3.7.12.°18.22.*25–*26; Tel Rekeš °1; Tell es-Sa'idiyeh 1.7; see also Münger (2011:138) with notes xxv to xxvii for further, non-Palestinian parallels.

26 Compare with, for example, Tufnell (1984: Pl. 12,1555–1568).

27 During this period, they are usually paired with a single sign; compare with Lalkin (2008:Pl. 89,1621 ['anra-formula in the center]; 1624–1630 [single *ḏd*-pillar in the center]; 1669 [winged scarab and cartouche filled with 'anra-signs in the center]); see also Brandl (2009: Fig. 12.29 = Keel 2010a:210–211, No. 250 [single *ḏd*-pillar in the center; impression on bulla] for an item from Beth Shean, Stratum S-3a).

28 Furthermore, it is also frequent in the so-called Locus-clypeus group of the Iron Age IIB (cf. Keel 2003).

29 Keel (2003) compares this base decoration with two earlier items from Tomb 934 at Tell el-Far'ah South (Keel 2010b:276–277, No. 576, and 322–323, No. 689); note, however, that the latter is quite differently executed; but see, for example, an item from Beth Shemesh, Tomb 11 (Keel 2010a:294–295, No. 176).

30 Examples are °Tel Anafa (Keel 1997:642–643, No. 5); Tell el-Far'ah South, Tomb 934 (Keel 2010b:288–289, No. 606); or Tel Harassim, Stratum IV (Lalkin 2008:No. 283).

31 Note that this epithet is already found on Middle Bronze Age II scarabs (cf., e.g., Keel 1995:Figs. 545 and 549 or Tufnell 1984:Pl. 58, 3284, 3286, 3288–3307).

32 For a comparable iconography, compare with, for exmaple, Beth Shemesh, Tomb 11 (Keel 2010a:266–267, No. 114).

33 For a comparable situation in the Early Iron Age cemeteries at Tell el-Far'ah South, compare with Münger (2011:127–129).

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12 New Iron Age Excavations at Copper Production Sites, Mines, and Fortresses in Faynan[1]

Erez Ben-Yosef, Mohammad Najjar, and Thomas E. Levy

The following chapter provides a comprehensive survey of Iron Age sites in the Faynan copper ore district reported to date, and a detailed description of the excavated Iron Age sites of the Edom Lowland Regional Archaeology Project. The data presented here provide the background for understanding copper production systems and related social processes throughout the Iron Age and constitute the "building blocks" of syntheses and models discussed in Chapter 15.

General Overview

To understand the dynamics of the changing role of Iron Age copper production in southern Jordan and adjacent areas, it is essential to build on the rich assemblage of archaeometallurgical research previously carried out in the southern Levant coupled with the new large data sets produced for the Edom Lowland Regional Archaeology Project (ELRAP). As part of our Iron Age research design, in addition to the surveys and major excavations in the Edom lowlands discussed in Chapters 2, 6, 7, and 10, we carried out test excavations at a number of key smaller sites in the Faynan region, including Khirbat al-Jariya (خربة الجارية), Khirbat al-Ghuwayba (خربة الغويبة), the Jabal al-Jariya mines (جبل الجارية), and the Ras al-Miyah (East) fortress system (راس المية). Here we summarize the data currently available for Iron Age copper production sites in the Faynan copper ore district (Table 12.1 and Figures 12.1–12.11), with emphasis on the sites investigated as part of the current research (cf. Ben-Yosef 2010; Levy et al. 2012). Several sites dated to the Late Bronze Age are also included because of chronological uncertainties (e.g., Wadi Dana 1; see Ben-Yosef 2010:Chapter 4). In addition to evidence of mining and smelting sites, other locales related to the copper production enterprise are also included. The issue of Iron Age cemeteries is discussed in depth in Chapter 9 (this volume). More ephemeral sites such as campsites and road stations near the mining and smelting sites and along the local trade routes are discussed in Chapters 6 and 7. This holistic regional approach to southern Levantine Iron Age society and copper production provides the foundation for developing anthropological models of technology and ancient society presented at the end of this study (Chapter 15, this volume; Ben-Yosef 2010:Chapters 9 and 10; Smith 2009).

As shown in Chapters 6 and 7 (this volume), results of high-resolution surveys in several areas in Faynan

Opposite: The fortress of Ras al-Miyah East represents a failed attempt of copper exploitation in the Late Iron Age Faynan. *Photo: Erez Ben-Yosef.*

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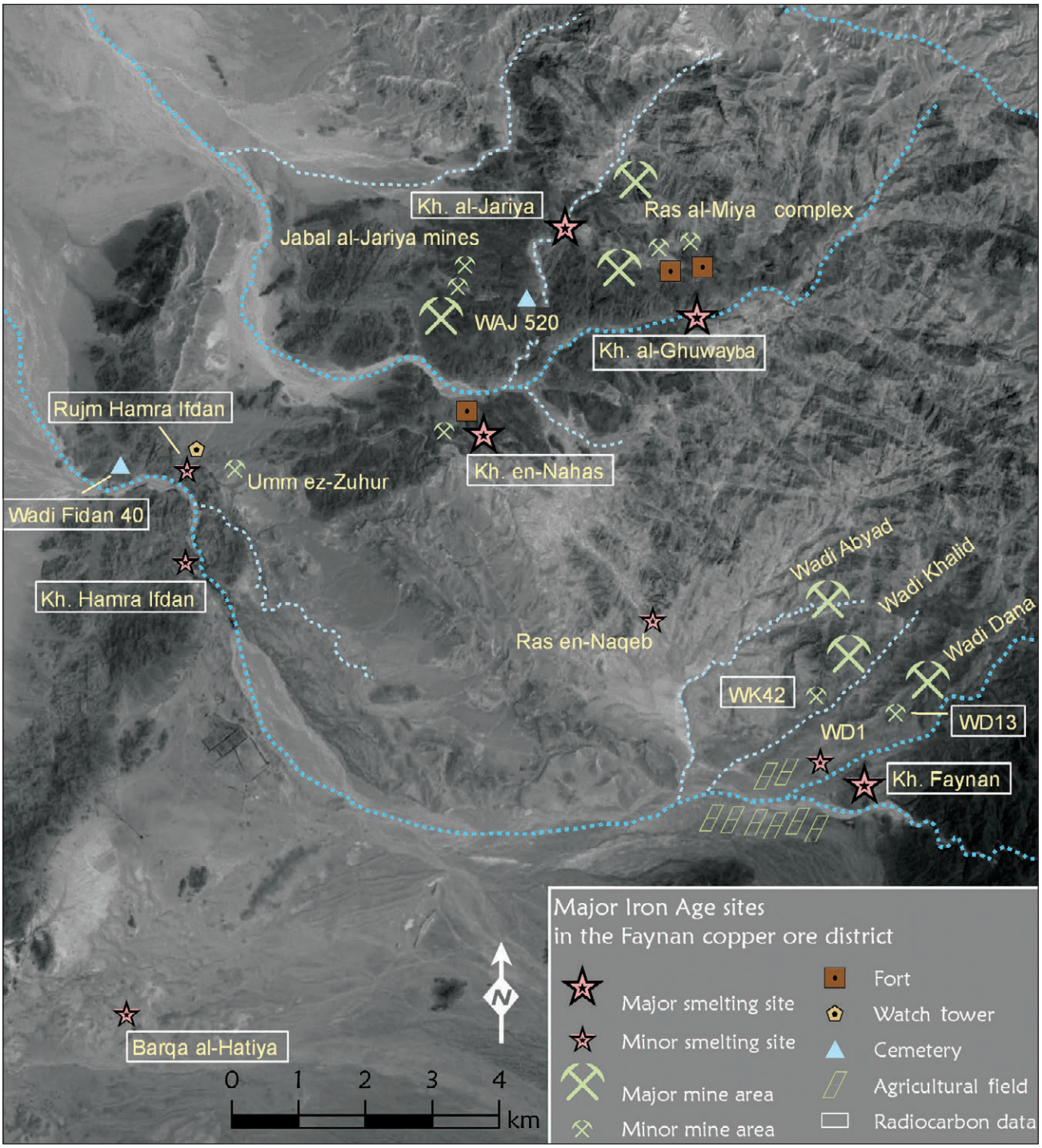

Figure 12.1 GIS map of the main Iron Age sites in the Faynan copper ore district on a Spot satellite image. Small sites found in specific surveys appear in Figures 12.4 to 12.11. Cf. Table 12.1 for site descriptions and Table 12.2 for radiocarbon dates (sites marked with a white rectangle).

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provide important data regarding Iron Age occupation and copper production activities. The definition of a site, the recording methods, the state of publication, and details provided are different for each survey, and thus comparison and general analyses need to be made cautiously. For example, the recent publication of the Deutsches Bergbau-Museum (DBM) team provides details about different "slag mounds" in the immediate vicinity of Khirbat Faynan (خربة فينان) (Figure 12.4a,b). Although these mounds surrounding Khirbat Faynan were all probably part of one extensive smelting site (now mostly covered by later remains of Roman and Byzantine age), they were given distinct site names (Faynan 3, 4, 5, 7, 14, and perhaps 1; Table 12.1). On the other hand, the Iron Age mine clusters of Wadi Abyad (وادي الأبيض) (Figure 12.5), Wadi Khalid (وادي خالد) (Figure 12.6), and Wadi Dana (وادي ضانا) (Figure 12.7) are described only in general, without specific details about each mine.[2] In our treatment of mines in Chapter 7 (this volume), we try to address this problem by providing data on each mine. The area near Khirbat Faynan was intensively surveyed also as part of the Wadi Faynan (وادي فينان) Landscape Survey (WFLS; Barker et al. 2007), and as a result, many of the sites were recorded twice and have different names (Figures 12.8 and 12.9). Also here, each slag mound or small scatter of Iron Age remains was assigned a distinct site name. The WFLS sites are described only in general (Mattingly, Newson, Grattan, et al. 2007), except for a few that were of more interest for the general landscape archaeology goals of that project (where ^{14}C dates or information regarding environmental impact were available). The surveys of the ELRAP (Figures 12.10 and 12.11) have been partially published and include some brief descriptions of each site. The results of all surveys are presented in Chapter 7 (this volume), including the 2004 Wadi Fidan survey published here for the first time. In the current chapter, we present more detailed descriptions of the Iron Age sites with emphasis on Iron Age copper production remains.

In the summary table (Table 12.1), the descriptions of the archaeological sites are presented with a focus on stratigraphy, chronology, function, and primary architectural features based on previous research (and its methodology, e.g., survey vs. excavation, etc.). A comprehensive bibliography is provided and should be consulted for further details. The radiocarbon dates published thus far for the Late Bronze Age and Iron Age sites in Faynan are compiled in Table 12.2. The dates for Khirbat en-Nahas (KEN), the Iron Age chronological anchor for the lowlands of Edom, are presented in Chapter 2 (this volume). These dates and their contexts provide foundations for the chronological framework of the Iron Age Faynan, partially replacing controversial relative dating based on material culture and in particular ceramic studies (see Ben-Yosef 2010:Chapter 4 for discussion; Smith 2009). Nevertheless, when radiocarbon dates are not available, ceramic assemblages are still the most reliable data for dating. This relative dating method is common for sites recorded in archaeological surveys (indicated in Table 12.1) around the world. There are inherent dating difficulties (e.g., Banning 2002) with survey data, and thus their assigned dates should be regarded as tentative. The ceramic assemblages of sites excavated or surveyed as part of the ELRAP are presented below (except for Khirbat en-Nahas, which is presented in Chapter 4, this volume[3]). Preliminary results of archaeomagnetic and optically stimulated luminescence (OSL) dating used in some cases to refine the dating resolution are also presented here.

Description of the ELRAP Sites Studied as Part of the Current Research

The excavations of sites described here were part of the ELRAP's 2006 (September–December), 2007 (July–August), and 2009 (September–November) field seasons in Faynan directed by Thomas E. Levy (principal investigator and co–field director) and Mohammad Najjar (co–field director), except for the new excavations at Timna Site 30, conducted in April 2009 and directed by Erez Ben-Yosef (see Ben-Yosef et al. 2012). The survey of Iron Age roads and sites (Faynan Busayra Regional Survey [FBRS]) described in Chapter 6 (this volume), essential for contextualizing the excavated sites described here and in other chapters of this volume, was part of the ELRAP 2007 field season. This project helped examine the relationship between the copper ore–rich lowlands of Edom with the highland zone where Busayra (بصيرا), the historic capital of the later Iron Age polity, is situated (Bienkowski 2002). The excavations at Khirbat al-Jariya (خربة الجارية) (KAJ), Ras al-Miyah East (راس الميه شرقي) (RAM East), Khirbat al-Ghuwayba (خربة الغويبة) (KAG), and Jabal al-Jariya 1 (جبل الجارية) (JAJ1), as well as the FBRS survey, were supervised by Ben-Yosef as part of his doctoral research. The excavations and surveys were designed to answer specific research questions related to society and copper technology in Iron Age Faynan, as discussed below.

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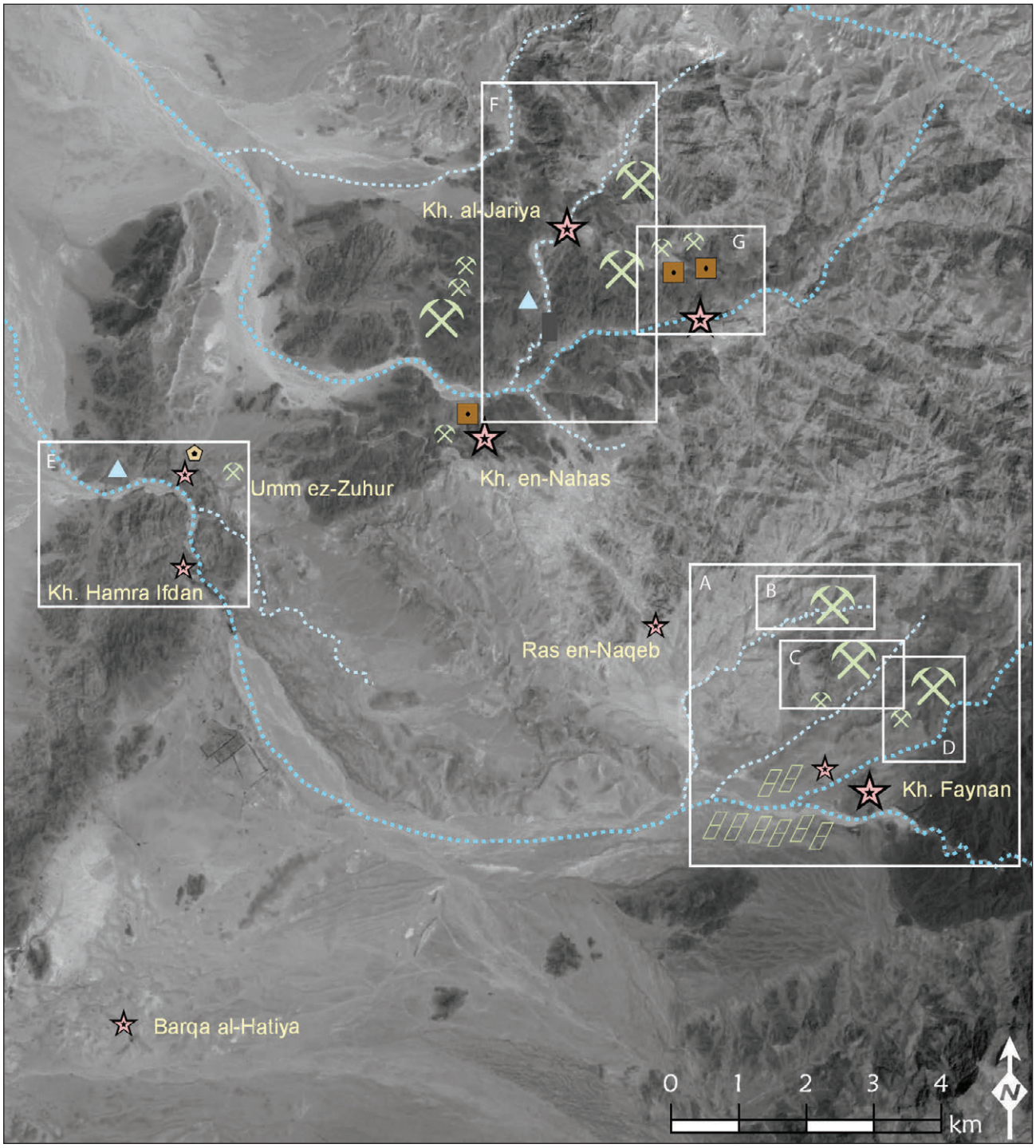

Figure 12.2 Faynan copper ore district, Spot satellite image. Main Iron Age sites (cf. Figure 12.1 for key) and location of detailed surveys with Iron Age finds: (*a*) Deutsches Bergbau-Museum (DBM) (Figure 12.4) and WFLS (Figures 12.8–12.9), (*b*) DBM mine survey in Wadi Abyad (Figure 12.5), (*c*) DBM mine survey in Wadi Khalid (Figure 12.6), (*d*) DBM mine survey in Wadi Dana (Figure 12.7), (*e*) JHF Wadi Fidan 1998 and 2004 surveys (Figure 12.10), (*f*) JHF and ELRAP Wadi Ghuwayba-Wadi Jariya 2002 and 2007 surveys (Figure 12.11), and (*g*) Ras al-Miyah Archaeological Complex, FBRS survey 2007 (Figure 12.30).

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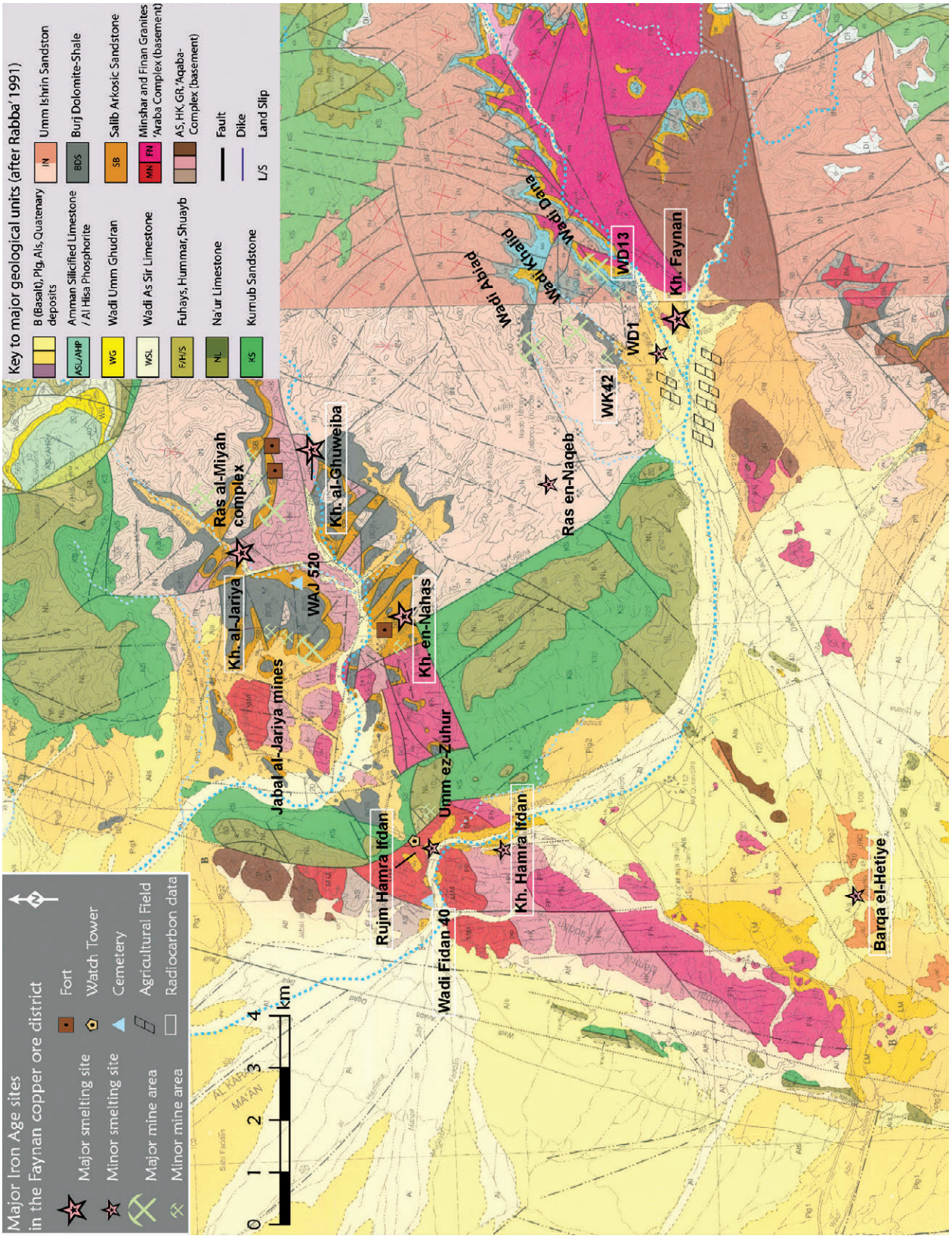

Figure 12.3 Main Iron Age sites in Faynan copper ore district depicted on local geological maps. GIS compilation of the al-Qurayqira sheet (left, Rabba' 1991) and ash-Shawbak (right, Barjous 1988). Differences in coloration are on the original maps. Note the distribution of the Burj formation, the main copper ore body in Faynan.

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Table 12.1 Summary of Late Bronze/Iron Age primary copper production archaeological sites in Faynan, Jordan.*

Site**	Description	References***
Khirbat Faynan WF1 30.626322N 35.493381E (central site) ☼	Khirbat Faynan is an extensive archaeological tel with substantial remains of later periods (Roman - Byzantine; see in particular Mattingly, Newson, Creighton, et al. 2007). In the immediate vicinity of the tel and on the margins of the late occupation d ebris, there are several slag heaps, numerous pottery scatters, agricultural fields, and other features dated to the Iron Age (Figures 12.4, 12.7, and 12.8). These Iron Age remains probably belong to one central production center that is mostly covered by the later remains. The DBM and the WFLS gave each individual slag mound or other archaeological feature a distinct site name, and the recording of the two projects is generally overlapping (WLFS recorded more sites, including nonmetallurgical features). Only a few sites were published in some detail, and those appear below.	Mattingly, Newson, Grattan, et al. 2007; Hauptmann 2007:94–110 Levy et al 2014 Related sites of the DBM and WFLS are not published yet.
Faynan 3 30.626322N 35.493381E ☼	Slag concentration visible underneath the Byzantine building at the southern slope of Khirbat Faynan; date based on pottery sherds and slag typology (Figure 12.4).	Hauptmann 2007:97
Faynan 4 30.626322N 35.493381E ☼	Slag concentration visible underneath the Byzantine building at the southern slope of Khirbat Faynan; date based on pottery sherds and slag typology (Figure 12.4).	Al-Shorman 2009:203–223; Hauptmann 2007:97
Faynan 5 30.627053N 35.496558E ^{14}C ☼	Smelting site, Iron II (probably also Iron I and possibly Persian) according to ceramic finds, slag typology, and radiocarbon dates (Table 12.2, Figure 12.4). The site is located directly adjacent to and east of Khirbat Faynan. Hauptmann's estimation of surface slag, around 30,000 tons, makes Faynan 5 the second largest smelting site in the region (after Khirbat en-Nahas). It is probably part of an extensive copper production center (together with Faynan 3, 4, and 7) now mostly covered by archaeological deposits from later periods. Two types of slag were recorded, bubbled furnace slag with charcoal and ore inclusions and semi-circular tap slag up to 0.5 m in diameter and 57 kg. Evidence of crushing was found, probably the result of an effort to obtain remaining metal trapped within the slag. A large number of tuyère fragments of two different sizes ("small" and "large") were found, as well as clay pipes ("bellows tubes") (Hauptmann 2007:Figure 5.10); they have been compared to finds from Timna and accordingly believed to represent different periods. This observation was confirmed and refined in the current research (see Chapter 7). The composite tuyères were studied also by Al-Shorman (2009:203–223). Several smelting installations were excavated in 1986 and 1988. One installation (L2) on the northern slope is dated to the early eighth century BCE and has a dome-shaped structure interpreted as the tap slag pit and a nearby pit interpreted as the bottom of the furnace itself. This installation is similar to the one reported from Timna Site 30 Stratum I, L10 (see Chapter 13, this volume). Another similar furnace installation was recorded in L1 and L4.	Hauptmann 2007:97–103; Al-Shorman 2009:203–223; Knauf 1992; Hart 1992
Faynan 7 Part of WF424 30.628694N 35.494478E ☼	A mound of approximately 5,000 tons of slag with similar metallurgical finds to those of Faynan 5 and Khirbat en-Nahas. Most of the slag is crushed to fine grain sand or gravel (Figure 12.4). Probably part of a larger copper production center around Khirbat Faynan.	Hauptmann 2007:103
Faynan 14 Part of WF424 30.629447 35.497481 ☼	Heavily washed (alluviated) and disturbed slag field of ca. 100 × 15 m, between Faynan 7 and Wadi Dana (Figure 12.4). Ceramic finds and metallurgical typology indicate Iron Age activity. Probably part of the larger copper production center around Khirbat Faynan.	Hauptmann 2007:108
Wadi Dana 1 30.631522N 35.4900E ☼	Smelting site in the "northwest cemetery" of Khirbat Faynan (Figure 12.4). Slag scatter and several slag heaps are located roughly 150 to 200 m from Faynan 7. Hauptmann (2007:122) states, "Thin plate slag found here had not been detected on any other find spot in Faynan. Similarly conspicuous are the tuyères which are also found here. With their interior width of ca. 1–1.5 cm, they are much smaller than their Iron Age counterparts. The impressions of reed on the tuyères' exterior are also very noticeable. They are identical to the type of "small tuyères" from Timna Site 30 Stratum 2, dated back to the Late Bronze Age. The tuyères seem to be contemporaneous there with the mining activities, demonstrated for mine [Wadi Khalid] no. 42 in the LBA." New stratified data from KEN and KAJ show that these types of tuyères were also in use during the Early Iron Age, twelfth to tenth centuries BCE (Chapter 7).	Hauptmann 2007:122

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Table 12.1 *(continued)*

Site**	Description	References***
Wadi Faynan 30.625N 35.471E (central site) #	Extensive field terraces along Wadi Faynan include numerous scatters of Iron Age pottery sherds (Figures 12.8, 12.9). Although it is difficult to date the terraces and fields (Early Bronze Age and later finds are also present), they may represent Iron Age agricultural activity in the valley.	Mattingly, Newson, Grattan, et al. 2007
Wadi Abyad 30.654N 35.494E (central site) □	Mining district. Fourteen blackish waste dumps on the valley bottom were recorded (Figure 12.5). They represent shafts dug into the lower Umm Ishrin (أم عشرين) formation to reach the ore-bearing DLS formation below (this formation is not exposed here, and it is located in an unknown depth). All of the mining waste dumps were dated to the "Iron Age II" by pottery finds.	Hauptmann 2007:115–116
Wadi Khalid 30.645N 35.498E (central site) □	Mining district. Fifty six mines along the Wadi were recorded and studied (as a "model area") by the DBM (Figure 12.6). Mines 42 and 7 were excavated (mostly Early Bronze activities). The target ore was the DLS, and in the Iron Age the shafts were dug from the lower parts of the Umm Ishrin formation to exploit the deeper occurrences of the ore. The visible outcrops of the DLS were exploited in earlier periods. The Iron Age shafts are usually double, one being sunk for climbing and the other for raising the ore. One of the deepest shafts is located on the upper part of the Wadi and is estimated to be 50–60m in depts.	Hauptmann 2007:116–121; Weisgerber 1989; Hauptmann et al. 1985
Wadi Khalid 42 30.639637N 35.490935E ^{14}C □	Excavated by the DBM in 1990 and 1993 (directed by A. Hauptmann). This mine represents mostly Early Bronze Age activity (according to pottery finds and contemporary smelting sites in Wadi Khalid). However, ^{14}C measurements of juniper wood spills (used for light) from the backfill of the mine yielded Late Bronze Age date (Table 12.2), and together with Middle Bronze sherds found in nearby mines (in particular in mines 11 and 18) the mine represents a continuous activity throughout the Bronze Age.	Hauptmann 2007:116–120; Engel 1992
WF 1422 Wadi Khalid 1 30.642916N 35.492923E □	Iron Age double mining shafts (one for climbing, the other for raising ore) and a Roman prospection shaft in the lower Umm Ishrin formation in Wadi Khalid. The Iron Age shafts are typical to Faynan and were dated by pottery. The Roman shaft was dated by pottery and coins (Vespasianic minting, 69–79 CE).	Hauptmann 2007:121; Hauptmann et al. 1991; Mattingly, Newson, Grattan, et al. 2007:280
Wadi Dana 30.644N 35.506E (central site) □	Mining district. Fourteen mines were recorded along the slopes of the mountain north of Wadi Dana (Figure 12.7). Pottery finds indicate Early Bronze Age and Iron Age mining, probably similar to the mining area of Wadi Khalid. This area was not studied in detail by the DBM. It was recorded by the WFLS as well, but the data are not published.	Hauptmann 2007:122
Wadi Dana 13 30.641904N 35.505281E ^{14}C □	A piece of wood from the tailing dump of the mine was radiocarbon dated to the end of the Late Bronze Age–Iron Age I (see Table 12.2).	Hauptmann 2007:89
WF1431 30.649299N 35.530466E □	Small settlement in lower Wadi Dana, a building with enclosure (dated by ceramic finds).	Mattingly, Newson, Grattan, et al. 2007:282
Ras en-Naqb 30.651944N 35.463333E ☼	The site, located on a hilltop, near the mountain pass of the main road connecting Khirbat Faynan and Khirbat en-Nahas. The slag mound is dated by radiocarbon to the Early Bronze Age; thermoluminescence dating gave an upper age constraint of 1,740 years. No pottery was found with the main slag scatter. A heap of slag piled up by a bulldozer represents some 100 tons and can be dated to the Iron Age II by pottery and exterior typology of the slag. This was interpreted as a product of reprocessing and remelting of the Early Bronze Age slag to extract the remaining metal inclusions. Rectangular structures nearby may also be Iron Age. Hundreds of cup marks in the bedrock may represent the result of slag processing in the Early Bronze Age.	Hauptmann 2007:123–127

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Table 12.1 *(continued)*

Site**	Description	References***
Khirbat en-Nahas (KEN) 30.679626N 35.436231E ^{14}C ☼■	Khirbat en-Nahas (KEN) is one of the largest smelting centers in the Levant (comparable to Khirbat Faynan and Bir Nasib). The site consists of dozens of slag mounds with estimated tonnage of some 50,000 to 60,000 tons (Hauptmann 2007:127) (This estimation probably should be doubled. The excavations in the slag mound of Area M resulted in exposing more than 6 m of copper production–related deposits, which shows that the depth of the slag is twice deeper than it was thought before), around 1,000 of which are layers of fine crushed slag located in distinct areas on the slopes surrounding the site. The site is located around 6 km north of Faynan (Figure 12.1). The site is the centerpiece of the ELRAP and has been investigated by various teams (Chapter 2, this volume). An extensive suite of radiocarbon dates (see Chapter 2, this volume), provides a solid and refined chronological framework for the Iron Age copper production activities in KEN, starting in the Late Bronze Age (thirteenth century BCE) and ending quite abruptly at the end of the ninth century BCE. The site was first excavated in 1990 by V. Fritz, who dated an elongated structure to the ninth century BCE; his report of later Assyrian pottery was not confirmed in later research. Intensive excavations took place in seven areas at the site as part of JHF and ELRAP in 2002, 2006, and 2009. The archaeometallurgical finds from Area M, a deep sounding into a slag mound excavated in 2002 and 2006, provide the main reference for analyses in the current research (together with KAJ-A; see Chapters 2 and 12, this volume). The ELRAP project at KEN recorded over 100 building complexes, including the 73 × 73–m fortress in the north part of the site near Wadi al-Ghuwayba. The stratigraphic analysis and dating suggest a major rearrangement of the site at the end of the tenth to the beginning of the ninth centuries BCE, with decommissioning of the fortress's gatehouse (and construction of a metal workshop instead, Area A), leveling extensive areas of slag mounds and construction of new building complexes. The current research suggests a major technological development associated with this rearrangement. The following areas were excavated as part of ELRAP: Area A = the fortress gatehouse (2002, 2006); Area F = metallurgical workshop at the fortress courtyard (2006); Area T = A massive building complex (2006); Area S = building complex (2002); Area R = A massive building complex and (associated?) metallurgical area (2006, 2009); Area M = slag mound (2009).	Bachmann and Hauptmann 1984; Hauptmann 2007:127–130; Finkelstein and Piasetzky 2008; Hauptmann et al. 1989; Levy, Adams, Najjar, et al. 2001; Levy and Najjar 2006a; Levy, Adams, Najjar, et al. 2004; Finkelstein 2005; Fritz 1996; Higham et al. 2005; Steinhof 1994; Smith and Levy 2008; Finkelstein and Singer-Avitz 2009; Levy et al. 2008; Al-Shorman 2009; Glueck 1940:57–61; Ben-Yosef, Tauxe, et al. 2009; Frank 1934; Glueck 1935; Musil 1908; Hauptmann et al. 1985; Knauf and Lenzen 1987; MacDonald 1992;; Levy, Petrovic, et al. 2010; Levy, Najjar, Higham, et al. in press; Kind 1965; Chapters 2, 4, 5, 8, 11, 13, and 15, this volume
Khirbat al-Jariya (KAJ) 30.70573N 35.452106E ^{14}C ☼	An extensive Iron Age smelting site on both sides of Wadi al-Jariya (Kind's Wadi Sei l es—Sarar?), first reported by the Kitchener 1883 expedition to the 'Araba. The site has remains of around 15,000 to 20,000 tons of slag (with 100 tons of crushed slag concentrated in the southern part of the site) (Hauptmann 2007:131). The investigation of the DBM suggested Late Bronze/Early Iron Age/beginning of copper production at the site (radiocarbon dates and tuyères typology). The site was excavated as part of ELRAP 2006 field season (Area A), and a new set of accelerator mass spectrometry (AMS) radiocarbon dates indicates that the site was occupied from the late twelfth to the tenth century BCE; the site was abandoned sometime during the second half of the tenth century BCE, probably corresponding to the major disruption and rearrangement reported at Khirbat en-Nahas.	Glueck 1940:61–63; Hauptmann 2007:131–132; Ben-Yosef, Levy, et al. 2010; Kitchener 1884:214; Kind 1965; Glueck 1935
Wadi al-Jariya 30.710N 35.456E (central site) □ ▫	The areas of Wadi al-Jariya and parts of Wadi al-Ghuwayba were surveyed by our team in 2002 (JHF; Levy et al. 2003) and 2007 (ELRAP;Chapter 7, this volume). In addition to various Iron Age campsites and small cemeteries, we recorded a concentration of mines along Wadi al-Jariya and its tributaries (Figure 12.11). In 2002 (with the help of the Deutsches Bergbau-Museum [DBM] team), 50 mines were recorded. In at least 26 mines, some indicative Iron Age sherds have been reported. All of the Iron Age mines are dug in the lower Umm Ishrin formation to get to the ore-bearing horizon of the DLS, and in many of them, there is additional evidence of earlier, Early Bronze Age exploitation, similar to the situation in Wadi Khalid documented by the DBM team.	Hauptmann 2007:132; Chapter 7, this volume; Levy et al. 2003
Ras al-Miyah Complex 30.703N 35.486E (central site) ☼ ■ □	A dense concentration of Iron Age sites in the upper Wadi Ghuwayba and the vicinity of the oasis of 'Ain al Ghuwayba was identified. The complex includes two Iron Age fortresses, a large smelting site, mine complexes, a unique cultic site, and various architectural features. The fortresses and mines were reported briefly by Hauptman (2007:132) and Weisgerber (2006); the eastern fortress was excavated as part of ELRAP 2006 field season, and the entire area was systematically surveyed as part of FBRS (see Table 6.1, this volume). Khirbat al-Ghuwayba (KAG) was sampled as part of the ELRAP 2009 field season. While KAG is dated by pottery finds (radiocarbon samples are being processed) to the Early Iron Age, the fortresses and mining complexes are dated (by abundant ceramic finds) to the Late Iron Age, not earlier than the eighth century BCE. The late activities in the RAM complex have no other clear parallels in Faynan (or in Timna) and present some difficulty of interpretation as a contemporary smelting site is yet to be securely identified.	Chpater 6, this volume; Ben-Yosef, Levy, et al. 2009b; Hauptmann 2007:132–133; Weisgerber 2006
Khirbat al-Ghuwayba (KAG) 30.693455N 35.47568E ^{14}C ☼	The site includes an extensive scatter of small fragments of slag on both sides of Wadi al-Ghuwayba and around the spring of 'Ain al-Ghuwayba. It was surveyed by Glueck and theDBM, who suggested an Iron Age date. In 2009, as part of the ELRAP field season, we excavated a building and an adjacent slag layers; the building was dated to the Roman-Nabataean period (pottery, glass) and the copper production debris to the Iron Age I to IIA (pottery).	Glueck 1940:61; 1935:22–23; Hauptmann 2007:132; Ben-Yosef et al. 2013

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Table 12.1 *(continued)*

Site**	Description	References***
Ras al-Miyah East (RAM) 30.703212N 35.486475E ■ □	A massive fortress built of sandstone blocks located near a mining complex on the cliffs above Wadi al-Ghuwayba. The fortress is dated by abundant pottery to the late Iron Age (seventh to sixth centuries BCE). It is related to a nearby mining complex. The archaeological evidence shows that the construction of the building was stopped abruptly. In 2006, we conducted small probes in the entrance corridor and one of the casemates.	Weisgerber 2006:15; Hauptmann 2007:132; Ben-Yosef, Levy, et al. 2009b
Ras al-Miyah West 30.701085N 35.471208E ■ □	A fortress comprised a tower, adjacent rooms, and a courtyard built of the local dolomite stones. The fortress is dated by abundant pottery to the Late Iron Age (seventh to sixth centuries BCE). It is related to a nearby mining complex.	Weisgerber 2006:15; Hauptmann 2007:132; Ben-Yosef, Levy, et al. 2009b
Wadi Fidan 30.669N 38.389E (central site)	Wadi Fidan is the western gateway to the Faynan region. In addition to the excavated Iron Age sites (WF40, WF4, RHI, and KHI), several other Iron Age sites were recorded in surveys only. The Wadi, from the 'Ain Fidan (عين الفيدان) oasis to the 'Araba, was surveyed by JHF project in 1998 (Levy , Adams, Witten, et al. 2001) and 2004 (first published here). The detailed surveys around the Wadi Fidan gorge resulted in documenting several Iron Age sites, including cemeteries, campsites, and a few small copper production sites that demonstrate small-scale smelting, probably with simpler technologies than those used at the major Iron Age sites in Faynan. A similar phenomenon was found in the current research in Timna Valley (Ben-Yosef 2010:Chapter 6).	Hauptmann 2007:133; Levy, Adams, Witten, et al. 2001
WF 601 □ ☼ ?	This site is situated on a level ridge below a steep hill. One large circular structure containing one stone circle and two tumuli (F5506, F5507). Three more stone circles (F5508–F5510), south of the large circular structure. F5504 (general): piece of slag.	Chapter 7, this volume 2004 JHF survey
WF 604 □	This site contains miscellaneous structures on a moderately sloping shelf of the Pleistocene terrace. One large wall and one small wall are the most conspicuous. The rest are cairns and small structures dotting the shelf. Mid-Paleolithic flints and Iron Age pottery were found.	Chapter 7, this volume 2004 JHF survey
WF 613 □ ☼ ?	The site is just east of Site 616 and south of Site 612, adjacent to the slag mound Site 614. Only three stone circles, two of them robbed, were found. Here, the slag thins out, but ceramics from Iron Age to modern Gaza Ware were found. Roman/Byzantine was dominant. (Site 614, the slag mound, ha3 associated Roman Byzantine pottery; these however may be related to the structures).	Chapter 7, this volume 2004 JHF survey
WF 615 □ ☼ ?	Bedouin camp clearance east and adjacent to Site 614, slag mound. Included is the west slope of Site 625. One 2-course wide, L-shaped wall line was found close to this slope. Very small amounts of Iron Age slag and Roman/Nabataean ceramics were found.	Chapter 7, this volume 2004 JHF survey
WF 630 □ WF 631 ☼	4 medium-size oval cairns (ranging 3–4m in length and 2m in width) are on top of a high mound between 2 gullies approx. 100m from the west edge of the Wadi Fidan. 4 pottery sherds, 2 of which were rim sherds: maybe Iron Age Negabite Ware. Cairn field with slag concentration, surveyed in 2004. On a Pleistocene shelf south of KHI, west side of Wadi Fidan. Several cairns and stone circles, slag scatter, pottery, and flint.	Chapter 7, this volume 2004 JHF survey Chapter 7, this volume 2004 JHF survey
Khirbat Hamra Ifdan (KHI) Wadi Fidan 120, Raikes' Site F, DBM Wadi Fidan 3, JD_9 30.661394N 35.392700E ^{14}C ☼	The majority of the excavated finds from this site date to the Early Bronze Age (II–IV) and represent an extensive settlement specialized in copper production. However, a large slag mound, clearly visible on the surface of the eastern part of the site, was excavated by our team in 2007 and dated by archaeomagnetic investigation to the Iron Age, probably parallel to the main production period at KEN. The new archaeomagnetic dating has confirmed previous suggestions of Iron Age date for the slag mound that were based on the typology of the slag alone. The JHF project's excavations of 2000 in Area L at KHI have yielded two unpublished radiocarbon dates; one is from the Abbasid period and the other indicates Iron Age I (twelfth to eleventh centuries BCE) occupation of the site. This area is mostly associated with the massive square structure (probably a caravansari) at the eastern edge of the site, dated probably to the Roman-Byzantine period; the date came from a deeper context, Stratum IIIA, dated by pottery to the Early Bronze Age IV. However, Iron Age samples are probably related to the smelting remains evident on the surface and may indicate that the EB finds were dumped in this location during the Iron Age along with some Iron Age artifacts. No direct evidence of smelting was found in this stratum. The source of copper ore for this site was probably the small mine district of Umm adh-Dhuhur (ez-Zuhur) (أم الظهور) located around 1.5 km to the north–northeast from KHI (the ore source for the EB smelting may have been the area of Madsus (مدسوس) , see below).	Hauptmann 2007:134–136; Raikes 1980; Adams 1992; Levy et al.; 2002; Levy et al. 2012; Ben-Yosef et al. in prep.

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Table 12.1 *(continued)*

Site**	Description	References***
Wadi Fidan 40 Raikes' Site D, SGNAS Site 14, DBM Wadi Fidan 9 30.673926N 35.381107E ^{14}C ▲	Wadi Fidan 40 is the largest Iron Age cemetery site in Edom and situated on a Pleistocene conglomerate terrace that forms a low plateau overlooking the Wadi Fidan, where it debouches into the Wadi Arabah. The cemetery marks the western entrance or "gateway" into the Faynan district. The site is large and extends over an area of around 3,450 m^2. JHF–ELRAP and a DOAJ emergency project made extensive excavations here. A total of 287 tombs and graves have been excavated to date. The exact number of graves present in the site is difficult to estimate but may range from as low as 1,500 to over 3,000. The typical tomb consisted primarily of subsurface cists lined with sandstone or cobble slabs accompanied by a circular stone-lined installation on the surface. The absence of settlement sites in the vicinity of the vast mortuary complex, the style of graves, and the character of their burial remains have led to the suggestion that the cemetery belonged to a nomadic community, perhaps the Shasu nomads known from sixteenth- to tenth-century BCE ancient Egyptian texts. High-precision radiocarbon dating indicates that most of the tombs date to the tenth century BCE. Preliminary toxic metal studies of the human remains from this cemetery suggest that some members of this community were actively engaged in smelting activities during the Iron Age (Beherec 2011). To date, the Wadi Fidan 40 cemetery provides the best data set for linking a local human population to the mining and metallurgy activities carried out in Faynan during the Iron Age. The nature of this nomadic population–production relationship is just beginning to be investigated.	Levy 2009b; Levy 2009a; Levy, Najjar, Muniz, et al. 2005; Levy and Najjar 2005; Levy and Adams 2001; Levy et al. 1999; Adams 1991; Raikes 1980, 1985; Beherec 2011; Levy, Adams, and Muniz 2004; Levy and Najjar 2006b; Chapter 9, this volume
Wadi Fidan 4 30.671285N 35.384405E ▲	Wadi Fidan 4 is the best-preserved Early Bronze I (ca. 3600–3300 BCE) village and metalworking site in the Faynan region. It is located on the south bank of the Wadi Fidan opposite the extensive Wadi Fidan 40 cemetery site. Several tumuli are located on the northeast edge of the site. Salvage excavations in 2003 carried out by the UCSD-DOAJ revealed that the tumuli were in fact isolated Iron Age tombs, not related to the EBI site. The material is currently being prepared for publication. In Tomb 1 (a large cairn on top of capstones of a cist grave), a total of eight individuals were found with Egyptian amulets and other objects. It is possible that Wadi Fidan 4 was used during a phase of the Iron Age when the main cemetery located at WFD 40 was abandoned.	Beherec 2011; Adams and Genz 1995:8; Levy 2006; Levy et al. 2012; Chapter 9, this volume
Umm adh-Dhuhur (ez-Zuhur) (أم الظهور) 30.673789N 35.399239E (central site) □	A small mine district consisting of 24 tailings of the DLS formation is located in the area between Wadi al-Ghuwayba and Wadi Fidan. The mines were dated by theDBM team to the Iron Age II based on "archaeological evidence" and probably were the source of ore to the Iron Age smelting sites in the nearby area of Wadi Fidan. The mines here were shafts dug into the whitish local gravel, aiming to reach the DLS formation below. Some of the galleries were cut by erosion and are exposed on the slopes (similar to the situation in Timna). Mining with shafts and galleries conform to the general pattern observed for Iron Age mining technology in the region of Faynan.	Hauptmann 2007:130–131
Madsus 30.671509N 35.410828E □?	In a small valley near Jabal Madsus, there are 20 to 30 refilled pits (*Tellerpingen*), somewhat similar in dimensions and geological location to the newly discovered JAJ mines. An early date for these mines has been suggested based solely on some finds of grooved hammer stones that show similarity to artifacts from the Early Bronze I site of Wadi Fidan 4. Furthermore, a small installation located nearby was accordingly dated to the Chalcolithic and interpreted as a smelting furnace (with slagless technology; see Craddock 1995:128). The proximity of the mines to Khirbat en-Nahas suggests that they may date to the Iron Age, similar to the JAJ mines.	Hauptmann 2007:130–131; Chapter 6, this volue; Craddock 1995:128
Barqa al-Hatiya (برقة الحطية) 30.600460N 35.380410E ^{14}C □ ☼	The area of Barqa al-Hatiya was excavated by V. Fritz in 1990 and 1993. In addition to Early Bronze Age II house and smelting remains, a large Iron Age "four-room" house was unearthed (BH2) with ceramic dated by Fritz to the Iron Age I. The ceramic analysis was criticized by Bienkowski (2001) and a radiocarbon date indicates a ninth-century occupation of the site. Midianite pottery was uncovered in the house and some (limited) smelting remains scattered around the site (and mostly to the west of it) were also attributed to Iron Age activities in the area. The closest ore sources are north of Wadi Fidan (Umm adh-Dhuhur and Madsus), some 7 km to the north. The location of the site, relatively far from the mines, suggests it served mainly as a road station along a route leading from Faynan to the Gulf of Aqaba via the Arabah Valley. A small oasis is located nearby and is probably the reason for the location of this road station in the middle of the sand dunes area.	Fritz 1994a, 1994b, 2002; Hauptmann 2007:141–143; Adams 2003; Bienkowski 2001

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Table 12.1 *(continued)*

Site**	Description	References***
Rujm Hamra Ifdan (RHI) رجم حمرة افدان (Glueck's Khirbat Hamra Ifdan) 30.672203N 35.390267E ^{14}C ⌂ ☼?	During his surveys in the Edom lowlands during the 1930s, Glueck identified some structural remains on a small inselberg on the north bank of Wadi Fidan as an Iron Age watchtower. There has been some confusion over the name of the site (Adams 1992). The site is located on the confluence of Wadi Fidan with the secondary drainage known as Umm edh-Dhuhur. In the 2006 ELRAP field season, two 5 × 5–m sondages were made at the site: (a) just below the summit of the inselberg where Glueck had identified the foundations of a small watchtower and (b) in an area adjacent to a large wall enclosure at the base of the site. The ^{14}C results are especially important because it is the only site in the Edom lowlands where evidence of both Iron Age IIA (tenth century) BCE and Iron Age IIC seventh- to sixth century BCE occupations have been documented (except probably from Khirbat Faynan itself). There was a rich ceramic assemblage representing these two phases at the site.	Glueck 1940:56; Levy et al. 2008; Chapter 10, this volume; Glueck 1935; Adams 1992;
Jabal al-Jariya (JAJ) جبل الجارية JAJ-1 (central) 30.695061N 35.429852E OSL □ □	Mining district. Three fields of pit mines (*placer*) located in the colluvium/alluvium deposits of the DLS formation north of Jabal al-Jariya. The mines were discovered in 2007 as part of the FBRS and excavated in 2009 as part of ELRAP field season. OSL dates support Iron Age mining activity, and the vast area was probably the main copper ore source for the nearby Khirbat en-Nahas. JAJ-1 is the main mine field, consisting of hundreds of pits easily visible on satellite images. A nearby structure complex may be related to the copper mining activities (FBRS Site 37, 30.695715N, 35.436720E). JAJ-2 (30.701655N, 35.432040E), and JAJ-3 (30.704487N, 35.434889) are much smaller fields, but with similar characteristics to JAJ-1. All three fields are associated with a young geological dike (north end: 30.705619N, 35.432410E; south end and volcanic plug: 30.693691N, 35.433778E).	Ben-Yosef, Levy, et al. 2009c

*Highlighted in blue are sites investigated as part of the current research and have more details presented below; also included are sites that are indirectly associated with the copper production enterprise.

**Bold names = excavated sites; ^{14}C = radiocarbon date available (cf. Table 12.2); site names starting with "Faynan" were recorded by the team of the Deutsches Bergbau-Museum (DBM) (Andreas Hauptmann et al.) and in many publications appear with different spellings (*Fenan, Feinan*); site names starting with "WF" (Wadi Faynan) were recorded by the Wadi Faynan Landscape Survey (WFLS), and some overlap those of the DBM. Symbol key: ☼ smelting; □ mining; □ buildings/settlement; ■ fortress; ▲ cemetery; ⌂ watchtower; ● campsite; # fields; + cultic.

***Hauptmann (2007) is an updated English version of Hauptmann (2000), and thus the latter is not cited here.

The recording of archaeological remains in the sites described here is based on the digital archaeology system developed as part of the ELRAP (see Introduction, this volume, and Levy 2010; Levy, Anderson, et al. 2001; Levy, Najjar, and Higham 2010; Levy, Petrovic, et al. 2010; Levy and Smith 2007;). Like any other basic archaeological practice (Hawkes 1954; Renfrew and Bahn 2004), the system provides a solution for three primary components: surveying, artifact and context recording, and photography. The excavations and surveys databases are based on a Geographic Information System (GIS; ESRI), associated digital forms (Microsoft Access), and digital photographs. These data are now integrated in a compressive database called the CSRO (Calit2 Strategic Research Opportunity) Archaeology Database (Gidding et al. 2013).

Excavation Methods

While the general excavation methodology used at KEN is described in the Introduction (Chapter 2, this volume), its relationship to the other excavated ELRAP sites discussed here warrants some discussion. Besides the work at KEN, most of the excavations conducted as part of the ELRAP research were limited probes in different sites, with the main goal being to establish the stratigraphy and chronological framework and to obtain representative reference metallurgical collections of artifacts. At KAJ, KAG, and JAJ, only one or half of a 5 × 5–m square was carefully excavated from surface to bedrock, with a focus on detailed recording of the sections of these probes. At KAJ and KAG, structures believed to be associated with Iron Age metallurgical remains were entirely exposed to reveal floor levels. At RAM East, we conducted soundings in one casemate room and the main fortress corridor to try and clarify the chronology and function of the site. In contrast to these probes, the excavations at Khirbat en-Nahas, the largest Iron Age copper production site in Faynan (and the southern Levant), have been the centerpiece of the ELRAP ancient metallurgy and Iron Age study project directed by Levy and Najjar. At KEN, seven areas were intensively excavated during three expedition seasons (each ca. 10 weeks long), resulting in extensive exposures of metal production remains and architectural features (Chapter 2, this volume). The large-scale excavations at KEN comply with one of the main goals of the project: to investigate the impact of technological practice on society using anthropological approaches.

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Table 12.2 Compilation of radiocarbon dates from Late Bronze Age–Iron Age copper production and related sites in the Faynan Copper Ore District (Northern Wadi Arabah).*

Site	Lab #	Radiocarbon Age BP	Cal. Age—68.2 percent Probability (BCE)*	Context	Reference
Wadi Khalid, Mine 42	HD1492	3197 ± 39	1500–1432	Backfilling, 17 m inside entrance	Hauptmann 2007:89
Wadi Dana, Mine 13	HD10578	2949 ± 63	1262–1056	Waste dump in front of entrance, –0.6 m	Hauptmann 2007:89
Khirbat al-Jariya (KAJ)	HD16351	2915 ± 30	1192–1048	KJ2-4	Hauptmann 2007:89
	HD10990	2886 ± 56	1191–979	Slag heap, wadi edge –0.3 m	Hauptmann 2007:89
	HD16530	2839 ± 22	1026–936	Base of slag heap, –0.75 m	Hauptmann 2007:89
	See Table 12.3				Ben-Yosef et al. 2010
Khirbat al-Ghuwayba	Radiocarbon dates from the 2009 ELRAP field season are being processed at the Oxford laboratory; two preliminary results that are probably of old wood are OxA-23159 (2919 ± 29 BP, 1192–1051 68.2 percent probability, L30) and OxA-23159 (3288 ± 28 BP, 1608–1526 68.2 percent, L23).				
Khirbat en-Nahas (KEN) basal strata	OxA17646	2871 ± 26	1112–1005	Layer M4: basal layer of slag mound, domestic and industrial mix	Levy et al. 2008:16463, here indicated as an "outlier"
	OxA19040	2942 ± 27	1254–1117	Layer M5a: charcoal (*Retama raetam*) near installation l.676	Ben-Yosef et al. 2010
	OxA19041	3026 ± 27	1373–1260	Layer M5b: charcoal from sediment above virgin soil	Ben-Yosef et al. 2010
	OxA12169	2899 ± 27	1126–1026	Layer S4: basal Stratum below industrial structure, domestic and industrial mix	Levy, Najjar, van der Plicht, et al. 2005:149, including important discussion on context
KEN, fortress, excavations at Area A	GrA25334	2910 ± 50	1193–1016	Layer A2A, l.21	Levy, Najjar, van der Plicht, et al. 2005:135
	GrA25318	2920 ± 35	1193–1051	Layer A3, l.89	Levy, Najjar, van der Plicht, et al. 2005:135
	GrA25354	2880 ± 50	1151–977	Layer A3, l.89	Levy, Najjar, van der Plicht, et al. 2005:135
KEN slag mounds	HD14308	2876 ± 38	1122–1002	KN-Eisen-5, –1.15/–1.25 meters below surface	Hauptmann 2007:89, after Steinhof 1994
	HD14057	2905 ± 40	1189–1016	KN-2, –0.85/–0.9 meters below surface	Engel 1993:209
	HD14302	2880 ± 28	1114–1012	KN-Eisen-2, –0.17/–0.2 meters below surface	Hauptmann 2007:89, after Steinhof 1994
	HD14336	2895 ± 35	1127–1014	KN-3, –1.15/–1.3 meters below surface	Engel 1993:209
	HD14113	2864 ± 46	1116–976	KN-Eisen-6, –1.65/–1.8 meters below surface	Hauptmann 2007:89, after Steinhof 1994
KEN tenth to ninth centuries BCE	See published dates in Levy, Najjar, van der Plicht, et al. (2005). For new results from Areas T, R, and F see Chapter 2, this volume. See also in Engel (1993:209), Higham et al. (2005), Hauptmann (2007:89), Levy et al. (2008), and Fritz (1996:5); cf. Appendix 2.2_14C-ELRAP in the DVD of this volume.				
Khirbat Hamra Ifdan	?	2910 ± 41	1192–1021	WF120, Stratum IIIA, Area L (2000), L3034, B45344, RC23	This study (unpublished date from the JHF 2000 field season)

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Table 12.2 *(continued)*

Site	Lab #	Radiocarbon Age BP	Cal. Age—68.2 percent Probability (BCE)*	Context	Reference
Khirbat Faynan (smelting activities)	HD10581	2726 ± 102	1000–801	Slag heap 5, l.3, storage jar	Hauptmann 2007:89
	HD10992	2664 ± 74	910–786	Slag heap 5, –0.3meters below surface	Hauptmann 2007:89
	HD10582	2647 ± 47	889–789	Slag heap 5, l.2, furnace (L2)	Hauptmann 2007:89
	HD10580	2380 ± 45	516–396	Slag heap 5, l.4, furnace (Locus 4)	Hauptmann 2007:89
	Beta203407	2900 ± 40	1188–1012	WF455, slag heap 9 or 7 (inconsistency in publications)	Mattingly, Newson, Grattan, et al. 2007:282; Hunt, Gilbertson, et al. 2007:1334
	Beta203406	2890 ± 40	1129–1005		
	Beta203409	2830 ± 40	1039–923		
	Beta203408	2790 ± 40	1001–901		
	Beta201410	2790 ± 40	1001–901		
	Beta203411	2680 ± 40	894–803		
	Beta110840	2630 ± 50	841–771	WF5017, barrage section, –2.4 m (bulk sediment)	Hunt, Gilbertson, et al. 2007:1334
	Beta110841	2630 ± 50	841–771	WF5017, barrage section, –2.6 m (bulk sediment)	
Rujm Hamra Ifdan (watch tower, minor smelting in Sounding A)	OxA14849	2747 ± 28	914–842	Sounding A (hill top), charred date	Levy et al. 2008:online supplementary material
	OxA14850	2849 ± 28	1050–941		
	OxA14851	2537 ± 27	791–595	Sounding B (hill bottom), charcoal (*Tamarix*)	
	OxA14852	2473 ± 28	752–524		
	OxA14853	2495 ± 28	761–546		
Wadi Fidan 40 Cemetery	Beta111366	2800 ± 70	1041–846	Grave 92, pomegranate seed, l.531	Levy et al. 1999:303
	OxA14233	2839 ± 28	1050–970	Grave 59, pomegranate seed	Chapter 2, this volume
	OxA14234	2819 ± 26	1005–925	Grave 59, pomegranate seed	
	OxA14235	2795 ± 30	980–905	Grave 59, pomegranate seed	
	OxA14236	2859 ± 26	1070–970	Grave 59, pomegranate seed	
	OxA14237	2863 ± 27	1090–970	Grave 59, pomegranate seed	
	OxA14238	2779 ± 31	980–890	Grave 59, pomegranate seed	
	OxA14431	2758 ± 35	970–840	Grave 59, pomegranate seed	
	OxA14239	2784 ± 28	980–895	Grave 701, pomegranate seed	
Barqa al-Hatiya (habitation, smelting activities)	HD13977	2743 ± 23	908–843	House BH2, l.108 (ceramic: Iron Age I [Fritz 1994b], but see Bienkowski [2001])	Levy et al. 1999:305; the date obtained by Fritz was not available in time of the original publication of the site (Fritz 1994a)

*Highlighted in blue are sites investigated as part of the current study with more details below; for a broader time frame covering all periods of the history of metallurgy in the southern Levant, see Avner (2002); Weisgerber (2006:27); Hunt, Mattingly, et al. (2007); and Hauptmann (2007). The complete compendium of ELRAP dates for KEN may be found in Chapter 2 (this volume).

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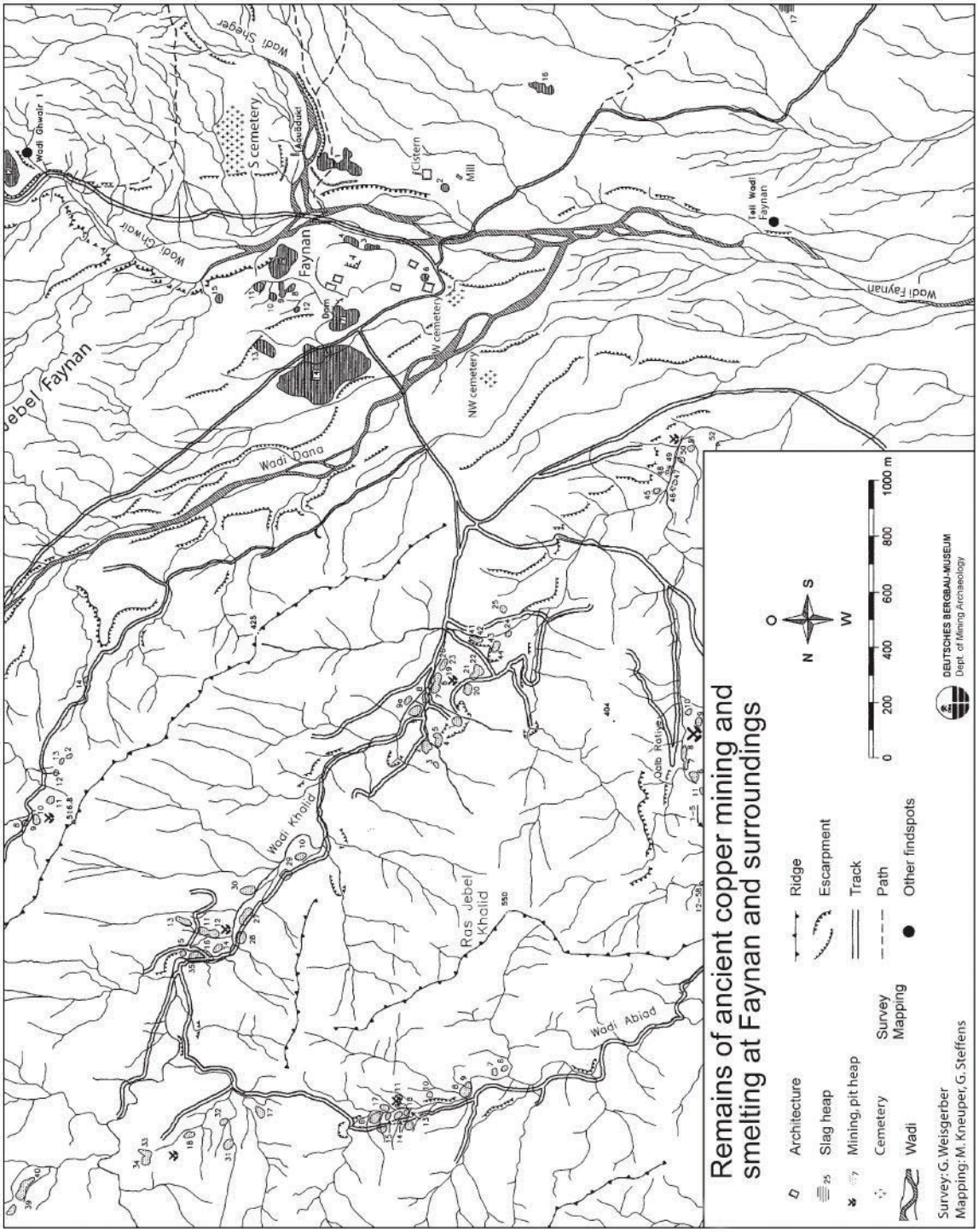

Figure 12.4a Schematic map of sites recorded by the Deutsches Bergbau-Museum in the vicinity of Khirbat Faynan (periods undifferentiated) (Hauptmann 2007:93).

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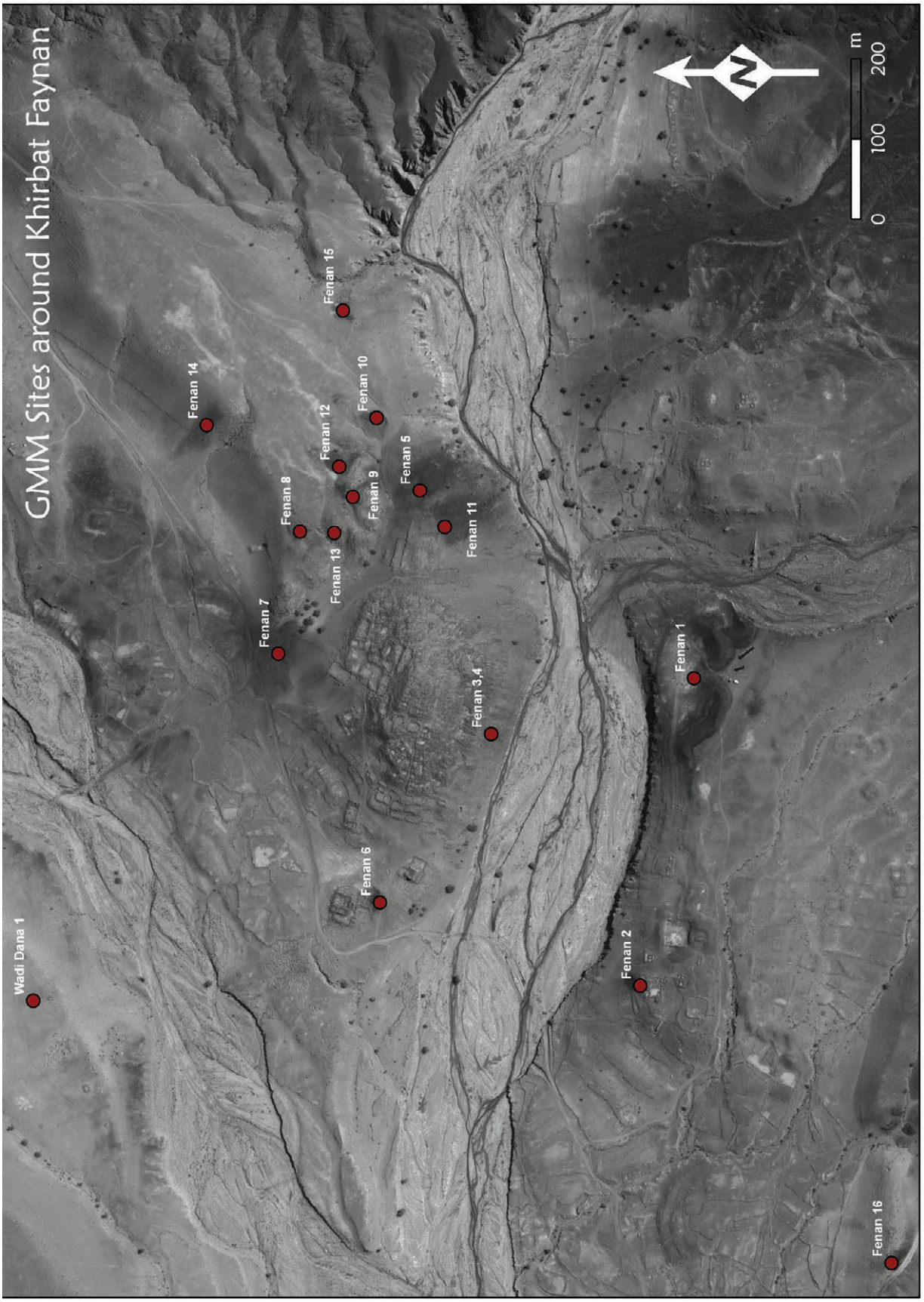

Figure 12.4b Site recorded by the Deutsches Bergbau-Museum near Khirbat Faynan on Ikonos satellite image (data courtesy of A. Hauptmann and the Deutsches Bergbau-Museum, Bochum). Wadi Dana 1 and Faynan (Fenan) 3, 4, 5, 7, and 14 were dated to the Iron Age. Note the clearly visible Roman-Byzantine remains of Khirbat Faynan in the center, probably covering Iron Age remains of a large copper production center.

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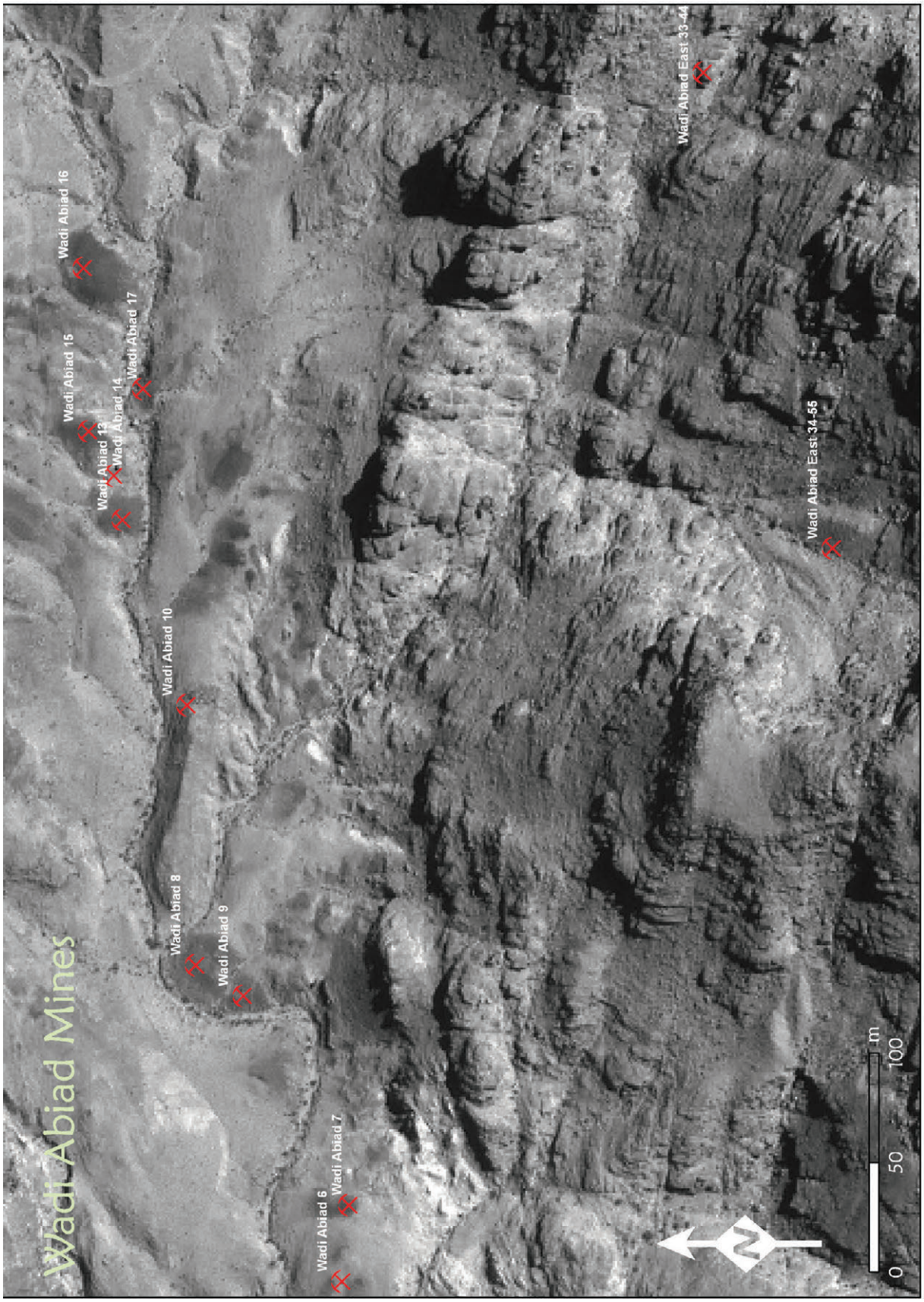

Figure 12.5 The mining district of Wadi Abyad (cf. Figures 12.1 and 12.4a) plotted on an Ikonos satellite image (data courtesy of A. Hauptmann and the Deutsches Bergbau-Museum, Bochum). The dark sediments visible in the valley bottom are Iron Age tailings of DLS ore dressings; the ore was mined through shafts into the lower Umm Ishrin formation. The mines in the bottom left part of the image were dug into the MBS unit and are dated to the Chalcolithic and Roman period.

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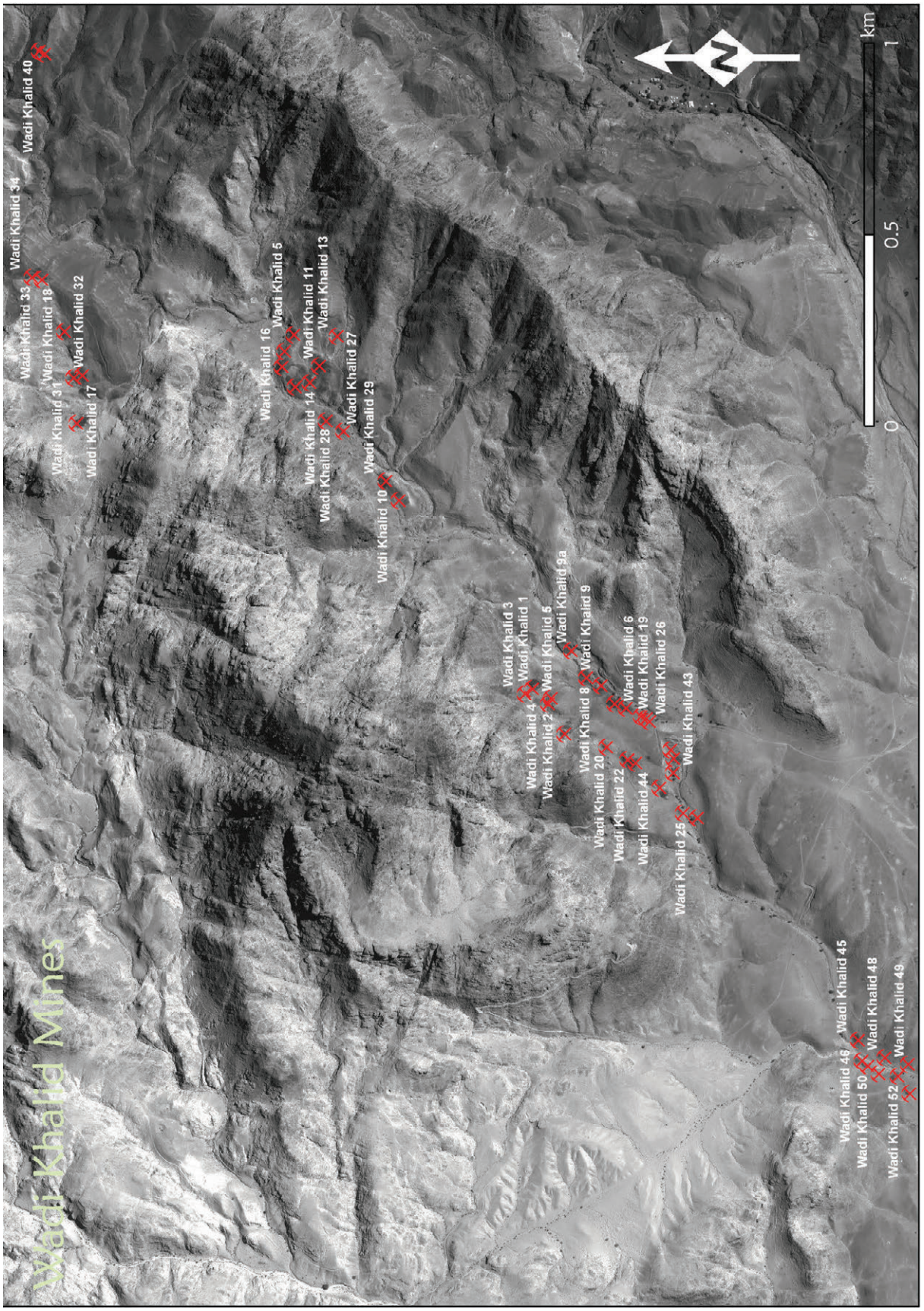

Figure 12.6 The mining district of Wadi Khalid (cf. Figures 12.1 and 12.4a) on an Ikonos satellite image (GIS data courtesy of A. Hauptmann and the Deutsches Bergbau-Museum, Bochum).

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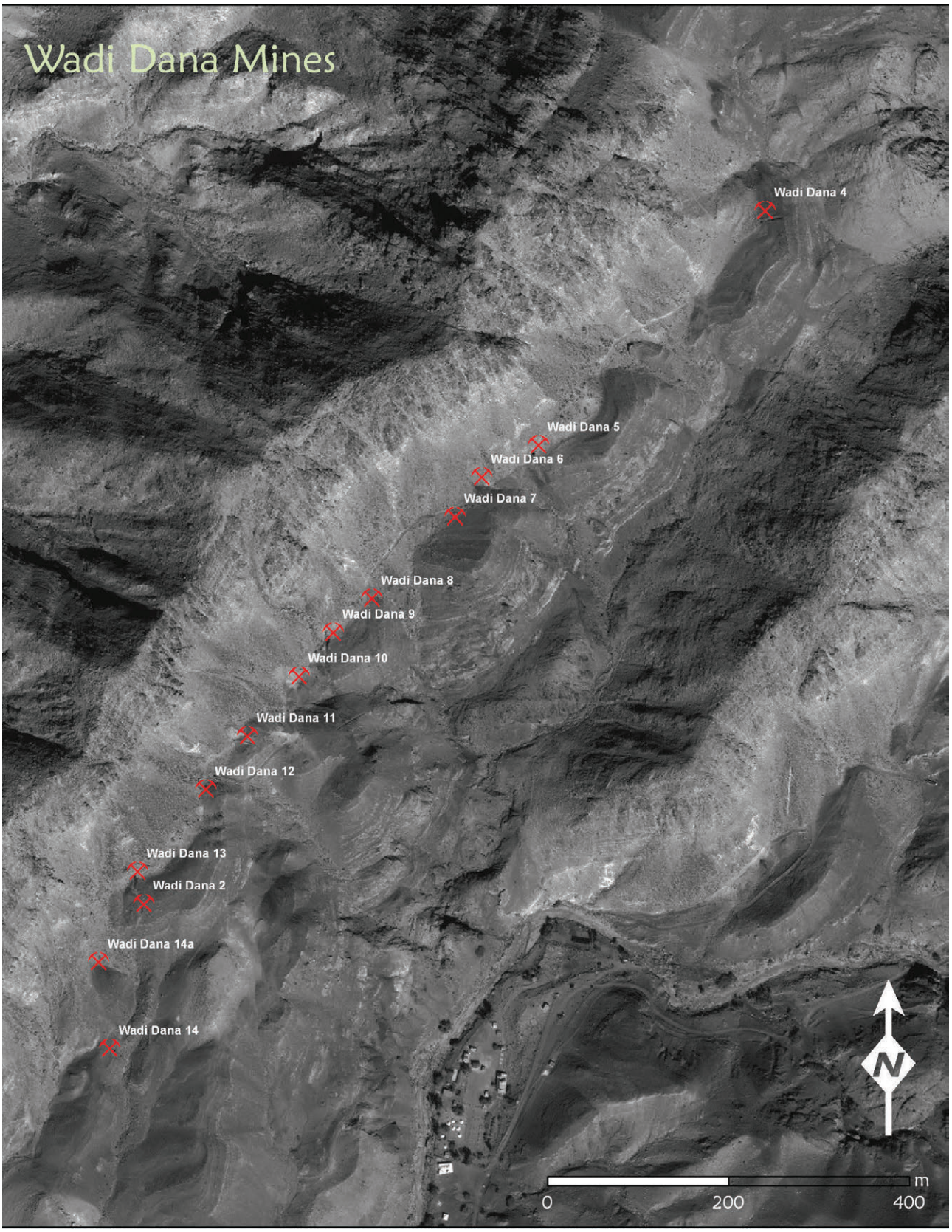

Figure 12.7 The mining district of Wadi Dana (cf. Figures 12.1 and 12.4a) on an Ikonos satellite image (GIS data courtesy of A. Hauptmann and the Deutsches Bergbau-Museum, Bochum).

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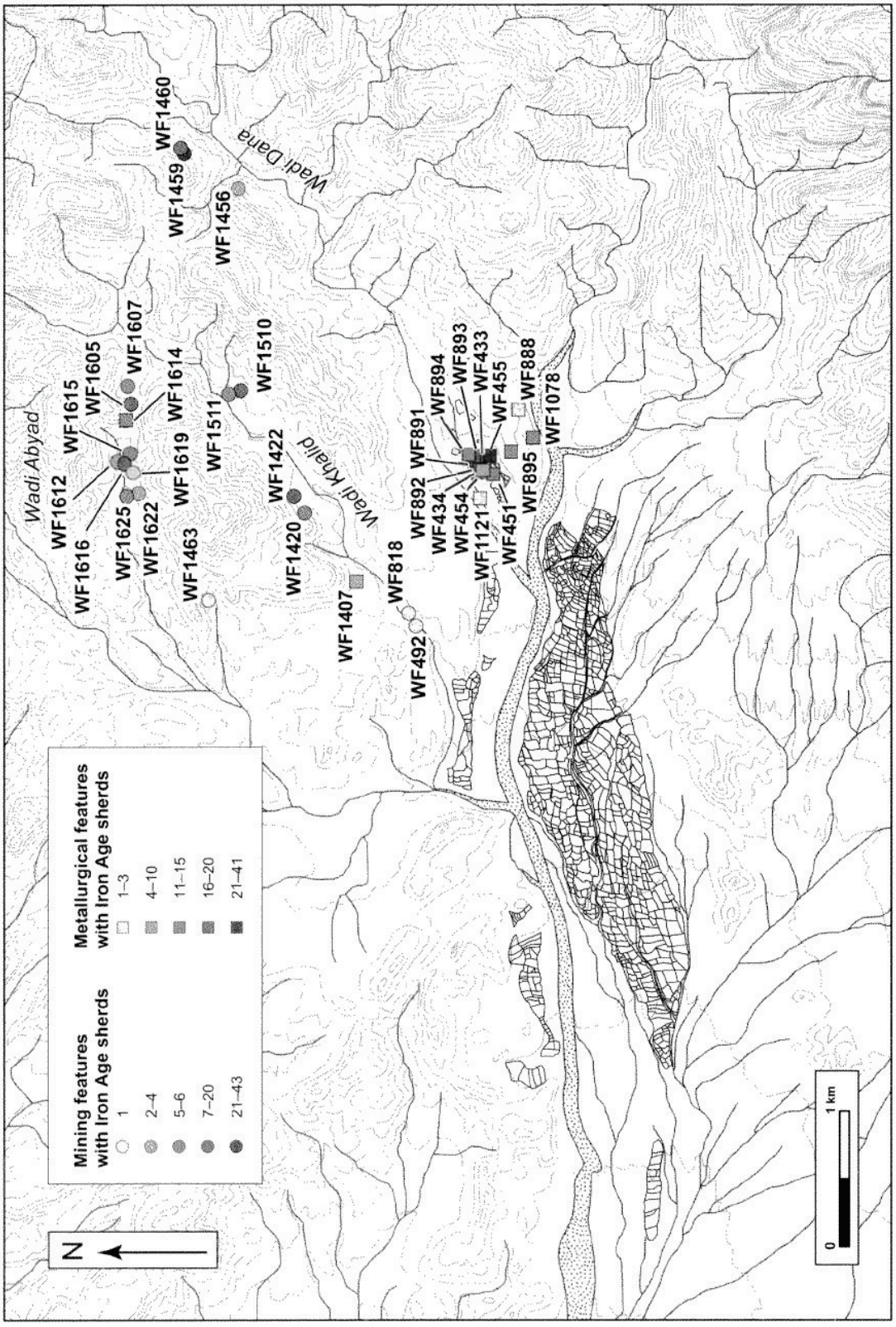

Figure 12.8 Mining and metallurgical Iron Age features recorded by the Wadi Faynan Landscape Survey in the vicinity of Khirbat Faynan (Mattingly, Newson, Grattan, et al. 2007:276); note that many of the sites were recorded also by the Deutsches Bergbau-Museum team (cf. Figures 12.4, 12.9).

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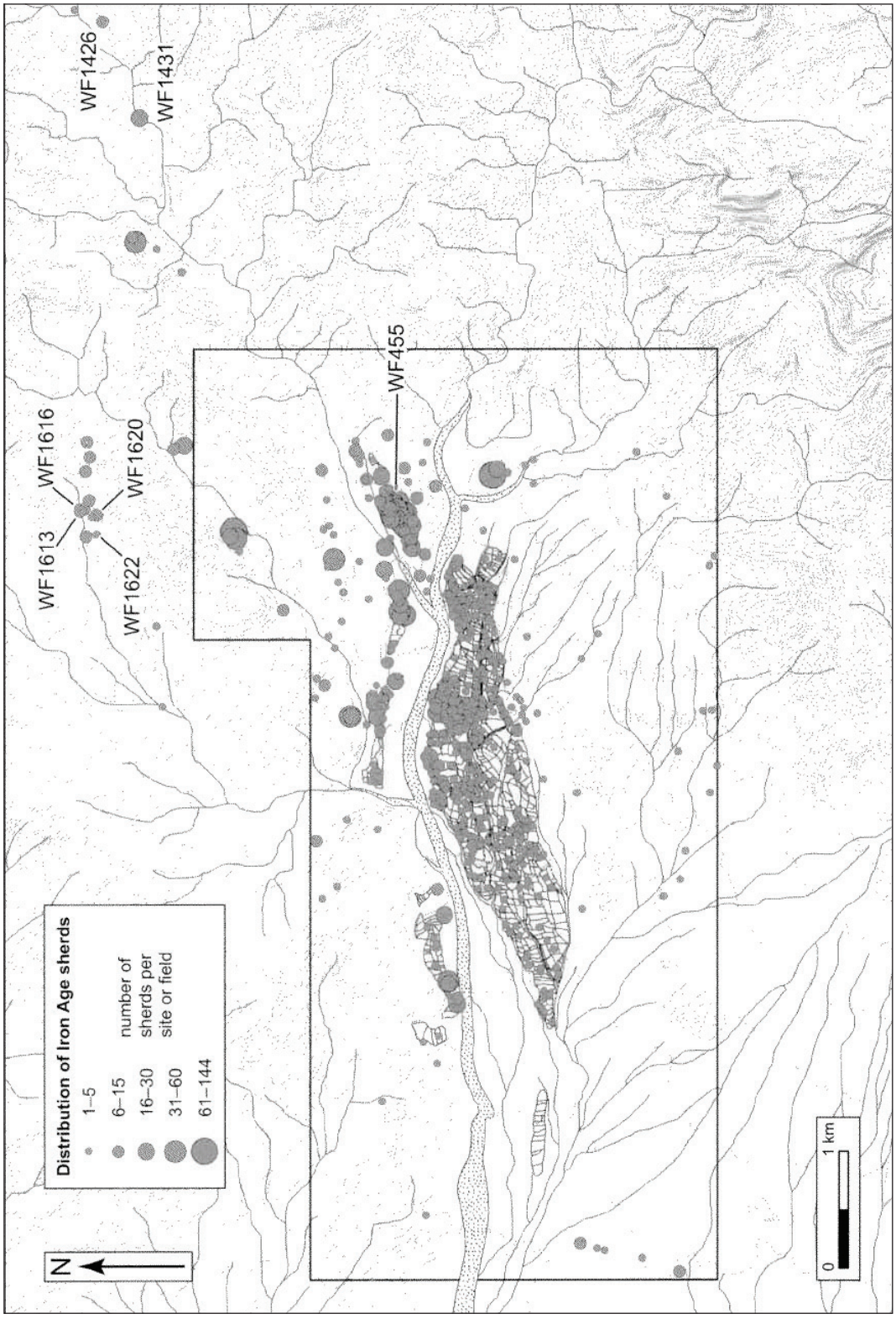

Figure 12.9 Iron Age pottery scatters recorded by the Wadi Faynan Landscape Survey (Mattingly, Newson, Grattan, et al. 2007:280); note in particular the high concentration in the agricultural fields and near Khirbat Faynan (WF455); cf. Figures 12.4 and 12.8.

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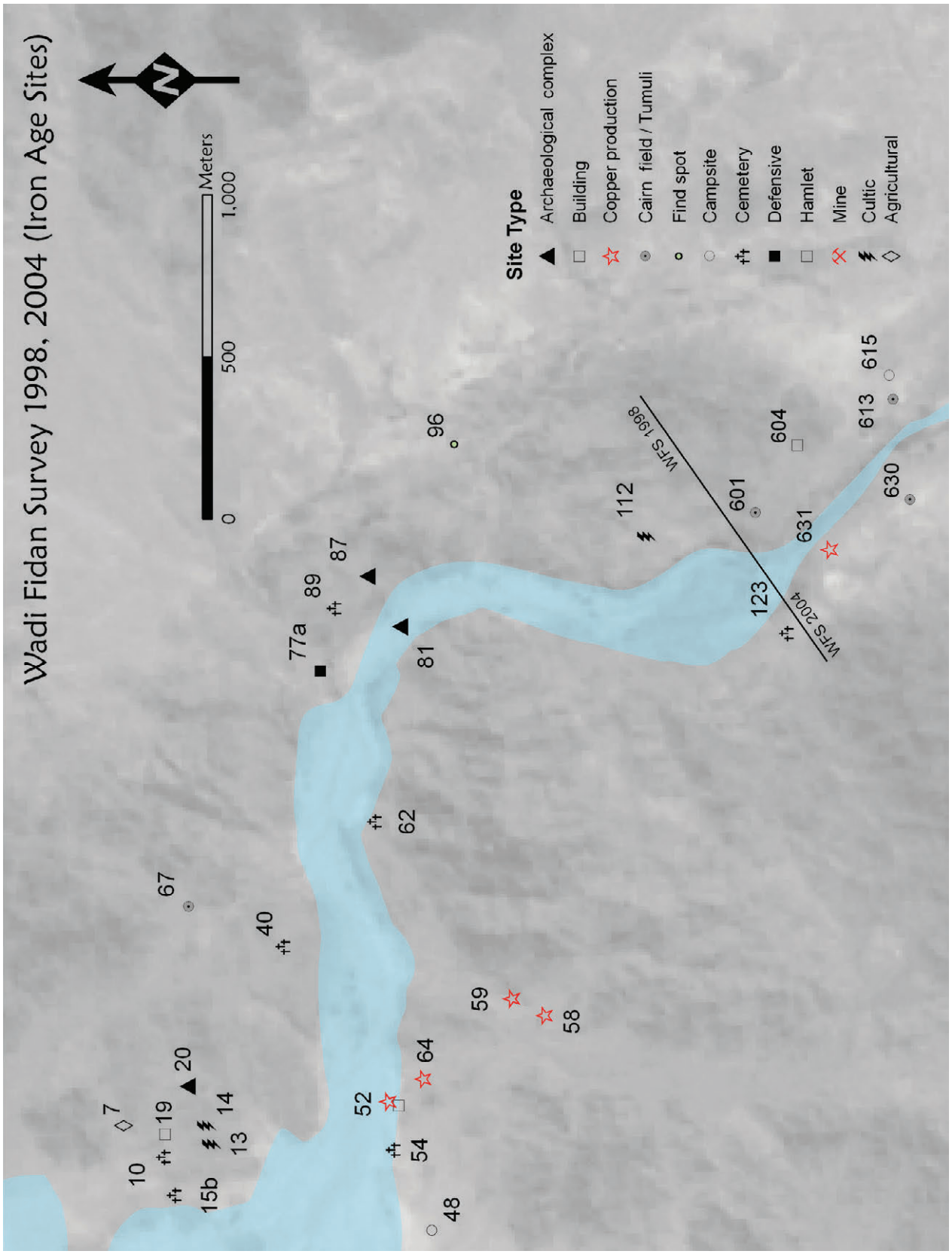

Figure 12.10 Iron Age sites of the Wadi Fidan Survey: the 1998 and 2004 seasons (see Chapter 7, this volume). Note that Khirbat Hamra Ifdan (WF120) is not indicated here as an Iron Age site; the current research shows that one of the major slag piles there is an Iron Age deposit.

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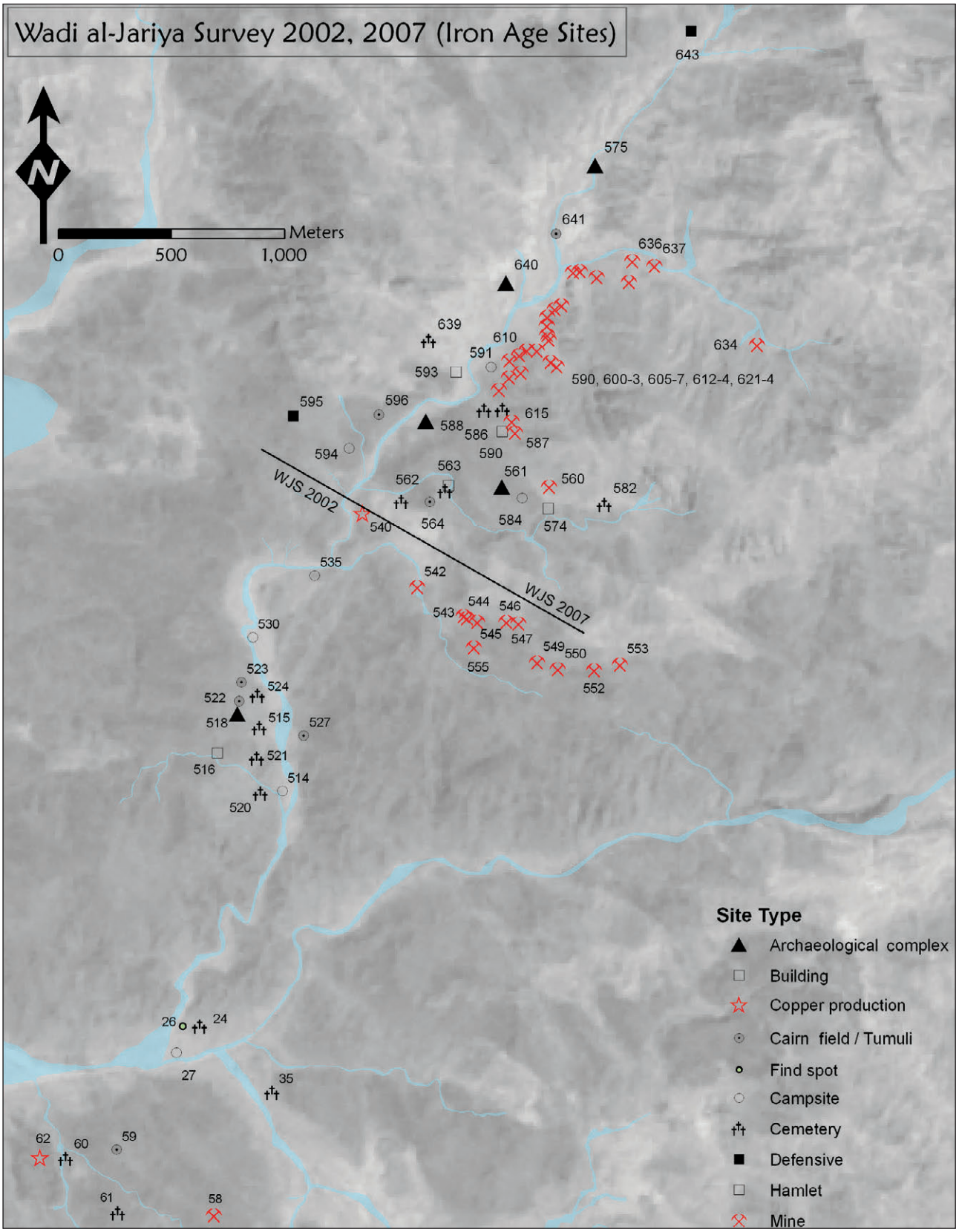

Figure 12.11 Iron Age sites of the Wadi al-Ghuwayba and Wadi al-Jariya surveys. Site 62 is Khirbat en-Nahas and Site 540 is Khirbat al-Jariya.

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The horizontal exposure is the basis for synchronic reconstruction of the organization of production, and the stratigraphic sections in the deep soundings are the basis for assessing diachronic social and technological processes. The digital recording system basically eliminates the need for excavating in squares (except when stratigraphic sections are required), and in most cases, the architectural features were entirely exposed with balks left only in a specific location for stratigraphic correlation and future reference. The basic excavation unit at KEN in open areas has been the 5 × 5–m square, a standard unit in the excavation of biblical sites in the southern Levant (Clark et al. 2010; Dever and Lance 1978).

The nature of excavation in archaeometallurgical sites is quite different from excavation in regular settlement sites (e.g., Rothenberg 1980). Like all excavations, this requires careful attention to both cultural and natural formation processes (Schiffer 1987, 2010). Metal production activities and especially the smelting process result in rather rapid accumulation of waste, and slag mounds can form in a relatively short amount of time. Such metallurgical deposits consist of thin horizons (layers) that may represent a single smelting cycle. Often, especially in areas designated for disposal of metallurgical waste, these thin horizons often have initial strong inclination (see, e.g., Chapter 2, Area M, this volume) that makes it difficult to delineate homogeneous loci and to interpret sections. The colorful interchanging horizons of clay, tuyère and furnace fragments, and various types of slag are often disturbed by intrusive pits and sometime invasive installations built on top of the metallurgical waste; they demonstrate a complicated three-dimensional depositional structure and often consist of a variety of sediments that are difficult to interpret. Even with careful and precise recording of sediments and finds in slag mounds, the reconstruction of the metallurgical processes is limited. This complexity stems from the inherent quality of the metallurgical process itself, mostly from the fact that each smelting cycle ended with deliberate destruction of the (upper portion) of the furnaces to obtain the metal chunks and copper-rich slag materials. Meticulous work on the archaeometallurgical collection in the laboratory and some random finds of semi-complete installations (rarely in situ) are the key to technological interpretations. The initial approach of defining each horizon as a "layer" in Area M during the KEN 2002 field season (supervised by E. Monroe) was abandoned in the 2006 field season (supervised by M. Beherec and E. Ben-Yosef) in favor of a larger scale excavation of the slag mound, more robust stratigraphic division, and more careful division into loci. This approach was also taken at other excavated slag deposits described below. The major stratigraphy in the excavation areas is based mostly on substantial changes in the sequence of the architectural remains. The accompanying radiocarbon dates helped to refine this stratigraphy (especially in the deep sounding at the KEN-M slag mound, where architectural features were scant) and to correlate between the noncontiguous excavation areas. As shown in Chapter 2, high-resolution radiocarbon dating, in conjunction with tight contextual control (Figure 12.12), is especially important when establishing stratigraphy and chronology of metallurgical mounds because of the very nature of such deposits, which, in addition to the rapid (or rather unknown and changing) and complex accumulation described above, usually lack a rich repertoire of pottery and other material culture remains conventionally used to establish chronologies and correlations (see Chapter 2, this volume). The excavations at KEN (Chapter 2, this volume), KAJ (see below), and Timna 30 (Ben-Yosef 2010) provide a unique case in which accumulation rates of ancient metallurgical debris can be estimated with a large and robust suite of high-precision radiocarbon dates.

All the associated information of the spatially recorded contexts (e.g., the excavation area, date, square, locus description, basket, special find descriptions) is stored in GIS as part of the shapefiles (the ESRI basic GIS file system) and as Access files (digital forms) directly linked with the spatial data. At the end of each excavation day, the data are exported into ArcGIS on GIS-designated PC laptops. A "daily map" with all the opened and closed loci of the day, together with all specific point finds, is drawn and serves as a graphic journal for the area supervisor. A key feature of the GIS recording system is that each artifact (or other recorded features) has its own recording symbol and can easily be graphically illustrated on the map (see Introduction, this volume).

The digital recording system also uses georeferenced digital photography shot in the field and digital photography of artifacts (also linked to the general GIS database) in the laboratory. Photographs taken in the field by the supervisor and directors were downloaded each day, and the files were renamed systematically and linked to the general database. Photographs taken

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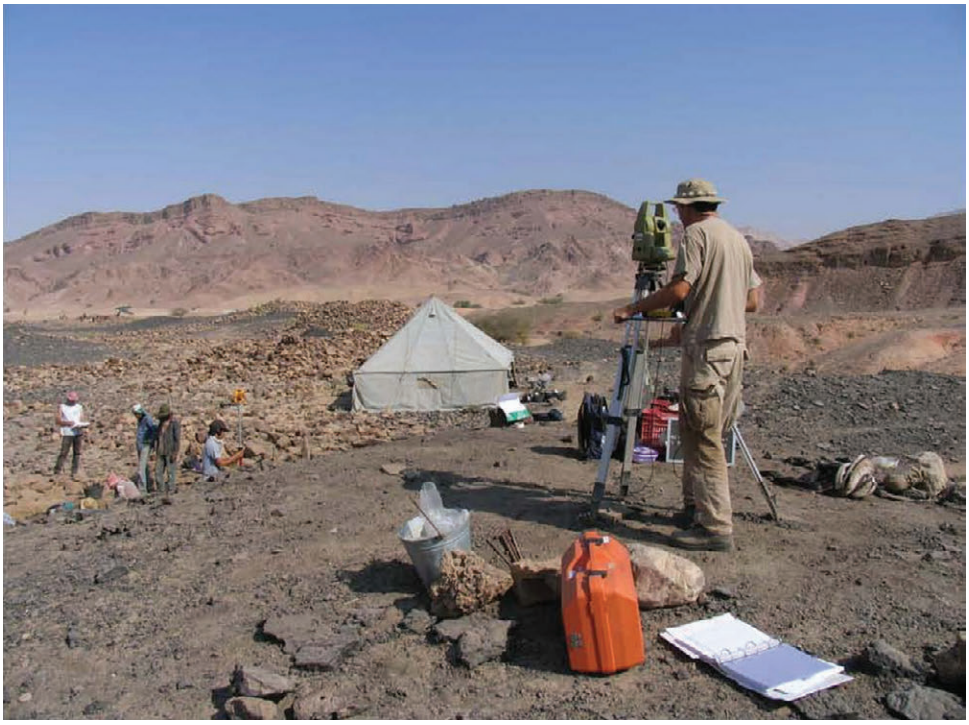

Figure 12.12 Recording point data with a total station at Khirbat en-Nahas, Area M (ELRAP 2006, supervised by M. Beherec and E.B.-Y.). The total station is located on the top of the slag mound over a datum and directed toward the center of the prism on top of a metric rod or "Pogo Stick." The coordinates (of the bottom tip of the Pogo) are subcentimeter resolution, assuming that the stick is held vertically (a bubble level is attached to the stick).

with a boom stick (Levy and Smith 2007:51, 53) or a helium balloon (in the ELRAP 2009 season; see Levy, Petrovic, et al. 2010) were georeferenced and used for drawing architectural features in the GIS laboratory. In addition, every artifact that was recorded separately in the field is photographed in the laboratory; with its unique EDM number, it is linked to the GIS database. This enables production of interactive maps in which the photos of the artifacts (and associated digital forms) can be presented to the user on the spot.

In the ELRAP 2009 field season, our expedition to Faynan used a portable X-ray fluorescence (XRF) device (Ben-Yosef 2010:Sections 8.2.1 and 8.5.1) to obtain quick chemical analyses of material and small three-dimensional scanners for documenting pottery sherds (Levy, Petrovic, et al. 2010). The chemical profiles of artifacts and the three-dimensional images are also in digital formats that are linked to the GIS system (Levy, Petrovic, et al. 2010).

The digital database includes thousands of spatial data points and digital images and hundreds of digital forms (Access files) and associated materials (Excel summary spread sheets, supervisor reports, etc.). In addition to fast and accurate graphic display, the GIS system enables powerful analyses and statistical manipulations of the data in a way not possible with manual recording. Storing all the recorded information in one database helps to share it with other scholars; the aim of the ELRAP system is eventually to make this material available online for the scholarly public. In addition, this recording system, coupled with the digital photography of each artifact, helps with later analyses of the finds after the end of each field season as most of the special artifacts have to be stored in their home countries (the Department of Antiquity of Jordan or Israel Antiquities Authority) and cannot be shipped to the foreign research universities such as the University of California at San Diego (UCSD). With the exception of special finds (such as metal tools, scarabs, etc.), most of the non-museum-quality artifacts, including the bulk of the archaeometallurgical inventory, were shipped to the laboratories at UCSD.

The Archaeometallurgical Recording System

The extensive deposits of archaeometallurgical debris in the Iron Age smelting sites excavated as part of ELRAP required a specific recording method, with special attention to organizing a large inventory of artifacts and sediments related to the copper production process. It is important to outline this method here as all the excavation probes described below, like KEN, used this system. The greatest challenge in developing such a method for the smelting sites of the Arabah is how to sort meaningful information out of the massive excavated material. In contrast to careful excavations at relatively

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small metallurgical workshops (e.g., the excavations of the iron smelting workshop and smithy at Tel Hammeh and Beit Shemesh; see Veldhuijzen 2009), the project at KEN unearthed over 8 tons of archaeometallurgical sediments focusing on large exposure rather than a detailed reconstruction of each installation, because these were rarely found intact in the excavations. Nevertheless, when unique metallurgical remains were recognized (mostly intact furnace bases), a more careful excavation procedure was applied. As part of the ELRAP's 2006 field season, we developed a system for excavating, collecting, and recording archaeometallurgical deposits[4] as described below.

The remains of the copper production processes include various types of materials and artifacts, some of which are found in huge quantities. A comprehensive list of metal production–related finds includes various types and sizes of slag (Bachmann 1982); fragments of technological ceramics (furnaces, tuyères, bellows tubes, crucibles, molds, and other related installations); ash and charcoal; stones (portions of installations); chunks of copper, manganese, and iron ore; copper prills; chunks of metal (copper and sometimes iron, products of the initial smelting); various ground stone artifacts for crushing and processing ores and slag (grinding slabs, hammer stones, pestles, mortars etc.); various sediments (mostly clayey soils mixed with ash, crushed slag, etc.); and some other related finds (see also Ben-Yosef 2010:Table 8.1).

The artifacts in most of the archaeometallurgical categories were recorded separately with and received their own EDM numbers and specific locations. Such artifacts were catalogued in the expedition digital recording system (GIS-based, including photography). Slag, furnace fragments, and associated sediments were present in large quantities and collected in bulk. In certain cases, tuyère fragments, copper ore chunks, and charcoals were not collected individually and were assigned a general basket associated with a specific locus and excavation day. Slag was documented in the field, classified, and weighed, and only sampled material was collected for the lab. Further documentation of the archaeometallurgical finds collected as bulk was done in the "dirty laboratory" (the laboratory back at camp where finds are cleaned, sorted, undergo preliminary analyses, and are processed for shipping/storage) at the end of each excavation day. The following provides more detail on how the archaeometallurgy samples were collected and initially processed in the field:

(1) Slag

Slag slabs and fragments are the most abundant find in KEN, KAJ, and other copper smelting sites in Faynan. For illustration, during the 2006 field season at KEN, the total amount of weighed slag was 16,666 kg (from Areas M, A, F, T, and R and KAJ, Area A), and in 2002 field season, it was 18,644 kg (from Areas A, S, and M). To deal with such large quantities without losing essential data, we developed a method of slag collecting and recording, ensuring sufficient description and sampling.

Most of the slag processing was done in the field and the rest in the dirty lab of the expedition after each excavation day. For each locus, we collected all the slag pieces larger than a fist size (greater than ~5 cm) into buckets (*guffas*, قفة Arabic for rubber buckets made of recycled tires). Then the slag pieces were sorted by size into three groups (smaller than ~10 cm, ~10 to 20-25 cm ["large"], and greater than 20-25 cm [slag slabs]), described (color, texture, inclusions), weighed (usually with a metric spring scale), and sampled. The samples, which we stored as part of the expedition collections, were made of 1 kg or more of slag pieces from each size type per locus. We also collected samples with characteristic features that were found during the sorting process (e.g., slag with charcoal, slag with ore, slag with copper metal, glassy slag, slag droplets, etc.). To estimate the amount of small slag fragments (less than ~5 cm), we sieved at least one plastic bucket (with a known volume) per locus with a ½-inch screen, weighed the remaining slag fragments, and collected a representative sample (knowing the concentration of small slag fragments from sieving a bucket of known volume, a rough estimation of the amount of small slag fragments in the entire locus was calculated, based on loci volume calculated with ArcView).

For each locus with slag remains, we documented the following: (1) description of the slag according to their size distribution, (2) exact measurement of weight for slag pieces that are larger than fist size and an estimation of the weight for the slag pieces that are smaller than fist size, (3) 1 kg or more of slag fragments per each size type, and (4) samples of slag with characteristic or unique features. The division into size groups corresponds to fine-crushed slag (the smallest size), slabs of tap slag (the largest size), and broken furnace and/or broken tap slag (the two intermediate sizes). In addition to the method described above, some unique slag pieces (e.g., slag droplets, slag with copper ore, glassy slag, etc.) or slag pieces with an important

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location inside the locus (e.g., slag with dateable charcoals, slag attached to furnace, etc.) were recorded as a point find with a total station.

All general samples of slag fragments (per locus per size) were also recorded by taking two scaled digital photographs for each, one of the bulk collection of slag pieces and the second of one representative piece. This last stage of recording is aimed to produce a "slag library" made of digital photos (for delivery over DAAHL; http://daahl.ucsd.edu/DAAHL).

The method of recording and collecting slag described above is more advanced and comprehensive than the one used in the 2002 season. Based on the experience acquired during the first season of excavation at the site, in 2006 we collected many more slag samples for further investigation. The slag-sorting procedure was simplified and included less categories (in 2002, six categories were used: large furnace slag, small furnace slag, large tap slag, small tap slag, granulated, and crushed). In the 2002 season, there was no systematic sieving per locus for documenting small slag fragments; instead, in Area M only, there was a designated 1 × 1–m "control area," in which all sediments were sieved, and all slag pieces were sorted, weighed, and collected.

(2) Furnace Fragments

All fragments of furnaces were collected in general baskets except in cases when unique, well-preserved, or concentrated assemblage fragments were uncovered and recorded as a point find with the total station (including photography). The hundreds of fragments recorded as point finds have been key to reconstruct the metallurgical installations of KEN and KAJ. The furnace fragments collected in buckets were sorted in the dirty lab of the expedition after each excavation day. During the routine work in the field, the designated "furnace fragment" buckets filled up with miscellaneous technological ceramics. Most of the misplaced tuyère fragments were sorted out in the dirty lab, but only during the work on the archaeometallurgical collection at UCSD in 2010 was it possible to distinguish between furnace fragments and fragments of what are probably crucibles, molds, and other unidentified parts of metallurgical installations (see Chapter 13, this volume).

During the field season (in the dirty lab), the furnace fragments were divided into three groups: bulk chunks of poorly preserved furnace fragments, well-preserved furnace fragments, and indicative or unique furnace fragments (e.g., furnace rims and bottoms). The fragments from the three groups have been counted (estimation), described, weighed, and measured (size range) per basket. The indicative or unique furnace fragments were photographed and stored separately; some are illustrated and presented here. Our experience shows that even careful excavation cannot replace the detailed study of the technological ceramic material in the laboratory for the precise classification of the finds and establishing basic technological interpretations (a similar experience was reported for the excavations in Timna by the Arabah Expedition; see e.g., Rothenberg 1990).

(3) Tuyère Fragments

In the majority of the loci in the excavation at KEN, KAJ, and KAG (and in all of the loci at Timna 30), tuyère fragments were collected separately; for ELRAP, this was done as point finds recorded with a total station (including photography). The number of fragments coupled with their description (front or back parts, preserved diameter, etc.) may be key for estimating the number of furnaces (or the minimum number of furnaces) in a specific context, and thus we counted and recorded them carefully (see Chapter 13, this volume). In some loci where a high density of tuyère fragments was found (mostly in Areas A, F, T, and R), we collected the fragments in general baskets (corresponding to specific locus and excavation day). In addition, fragments of misidentified tuyères appeared from the sorting of furnace fragments buckets in the dirty lab. These were assigned general basket numbers and stored separately.

Every fragment of tuyère, the ones that were collected separately and those that were collected as part of a general basket, was also documented in the dirty lab. The sample was given a detailed description, including size (length parallel to the tube), color, inner diameter of the tube and minimum outer diameters (usually a fragment of a conical shape), material characteristics, and presence of attached slag. Special attention was given to unique features such as residue of copper ore, charcoal or prills, textile or reed imprints on the clay, whether the sample was well preserved, and if it had an unusual shape. Fragments with unique features found in the general baskets were stored separately. The entire inventory was carefully counted.

In the field, tuyères and clay bellows pipes were often confused by the student excavators. Only when we reinvestigated the archaeometallurgical collection in

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the laboratory was this corrected, although not in the digital database used for GIS analyses. The recorded information, especially in Area F, where bellows pipes were relatively abundant, may be not accurate in the current GIS database. The tuyères and bellows pipes were processed in the same way during the field season (counting, description, and measurements). In general, bellows pipes are rare in KEN and completely absent in the recent excavations of KAJ, KAG, and Timna 30. They probably represent an even more specialized and specific activity (see below).

(4) Copper Ore, Charcoal, and Sediment Samples

The method of collecting copper ore fragments depended on their frequency. In contexts where ore fragments were abundant, they were collected in general baskets (corresponding to the locus and excavation day); otherwise, they were collected as point finds. In some cases, oxidized copper metal was confused as copper ore fragments; this was corrected only in the laboratory (and sometimes even then it is not easy to distinguish between the two, especially when they are attached to slag).

Charcoal was collected mostly as point finds, but in contexts where they were abundant, we collected them in general baskets for species identification and other investigations not related to radiocarbon dating. Sediment samples were collected as point finds, and a representative sample was collected for each metallurgical locus or distinct context (identified primarily by color and texture).

The excavations resulted in a vast inventory of archaeometallurgical artifacts and ecofacts, digitally recorded as part of the GIS database and stored in the UCSD Levantine Archaeology Laboratory (most of the collection), in the storage facilities of the Department of Antiquity of Jordan, and at the Institute of Earth Sciences at the Hebrew University of Jerusalem (artifacts from the new excavations at Timna 30; after final processing, these objects will be stored with the Israel Antiquity Authority). The artifacts stored at UCSD constitute one of the most comprehensive Iron Age archaeometallurgical collections currently available for research in the world. Only a small portion of these artifacts has been analyzed as part of the current research, and the collection provides ample opportunities for future investigations. The organization of the metallurgical collection at UCSD is described in Ben-Yosef (2010:Chapter 8); finally, a number of future research questions are presented as part of the conclusions of this chapter.

Survey Methods

Several important Iron Age sites investigated as part of the current research were recorded as part of the FBRS conducted in 2007 as part of ELRAP and supervised by Ben-Yosef. These are described in detail in Chapter 6; however, to help contextualize the regional picture of the copper production system, some FBRS data are discussed in this chapter. As described in Chapter 6, the focus of the FBRS survey was to identify and record Iron Age roads in the region between Faynan and Busayra; therefore, a special recording system for routes was also included. In general, the recording method is tied directly to the GIS-based system of ELRAP described in the Introduction to this volume, but for the survey, the total station was replaced by a differential Global Positioning System (GPS) device as described in Chapter 6.

The accessible terrain of the northeast Faynan region was surveyed by a team of four, with a four-wheel-drive pickup truck and by foot, sometimes backpacking and camping to explore remote destinations. Locations of FBRS sites and road segments were recorded by a differential GPS system (see Chapter 6, Figure 6.9, this volume), with the base station located on a roof of a rented house in the village of Quraiqira.[5] Each GPS reading was assigned a unique number in a running order (1 to 12,501). The precision of the location records after correction is subcentimeter in both the x–y coordinates and the elevation, although technical problems during the fieldwork sometimes resulted in precision of up to a submeter resolution. For any practical and interpretational purposes, a submeter resolution is adequate and more than the commonly available resolution in archaeological surveys (until the 1990s, location coordinates were obtained only from topographic maps). To check the accuracy of the system, we established control points that were measured repeatedly and on different days (they were also used as a reference for the daily initiation of the GPS). The greatest benefit of a differential GPS system is that it enables recording architectural features relatively fast and "on the fly," resulting in accurate architectural plans (e.g., FBRS Sites 12 and 37; see below). For each site, we recorded with the GPS system a point in the center, a polygon of its area, and its architectural features. Site recording included also

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collecting pottery sherds and any diagnostic artifacts (if found), digital photography (almost 1,700 in total, including road segments), and detailed written descriptions (Chapter 6, Figure 6.9a,b, this volume).

Road segments were recorded by walking with the GPS antenna (Chapter 6, Figure 6.9c, this volume) or, in a few cases, by holding it in the back of the truck. Sometimes only representative segments of a road were recorded (start/end, switchbacks, etc.). The roads were divided into six categories according to their accessibility level: current/old dirt roads and goat, donkey, and camel (and unidentified) (see further details in Chapter 6, this volume).

The data collected by FBRS are part of a GIS and Microsoft Access database. A daily topographic journal was the basic method of collecting field notes, including the description of many archaeological features not recorded as a site or a road segment. Field observations were noted on a printed large-scale UTM map and additional data can be found there.

Archaeometallurgical Features at the Outskirts of Khirbat en-Nahas

On the slopes surrounding Khirbat en-Nahas from all directions (except in the north, where the site boundary is Wadi al-Ghuwayba), there are several locales with thick layers (up to 1.8 m high) of fine-crushed slag (Figures 12.13 and 12.14).

The fine-crushed slag deposits are some distance from the main activity areas of the site and are not associated with any substantial architectural features. They consist of several thousands of tons of solid black granular slag with an individual grain size of up to 0.5 cm. The depositional characteristics of these deposits, including condensed and cemented layers with flow patterns, raised the possibility that water was used in the crushing process for washing out and sorting copper prills (Hauptmann 2007:129–130). This suggestion does not seem to be probable, if only because of the severe problem of water supply in this arid region. It is more likely that the consolidation of these deposits

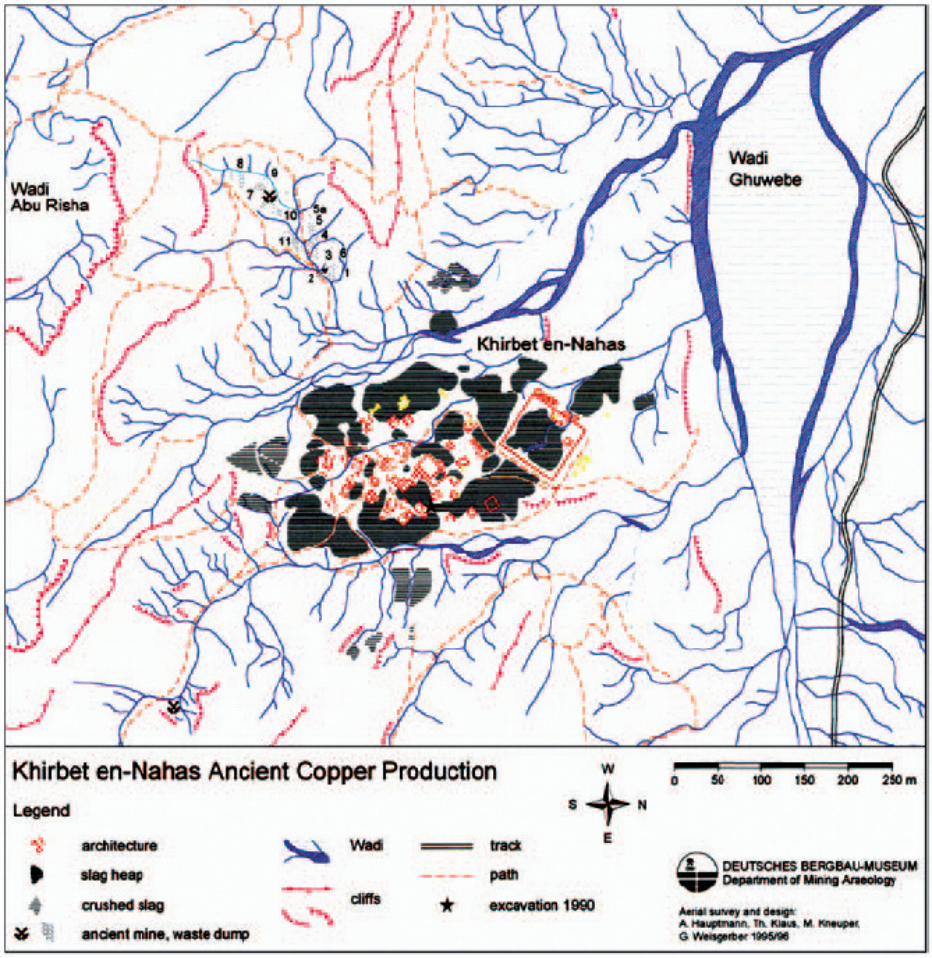

Figure 12.13 A map of Khirbat en-Nahas and its vicinity (Hauptmann, 2007:129) showing the location of the unique crushed-slag deposits on the slopes surrounding the site and the location of copper mines surveyed by the GMM team.

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Figure 12.14 Thick deposits of fine-crushed slag on the slopes surrounding Khirbat en-Nahas.

relates to post-depositional processes and exposure to random rains throughout the millennia. In any case, the vast layers of fine-crushed slag testify to the importance of slag crushing in the copper production process at Khirbat en-Nahas (see Chapter 13, this volume, and Ben-Yosef 2010:Chapter 9).

In the immediate vicinity of Khirbat en-Nahas, a number of mines were reported by the DBM team (Figures 12.13 and 12.15). Most of these mines concentrate in a small wadi to the west of the site and are represented by large waste/tailing piles. A few are located to the southeast of the site, in the small wadi connecting KEN and el-Furn (الفرن) (see also Figure 12.11). These mines penetrate the copper-bearing horizons of the Burj formation and are probably similar (technologically) to the ones recorded by our team in Wadi al-Jariya (Chapter 7, this volume; Levy et al. 2003). Until the discovery of the nearby Jabal al-Jariya mine fields in 2007 (see Ben-Yosef, Levy, et al. 2009a), it was assumed that these few mines around KEN were the main copper ore source for the site throughout the Iron Age, notwithstanding the recognized discrepancy between the vast evidence of smelting at KEN and the relatively minor evidence of mining near KEN and generally in Faynan (e.g., Hauptmann 2006:128).

Khirbat en-Nahas Archaeometallurgical Remains A Summary

The approximately 10-ha site of Khirbat en-Nahas is located on an elongated shallow wadi terrace (or a spur) between Wadi al-Ghuwayba in the north and two local small wadis to the east and west (Figure 12.13). Field surveys and investigation of the maps (Figure 12.13), aerial photographs, and satellite images (e.g., Figure 12.15) show that the slag mounds are concentrated mostly around the perimeter of the site, probably because the edges of the occupied areas and the slopes of the local wadis were preferred locations for smelting activities and dumping of metallurgical waste. Khirbat en-Nahas is not surrounded by any wall or other defensive elements; however, the pattern of distribution of slag mounds, although not strict (many small slag mounds are also located throughout the site), created a well-defined central area dense with structures of various size and function. In the north of the site near the entrance to the smelting complex from Wadi al-Ghuwayba, a large, 73 × 73–m fortress, founded during the tenth century BCE, was on top of earlier layers of slag and other copper production waste (probably dated to the twelfth to first half of the tenth century BCE). Inside the courtyard of this fortress, a unique refining and casting workshop was excavated

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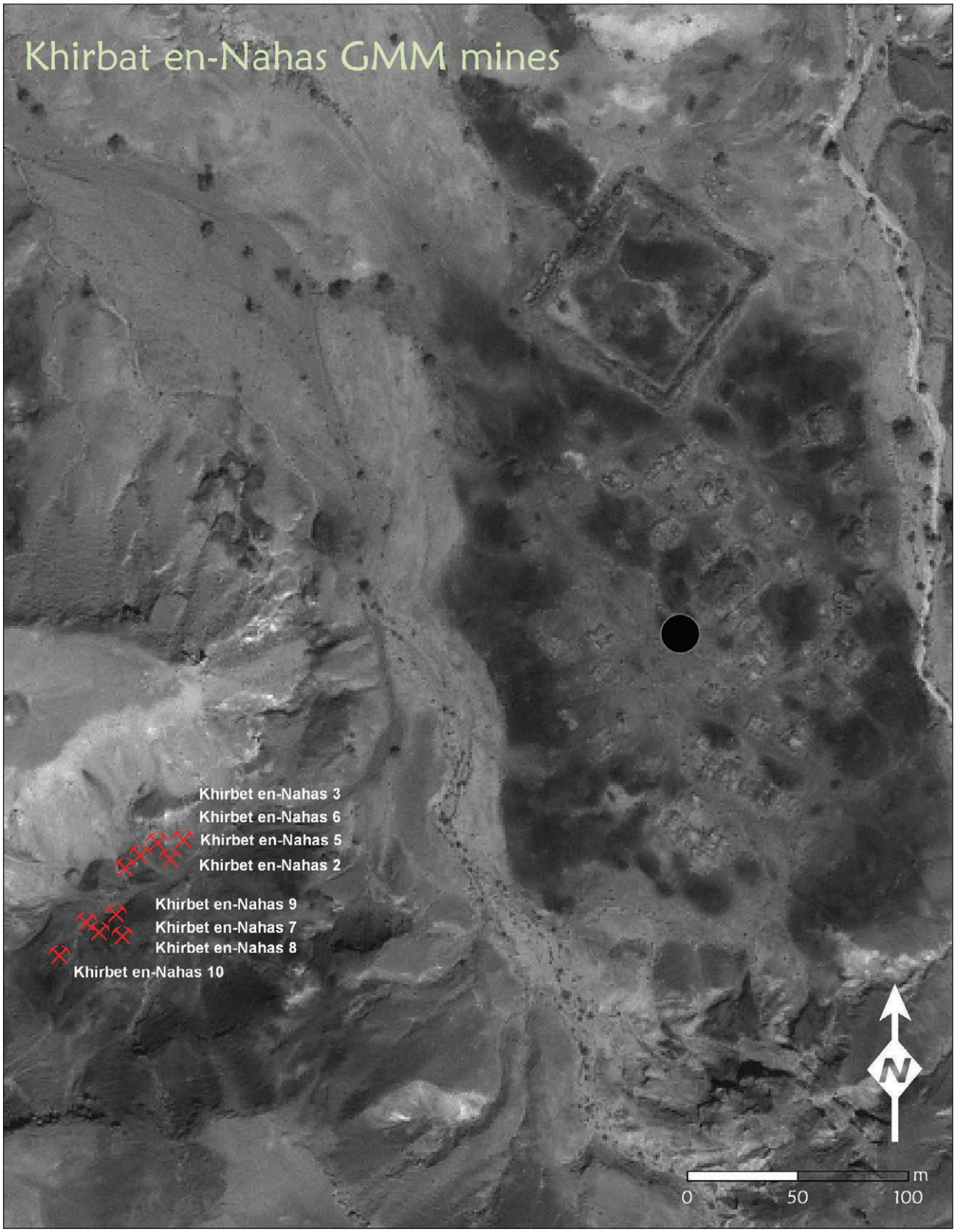

Figure 12.15 Satellite image of Khirbat en-Nahas and its close vicinity (Ikonos, Geoeye) showing the location of the Iron Age mines surveyed by the DBM team.

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in Area F. The radiocarbon dating of both the fortress's gatehouse and the workshop indicates that the structures are contemporaneous, suggesting multifunctional use of the fortress, including defense purposes, as well as an enclosed compound for special metallurgical activities, probably the most specialized crafts of refining the raw metal and preparing and storing the final products prior to their further distribution. This interesting situation of having a metallurgical workshop and other metallurgical activities in the open space of the fortress also suggests that the latter functioned not only as a defensive structure (or a compound for prisoners [cf. Glueck 1935] or some kind of projection of social power [cf. Stein 1998]) but also as a confining element separating the highly specialized metallurgical practice from the rest of activities in the site. Except for one room on the south side of the gatehouse, there are no rooms associated with the fortress's walls, and the architectural plan is quite different from the "typical" Iron Age desert fortresses in the southern Levant (see Chapter 2, this volume). Most of the complex is an open space with abundant metallurgical remains. This space also may have stored the final product of copper before shipment, via Wadi al-Ghuwayba, westward to Egypt, the Levant, and the Mediterranean. The practice of highly specialized metallurgical activities inside a confined space has parallels in Timna Sites 30 and 34 (see Ben-Yosef 2010:Chapter 6), in which the layout of the walls suggests even more a nondefensive function. Additional interpretations of these "enclosures" have been suggested, such as compounds for keeping slaves from escaping hard labor (Glueck 1935:28, who describes the fortress at KEN as "a large prison camp") (see further discussion in Ben-Yosef 2010:Section 9.1.3).

The fortress of Khirbat en-Nahas continued to be used for copper production after the gatehouse was decommissioned, and its southern entrance was blocked. It seems that in this period, the walls of the structures were robbed to construct the ninth-century buildings at the site, and entrance to the fortress courtyard was possible from any direction (Chapter 2, this volume). This is indicated by the current conditions of the walls: they are short and easily passable, and they lack sufficient collapsed stones around them to reconstruct a massive wall. The only reasonable candidates for the destination of the original stones are the nearby ninth-century buildings. The last phase of activities in the gatehouse of the fortress was some sort of metallurgical workshop and/or a designated dumping place for metallurgical waste. This probably suggests an exhaustive use of the available spaces at the site during the intense copper production activities of the ninth century BCE.

At least four massive structures with two stories and/or "towers" that are located at the center of the site (Area R) and around its perimeter (Area T); a similar structure is located to the north of this area, and another, a bit smaller, is located on the opposite side of the site, (Chapter 2, this volume)—all identified by Glueck (1940). The first phase of construction and occupation of the massive structures in Areas R and T is dated to the tenth century BCE, similar to the fortress (Chapter 2, this volume), and they are all founded on top of massive accumulations of metallurgical debris (e.g., Area T, Chapter 2, this volume). These structures have been interpreted as houses of the local elite and important local persons who were perhaps responsible for supervision of the production activities at the site. The structures in Areas M, S, and W are less massive and have been interpreted as residential, residential/industrial, and residential/cultic, respectively. In all of these structures, metallurgical-related artifacts and an abundance of various ground stones have been recorded.

The excavations in the slag mound of Area M resulted in exposing more than 6 m of copper production–related deposits, including interchanging horizons of various types of slag (fine crushed, tap, and furnace in different sizes), as well as clayey and ashy sediments mixed with tuyère and furnace fragments. Most of the accumulated material represents deliberate dumping of production waste (in particular primary smelting) at this location. In a few places, working surfaces and installations, including a complete intact furnace base and a few stone alignments, were uncovered. The metallurgical horizons present an intricate stratigraphy derived from their complex depositional process, which is fundamentally different from settlement sites. Thus, in addition to the detailed recording of the excavated material, we carefully studied the exposed walls of the pit. These sections provide invaluable information regarding the history of copper production at the site and are a basic reference for some of the analyses of the research presented in this volume (Chapters 2–13), for our investigation of the chronological framework of the site (Levy et al. 2008) and of the development of Iron Age copper production and society in Faynan (Ben-Yosef, Levy, et al. 2010; Smith 2009). In addition, slag material from these sections was the basis for archaeomagnetic studies

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focused on reconstructing the geomagnetic intensity during the period represented in Area M (Ben-Yosef, Tauxe, et al. 2009; Shaar et al. 2011).

Basically, five major stratigraphic units were distinguished in Area M (Layers M1–M5, Area M, Chapter 2, this volume). These were dated with a suite of 24 high-precision accelerator mass spectrometry (AMS) radiocarbon dates from well-controlled contexts. The basal sediments and installations belong to the last phase of the Late Bronze Age. Already in this context, fine-crushed slag was present, suggesting copper production activities at the site already in its early occupation stages. Layer M4 (Iron Age I, twelfth to eleventh centuries BCE) and Layer M3 (tenth century BCE) represent copper smelting activities, with the latter in a much more intense scale. The transition between Layer M3 and M2 represents a major change in the layout of this area of KEN. The mounds of debris were flattened to prepare the ground for a new occupation phase at the site, including the foundation of the structure complex. This transition dates to the end of the tenth century BCE and corresponds to the approximate date of the Egyptian campaign of Shishak I to the southern Levant (Kitchen 2003), suggested to be responsible for the observed disruption (Levy et al. 2008:16461). Interestingly, at approximately the same time, the sites of Khirbat al-Jariya and probably also Khirbat al-Ghuwayba were abandoned (see below). The new phase of copper production at KEN, represented in Area M by Layers M2 and M1, also included intense copper production throughout the ninth century BCE. Sometime during this period, we recognize a major change in the smelting technology with the introduction of larger installations (furnaces) and larger and different tuyères. This change has been observed in other sites (e.g., Faynan 5 [Hauptmann 2007] and Timna 30 [Rothenberg 1980]), but it is the first time we are able to precisely date this change in a well-stratified site and to thoroughly study the details of this substantial development (Chapter 13, this volume). The latest and most advanced technology is responsible for the huge slabs of tap slag visible on the surface of the site today. During this time, the slag mound of Area M became so high that the weight of the debris and the heat of the smelting activities damaged the walls of Structure 1 and put at least one of its rooms out of use. Area M, like the rest of the site, was abandoned at the end of the ninth century BCE.

According to Hauptmann (2007:127), the site of Khirbat en-Nahas contains 50,000 to 60,000 tons of slag, an estimation based on calculating the volume of visible slag mounds at the site and assuming that such mounds contain mostly slag material. However, the results of the detailed excavations of slag mound contexts at the site, particularly the slag mound at Area M, demonstrate that such mounds contain only 40 percent or less of slag material (by volume; see detailed description of the excavations in Area M and the different deposits exposed in Chapter 13, this volume). On the other hand, the excavations in the slag mound of Area M resulted in exposing more than 6 m, twice deeper than previously assumed, of copper production–related deposits. All of the excavated areas at KEN contain large amounts of copper production–related artifacts; the industrial waste is found everywhere and "penetrated" almost any context. These artifacts are discussed in Chapter 13 (this volume).

Notwithstanding the extensive excavations in recent years described above, only a tiny fragment of the archaeometallurgical deposits and related architecture was uncovered at Khirbat en-Nahas. Most probably, the data we obtained do not represent the entire metallurgical processes of Iron Age copper production in Faynan (for example, the discovery of the Area F workshop was a surprise); there are more than 90 unexcavated structures, and some may represent other specialized workshops. However, the general pattern of the industrial-scale copper production process, the spatial distribution of its various components, and diachronic changes in technology at Khirbat en-Nahas can be cautiously reconstructed. Together with detailed analysis of the archaeometallurgical artifacts (Chapter 13, this volume) and laboratory analysis of slag from various contexts (Ben-Yosef 2010:Chapter 8), the basic skeleton of the changing *chaînes opératoire*s can be established (Ben-Yosef 2010:Chapter 9).

Khirbat al-Jariya (خربة الجارية)

Khirbat al-Jariya (KAJ) is located around 3 km northeast of Khirbat en-Nahas (30.707°N, 35.452°E, ca. 150 m above sea level; Figure 12.1) in an enclosed valley hidden in the rugged terrain of the eastern Wadi Arabah. While the basic details of our excavation were previously published (Ben-Yosef, Levy, et al. 2010), it is important to review these data here to obtain a regional picture of Iron Age copper production in Faynan. The site extends over both banks of Wadi al-Jariya and consists of shallow slag mounds, numerous

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architectural features, installations, and some large structures preserved to a height of five courses and more (Figure 12.16 and 12.17). Deepening of the wadi bed over the past three millennia has eroded the center of the site (ca. 3 ha) that was mostly situated on the western bank of the wadi (note the "empty" portion in the middle of Figures 12.16–12.18). With the exception of several recent Bedouin graves and some robber trenches, the site has been left relatively undisturbed since its abandonment in the Iron Age.

The first to report KAJ was Major Horatio H. Kitchener of the Palestine Exploration Fund (PEF) in 1884 (Chapter 6, this volume; see also Ben-Yosef 2010:Section 3.1). In 1883, Kitchener led an expedition along the Arabah Valley, leaving 'Aqaba on December 3 and traveling north along the eastern margin of the valley, reaching the Faynan region after several days. Their first campsite was at 'Ain al-Buweirdeh, a small oasis in the sand dunes of the southwestern part of the region.[6] The next day, the expedition continued north, missing Khirbat Faynan (which is further to the east than their course of travel), and pitched a campsite near the mouth of Wadi al-Ghuwayba. While Kitchener himself explored the western side of the Arabah (although without reaching 'Ain Huseib "owing to the want of knowledge of the locality by [his] guide"), G. Armstrong (Royal Engineer) explored the landscape to the east:

> Camp was pitched near the mouth of Wady Guweibeh, and I was extremely glad to find that a day's halt was to be made in this locality. … Armstrong explored the country towards the east, and found, six miles north-east of Feidan, the ruins of a small town in a valley, surrounded by bold and precipitous cliffs; the ruined walls are from a foot to 3 feet high, the stones roughly squared, and of no great size; some black heaps resembling slag heaps point out that very probably ancient mines may be found in the neighbourhood [Kitchener 1884:213–214].

A study of the PEF map of this expedition (Chapter 6, Figure 6.5a,b, this volume) shows clearly that the small town is Khirbat al-Jariya, making this report to be the first to mention the site and to recognize this part of Faynan as an ancient mining district. The next passage is also interesting:

> A path leads from Wady 'Arabah to this valley [of Khirbat al-Jariya], crossing the watershed into Wady Ghuweir, where it joins, leading up the valley in a south-easterly direction, a beaten and well-worn track: this was probably the pilgrimage road from Gaza to Mecca. Lower down in the Wady (Wady Ghuweir) are numerous springs of sweet water trickling out of the bed of the wady; and in a narrow gorge the rocks are literally covered with Bedouin tribe marks, Arabic inscriptions, &c., the work of pilgrims on their way to Mecca [Kitchener 1884:213–214].

This unique description actually follows Naqb al-Jariya to Wadi ad-Dahal (here named Wady Ghuweir) and clearly indicates the importance of Naqb ad-Dahal as a central route connecting Wadi Arabah to the highlands for centuries and millennia.

The American archaeologist Nelson Glueck (1935:23) visited KAJ on March 25, 1934, after exploring the nearby Khirbat al-Ghuwayba. Glueck believed he was the first to discover the site and attributed his find to the seclusion of the ruins, mentioning that even the Czech explorer Alois Musil, who visited the nearby Jabal al-Jariya in 1898, could not find them. Glueck correctly assigned the site to the Early Iron Age but incorrectly interpreted certain structures as smelting furnaces (Glueck 1935:23–25; 1940:63, Figure 28). This problem plagued Glueck's interpretations at other archaeometallurgical sites along the Arabah Valley as he probably was following the misinterpretations of one of his mentors: Sir W. F. Petrie in Sinai (1906:18). At Timna, some of these same small structures were suggested to be the graves of the workers (Rothenberg 1967:12 and n49, n79, n154). In addition, Glueck's (1935:23) claim that "the two main sections of the site seem originally to have been enclosed with strong walls" probably relates to his supposition of servile labor in the smelting camps (e.g. Glueck 1935:28) and has no support in current field observations.

After Glueck, KAJ was visited by the Deutsches Bergbau-Museum (DBM) team (Hauptmann 2007:131–132). They estimated the amount of slag at the site to be around 15,000 to 20,000 tons (cf. estimation for KEN = 50,000–60,000) and published three radiocarbon measurements from the upper portion of some slag mounds that suggested an early IA I date (see Table 12.2 and Hauptmann 2000). In 2002, our team surveyed and mapped the site (see Figure 12.18) together with some other small IA ruins and copper mines around Wadi al-Jariya (Figure 12.11) (Levy et al. 2003).

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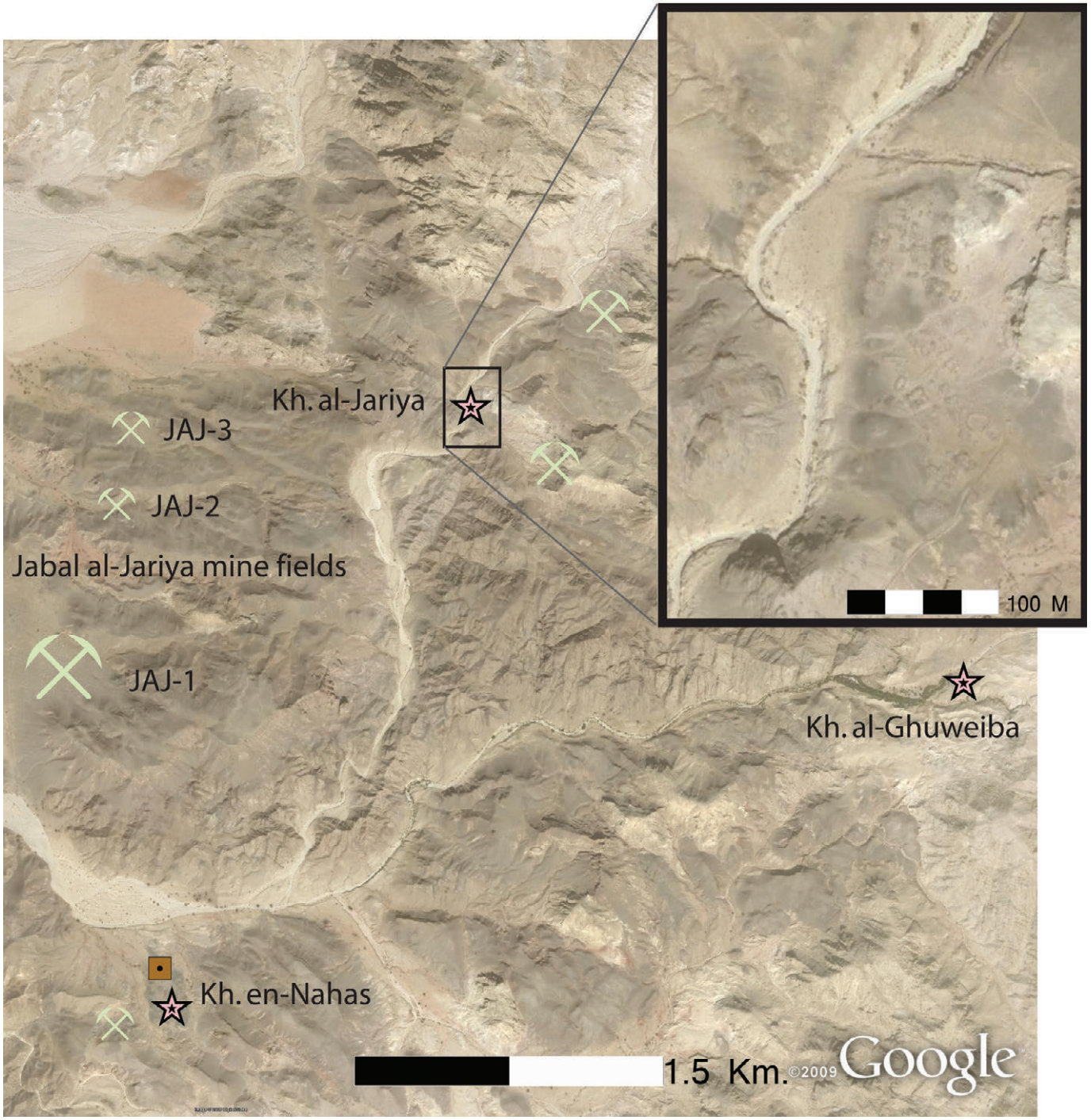

Figure 12.16 Satellite image of Khirbat al-Jariya and its vicinity; for key see Figure 12.1 (reproduced using Google Earth Pro) (after Ben-Yosef, Tauxe, et al. 2010).

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Figure 12.17 The Iron Age copper smelting site of Khirbat al-Jariya, looking toward the north (note people in Area A for scale). The site is bifurcated by Wadi al-Jariya, whose deepening eroded a significant portion of the ~5-ha ruins. Also visible are the relatively shallow slag mounds and some substantial stone structures, probably dating to the eleventh to tenth centuries BCE.

The first stratigraphic probe took place at KAJ from November 13 to 27, 2006, aiming to clarify the chronology of the site and characterize diachronic changes in the copper industry by comparison with the large-scale investigation at nearby KEN (Figure 12.18) (Ben-Yosef, Levy, et al. 2010). Area A was selected in the southern portion of the eastern bank of the Wadi al-Jariya, where a rectangular structure (#276 from the 2002 survey; see Levy et al. 2003) seemed to be associated with one of the larger slag mounds. This seemed to be similar to the situation in Area M at KEN (Figure 12.19) (Levy et al. 2008). A grid of four 5 × 5–m squares was established over the slag mound and structure. The building was exposed to its floor level and the western half of the slag mound to bedrock (Square F-16), where the accumulation of archaeological material appeared to be the thickest (Figures 12.19) and six layers representing at least three occupation phases were recorded (Figures 12.20–12.22, Table 12.3). The distribution of loci is summarized as a Harris matrix (Harris 1977) in Table 12.4.

The Slag Mound Sounding: Copper Production at Khirbat al-Jariya

Although commonly regarded in the literature as piles of slag, "slag heaps" or "mounds" are rarely composed of only slag material. At KEN, less than 40 percent (in volume) of the excavated material of the slag mound in Area M was slag in various forms and types, with the remainder of material consisting of decomposed furnace material, tuyères, charcoal, and so on (see Chapter 2, Area M, this volume). At KAJ, the situation is even more striking as only a very small volume of the excavated material was slag. The rest of the deposit consisted of fills with considerable amounts of domestic (*not* pyrotechnological) debris, including relatively large quantities of ceramic sherds, ash, and other material (see below). This observation should be taken into consideration when calculating production intensities by estimation of slag mass from surface observations, as is commonly done in archaeometallurgical research around the world (and see Ben-Yosef 2010:Section 9.1.3). The Area A slag mound is 2.4 m deep and includes three distinctive activity horizons (Layers A6, A4, and A1a/A2; Figures 12.20–12.22) and two thick fill layers that accumulated as a result of deliberate disposal of waste in the direction of the wadi channel, which originally was a few meters to the west.

Above the red sandstone bedrock (Salib Formation; Rabb'a 1994) is a layer that probably represents the initial occupation phase of the site (A6). Evidence for copper production–related activities was found here, including thin, cemented patches of fine-crushed slag (L123), small pits dug into the bedrock (related

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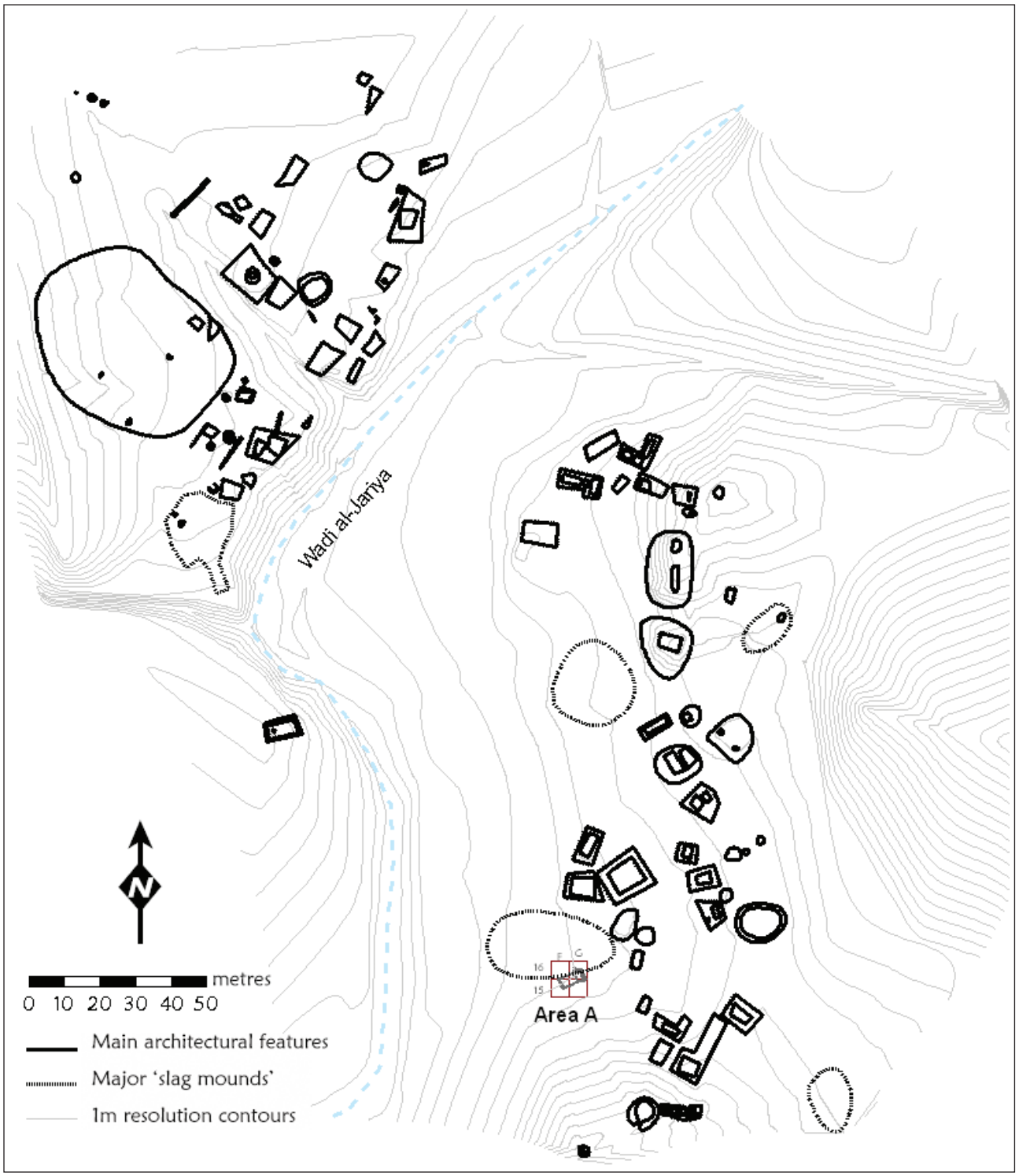

Figure 12.18 Architecture and slag mounds in Khirbat al-Jariya (after Levy et al. 2003:274). The 2006 excavation Area A, including its grid and Building 276, is indicated in the southeast part of the map. The "empty" area in the center is a result of erosional processes (see text).

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to crushing activity? Figure 12.20), ash pockets, and some copper ore fragments in a thin and noncontiguous layer of light brown sediment (L124). This supports the supposition that the raison d'être of KAJ, like most IA archaeological sites in the extreme arid environment of Faynan, was the exploitation of the copper ore deposits. There are no water sources in the close vicinity of the site (the closest is 'Ain al-Ghuwayba, located across a steep ridge ca. 2.7 km to the southeast; Figure 12.1), but numerous IA copper mines are located a few hundred meters up the wadi and its tributaries (Figure 12.11) (Levy et al. 2003:270) as well as around 2 km to the southwest, on the other side of Jabal al-Jariya (Jabal al-Jariya mines; Ben-Yosef, Levy, et al. 2009c) (Figure 12.1).

Above the horizontal basal layer was around 70 cm of "fill"—mostly domestic debris, composed of light brown sediment rich in ceramic sherds, bone, and ash pockets (A5). The scant copper production refuse included small fragments of furnace linings, slag and tuyères (cf. Figure 12.24), copper prills (Figure 12.24), and some chunks of copper metal (Figure 12.24j); nevertheless, the general characteristic of the fill is of domestic activities, mostly cooking, eating, and storage of water and food (see the ceramic discussion below). The sequence of inclined fine layers was cut abruptly by leveling of the surface in preparation of a flat area for habitation and other activities represented in Layer A4 (this transition is clearly evident in Figure 12.2a,b). The latter is made of thin horizons of hardened light brown earth with some charcoal and pottery sherds, stone installations, patches of stone pavement, and several pits dug into the fill of A5 (Figure 12.17a,b). Two of the pits were distinctive narrow (3–5 cm in diameter) "holes" in the ground; one was 23 cm deep with hardened blackish walls and a red clay plug in its bottom (Figure 12.24a) and the other, 0.5 m to the north–northwest, was 10 cm deep (Figure 12.23). The holes may indicate the location of tent stakes or the base of a tripod. Coupled with the stone installations and other finds from Layer A4, these may reflect tent habitation activities. Other finds from Layer A4 include a copper pin (Figure 12.24k), several grinding stones (see similar examples in Figure 12.24d–f), and a mollusk fossil probably used as an ornament and similar to a worked fossil of a sea urchin found in L118 above (Figure 12.24m). It is interesting to note the abundance of such fossils in the eighth- through sixth-century BCE site of Busayra, approximately 15 km to the northeast on the Edomite plateau (Reese 2002, including comparative discussion of this phenomenon). A similar worked fossil of sea urchin was found also in Khirbat en-Nahas, Area A (L118, B3210; EDM 20239).

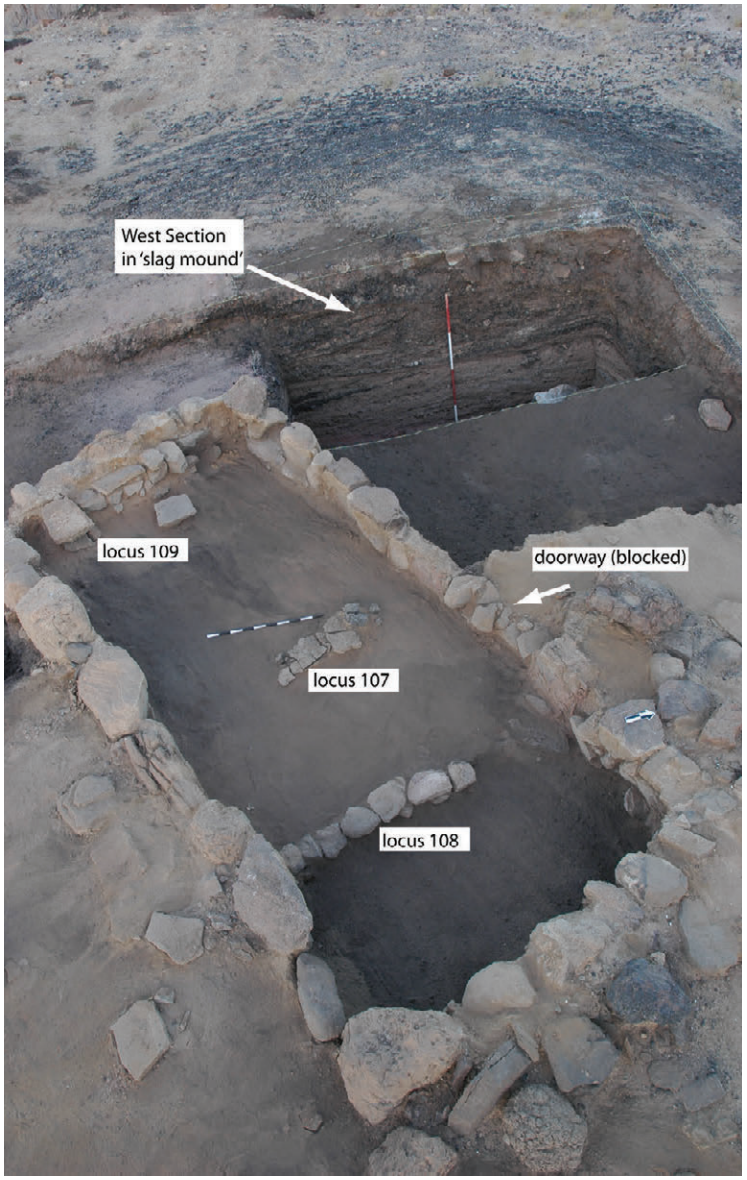

Figure 12.19 Khirbat al-Jariya, Area A, general view at the end of the 2006 season. The excavation exposed Structure 276 to its floor level (hardened earth), revealing a stone-and-plaster "bench" with a flat worked stone in front of it (L109), a patch of large tap slag close to the doorway (L108), and a partitioning stone line abutting one of the structure walls (L108). In half of Square F-16, the excavation penetrated a slag mound to bedrock, exposing a stratigraphic sequence of waste and occupation layers (cf. Figure 12.20a, a drawing of the west section visible here) (after Ben-Yosef, Tauxe, et al. 2010).

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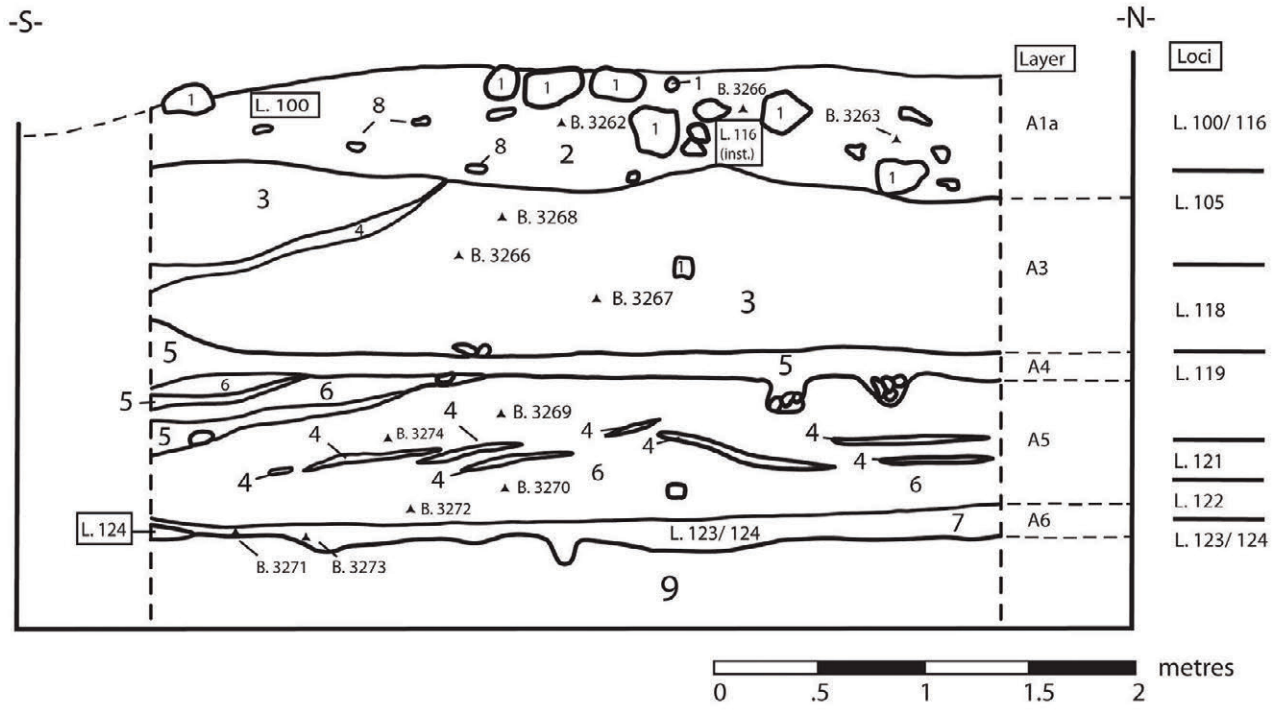



Figure 12.20 (*a*) Khirbat al-Jariya, Area A, schematic drawing of the west section in the slag mound probe, representing the stratigraphic sequence of the site, from surface to bedrock (see Figure 12.19) (after Ben-Yosef, Levy, et al. 2010): (1) stones; (2) broken slag with ashy sediments; (3) broken slag with clay and silt; (4) light-colored ash pockets; (5) hardened ashy sediments; (6) light brown soil, domestic debris, and ashy pockets; (7) fine-crushed slag; (8) large slag fragment; (9) bedrock. (B) archaeointensity sample (slag/ceramic). For description of layers and associated ^{14}C dates, see Table 12.3. Note that only the location of samples for archaeointensity research is indicated here, as they were collected directly from the western wall of the excavation pit. (*b*) Khirbat al-Jariya, Area A, the west section in the slag mound probe, representing the stratigraphic sequence of the site, from surface to bedrock (cf. Figure 12.20a).

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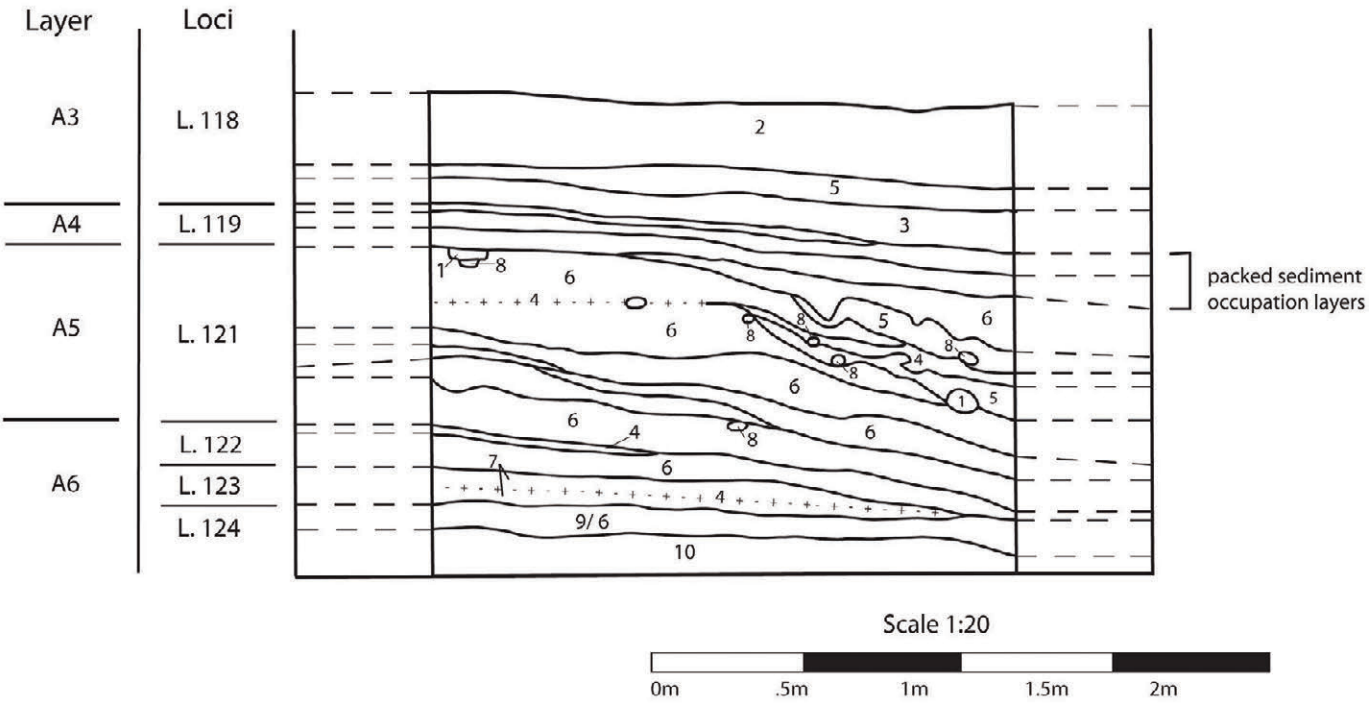



Figure 12.21 (*a*) Khirbat al-Jariya, Area A, schematic drawing of the south section in the slag mound probe, representing the stratigraphic sequence of the site, from surface to bedrock (see Figure 12.21b). For key, see Figure 12.21a. (*b*) Khirbat al-Jariya, Area A, the south section in the slag mound probe, representing the stratigraphic sequence of the site, from surface to bedrock (cf. Figure 12.21a).

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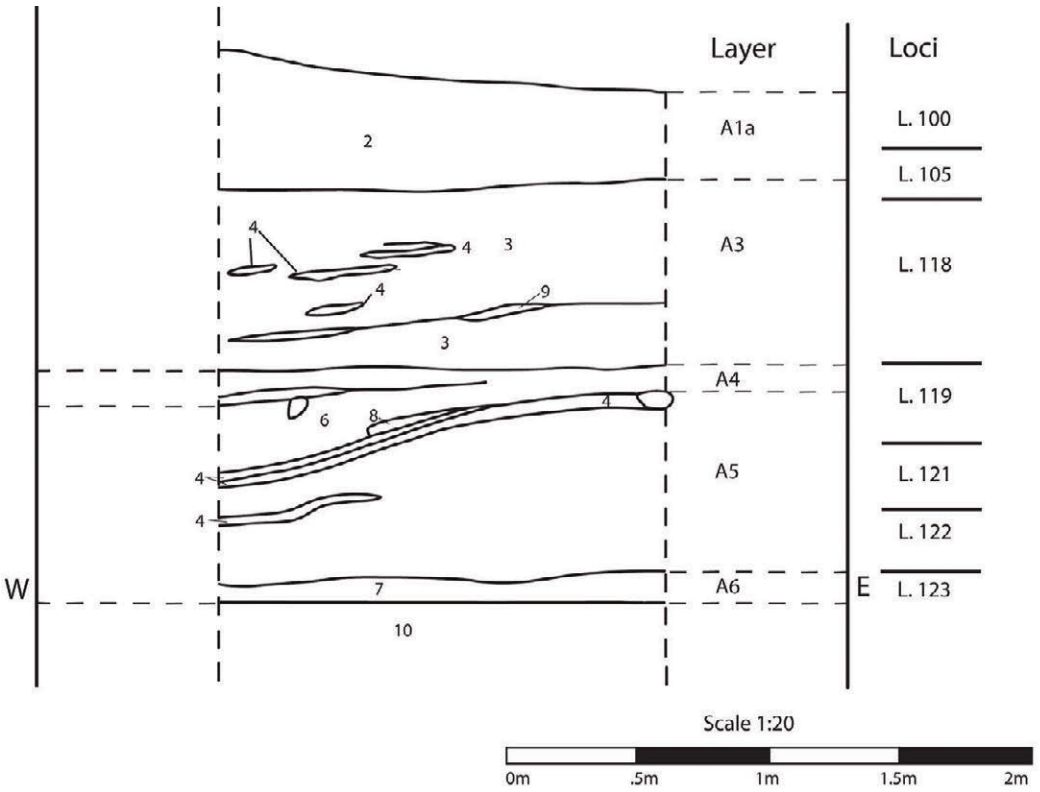



Figure 12.22 (*a*) Khirbat al-Jariya, Area A, schematic drawing of the north section in the slag mound probe, representing the stratigraphic sequence of the site, from surface to bedrock (see Figures 12.20, 12.23b). For key, see Figure 12.20a. (*b*) Khirbat al-Jariya, Area A, the north section in the slag mound probe, representing the stratigraphic sequence of the site, from surface to bedrock (cf. Figure 12.22a).

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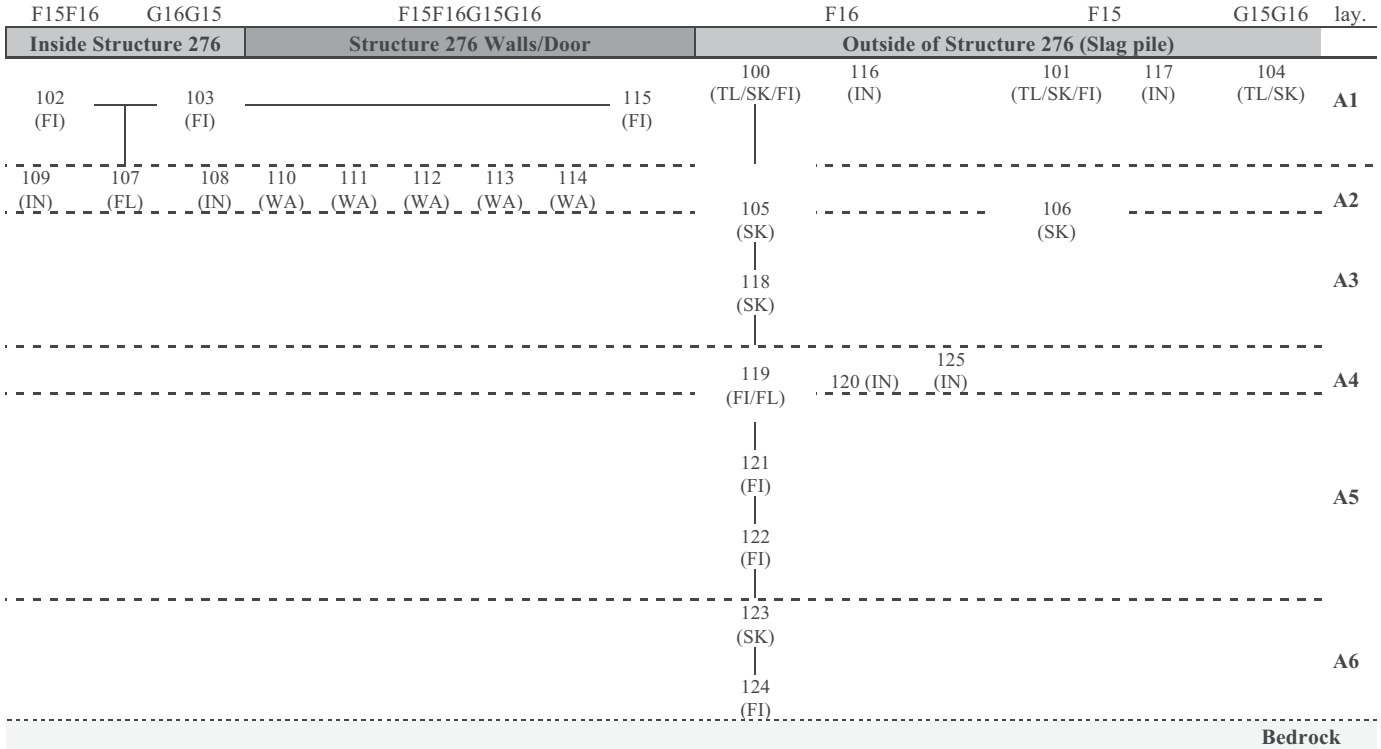
Table 12.3 KAJ Area A stratigraphy, radiocarbon, and archaeointensity results.*

Layer	Description	^{14}C Results (Calibrated with OxCal4.1 ©C. B. Ramsey 2009)					Archaeointensity Results				
		Lab #	Material	δ^{13}C ‰	Radiocarbon Age BP	Cal. Age—68.2 Percent Probability BCE	Lab #	Material	*N*	B_{anc} (μT)	VADM (ZAm^2)
A1a	Top sediments of the slag mound: copper production debris, aeolian dust, and a few stone installations	OxA-19033	Charcoal *Tamarix* sp.	–24.54	2864 ± 28	1113–997	JS02b	Tap slag and clay (slag attached to furnace fragment)	5	76.8 ± 8.7	149 ± 17
A1b	Fill inside Structure 276, large boulders, and stones	OxA-19034	Charcoal *Retama raetem*	–11.18	2898 ± 28	1125–1026					
A2	Occupation phase of Structure 276 and probably copper production debris at the top of the slag mound	OxA-19087	Charcoal unidentified	–26.98	2797 ± 26	995–912					
A3	"Fill": accumulation of copper production debris, part of the "slag mound"	OxA-19035	Charred seed *Phoenix dactylifera*	–22.92	2799 ± 26	994–915					
		OxA-19130	Charred seed *Phoenix dactylifera*	–23.5	2851 ± 36	1108–934	W03268a	Ceramic	3	68 ± 3.1	131 ± 6
A4	Occupation phase: stone installations, leaving floors, tent dwelling?	OxA-19036	Charcoal *Tamarix* sp.	–22.54	2803 ± 26	995–919					
A5	"Fill": accumulation of domestic debris mixed with industrial remains	OxA-19037	Charred seed *Phoenix dactylifera*	–24.75	2902 ± 27	1128–1026	W03269a	Slag	3	63.3 ± 8.9	122 ± 17
A6	Occupation phase above bedrock: fine-crushed slag, ore, ash pockets, and pits dug into bedrock	OxA-19038	Charcoal *Phoenix dactylifera*	–26.7	2880 ± 26	1113–1012					
		OxA-19039	Charcoal indet.	–21.53	2884 ± 27	1114–1016					

*Compare with Table 12.4 and Figure 12.23 for sample location and Figure 12.27 for the Bayesian model of the results at 68.2 and 95.4 percent probability. *N* = number of specimens per sample; archaeointensity sample JS02b is from Ben-Yosef, Ron, et al. (2008).

Table 12.4 Harris matrix of the loci at Khirbat al-Jariya, Area A.*



*Loci definitions: FI = fill; IN = installation; WA = wall; TL = top soil; SK = copper production debris.

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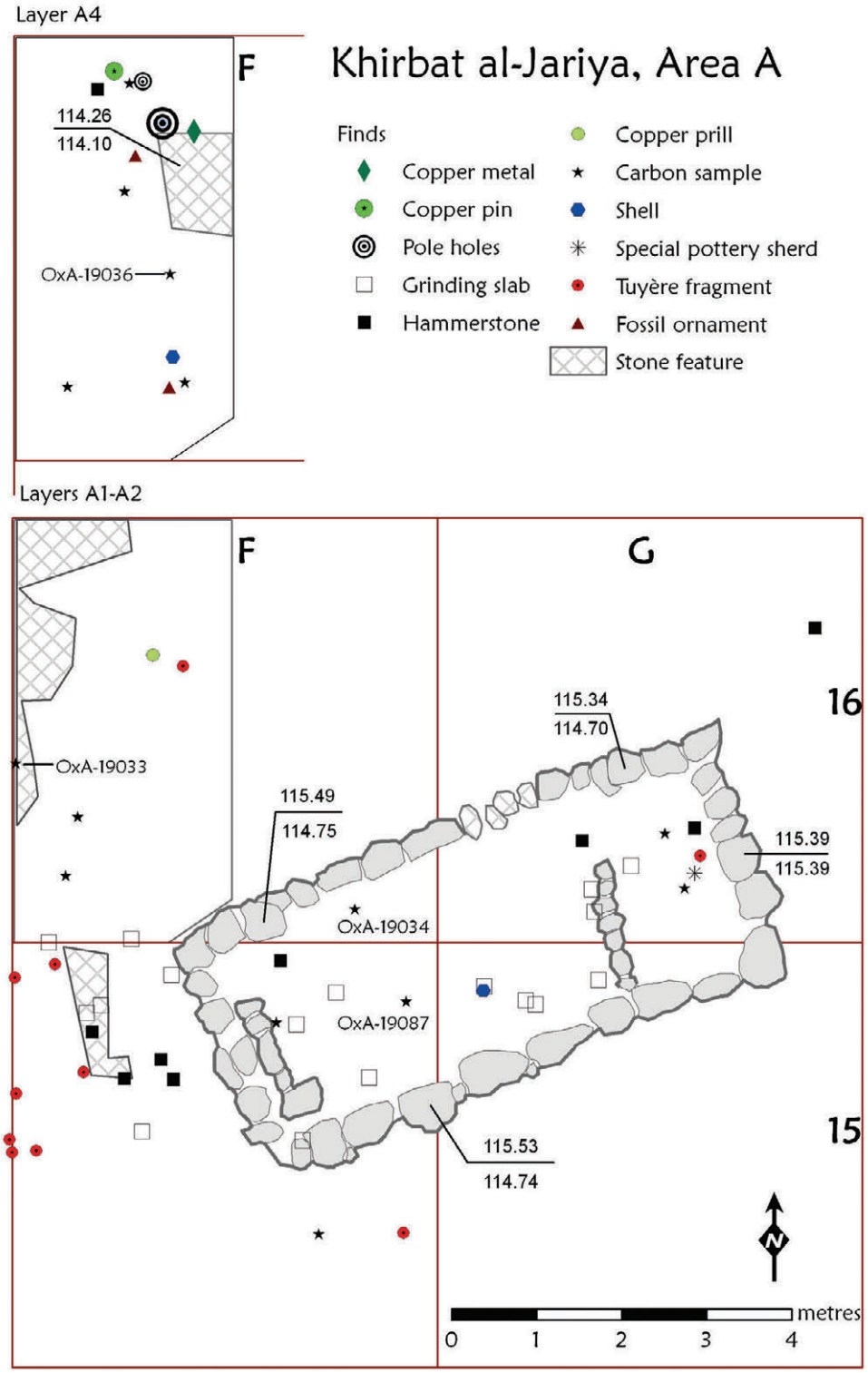

Figure 12.23 GIS map of Khirbat al-Jariya, Area A: Layer A4 at the top and Layers A1–A2 (including Structure 276) at the bottom (see Table 12.3 and text for description of layers) (after Ben-Yosef, Tauxe, et al. 2010). The GIS-generated map displays the spatial distribution of artifacts and helps interpret the occupation layers. For example, note the concentration of tuyère fragments in Square F-15, Layers A1–A2 that may represent a broken furnace in this location, the high density of hammer stones and grinding slabs inside the structure that may hint to its usage, and the relative size and location of the "pole holes" in Layer A4 that suggest a smaller construction than a tent (maybe a wooden frame for a churn?). Note the location of carbon samples; the ones used for radiocarbon dating are indicated with their laboratory numbers (cf. Table 12.3).

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Figure 12.24 From ore to metal—finds from Area A excavation: (*a*) 23-cm hole in the ground level of Layer A4 with a red clay plug in its bottom (L120), (*b*) sandstone basin unearthed by robbers near the slag mound, (*c*) copper ore from the manganese-rich dolomite-shale Burj formation, (*d*) hammer stone made of a chert nodule, (*e*) dimpled hammer stone, (*f*) grinding slab, (*g*) tuyère (front) with mat imprints on the clay, (*h*) tuyère (back) with a "niche" for fixing the inner part the nozzle, (*i*) copper prill, (*j*) a chunk of copper metal, (*k*) copper pin, (*l*) decorated pottery fragment, and (*m*) worked fossil of a sea urchin used as an ornament (L118) (after Ben-Yosef, Levy, et al. 2010:736).

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After the Layer A4 occupation ceased, the area became a disposal zone again, but rich with archaeometallurgical remains (A3), including pieces of tap and furnace slag (2–10 cm in diameter), ample charcoal remains, tuyère and furnace fragments, and chunks of copper metal and ore in a matrix of ashy sediment and clay indicating decomposed furnace materials. Evidence of some domestic trash was present as well, including ceramic sherds and date pits. Layer A3 is truncated by a horizontal accumulation of copper production debris, representing the last phase of activity in this part of the site (A1a–A2). This top layer probably belongs to the same occupation period of Structure 276, although some of it may be related to a poststructure abandonment phase, including some ephemeral stone installations close to the surface (L116 and L117). It includes similar materials to Layer A3, only with larger pieces of slag (3–15 cm in diameter) and a yellowish horizon of aeolian sediment that accumulated below the slag fragments covering the surface. A few meters to the north of the slag mound, a huge sandstone basin (ca. 1.5 × 1.2 m; see Figure 12.24b) was found on the surface, exposed by recent robbery. The basin also relates to the last phase of copper production and was probably used to crush ore, flux, charcoal, or slag or to keep water as part of the copper smelting process. The large size of this ground stone mortar is similar to ones found in Area F at KEN that date to the tenth century BCE and indicate considerable investment in metallurgical activities at this time (Chapter 2, this volume).

The evidence from the slag mound in Area A indicates small-scale copper production, considerably different from the massive enterprise at nearby KEN. The mound is relatively shallow (cf. 6.5 m of industrial layers at KEN-M) and only partially represents copper production activities. All contexts show a mixture of industrial and domestic debris, and even in layers directly related to smelting procedures, the archaeometallurgical artifacts indicate work in small installations and quantities indicative of limited production. The most notable technological difference between the sites relates to the size of the metallurgical installations. Furnace fragments and tap slag at KAJ are smaller than in most excavated contexts at KEN, and the tuyères are shorter and less sophisticated (Chapter 2, this volume). The latter was first recognized by Hauptmann (2007:131–132), who points out the similarity between the small tuyères of KAJ and the Late Bronze Age tuyères of Timna, suggesting to date the beginning of the smelting activities at KAJ to the Late Bronze Age.

Structure 276 at Khirbat al-Jariya Area A

Structure 276 is a small, isolated, rectangular building with outer dimensions of 6.5 × 3.2 m and one doorway in its north–northwest broad wall (Figure 12.23). Its walls have only one course of massive local boulders and roughly cut stones of around 0.5 m in width, built on the truncated pile of copper production debris (A3). Limited finds from the occupation phase of the building (A2) came from an elusive floor level and included small quantities of pottery sherds, some grinding stones, and charcoal, in addition to three interesting features: a line of stones perpendicular to Wall 111 (L108) partitioning the inner space of the building, a pavement of large tap slag (in sizes not found in the slag mound in the middle of the structure), and a bench-like installation abutting Wall 112 made of flat stones, stuck together with plaster (L109; Figure 12.25). Some 10 to 15 cm in front of the bench-like installation, on the floor level of the building, a flat, square, hewn stone with marks of intensive use was found. The building had a massive fill of heavy irregular stones (A1b) not indicative of wall collapse but rather of an intentional blocking of the structure's inner space. Approximately 15 grinding stones of various types and a few pieces of charcoal were found in the fill.

Structure 276 presents difficulties regarding its interpretation. It was abandoned (or evacuated) prior to the deliberate filling of its inner space, resulting in scarcity of finds. It has substantial stone foundations that did not hold any substantial walls, as well as a few intriguing installations. Whatever the interpretation of these may be, it does not seem that the building was an important industrial feature.

The Ceramic Assemblage of Khirbat al-Jariya

The ceramic assemblage of KAJ-A was investigated by Neil G. Smith, and the following short report is based on his observations in the UCSD Levantine Archaeology Pottery Laboratory. We present here only a basic ceramic plate for general reference with the intention of publishing a more thorough pottery analysis in the future.[7]

Khirbat al-Jariya provides the first well-documented stratigraphic evidence for the Iron Age I ceramic sequence in the lowlands of Edom. Although a few similar stylistic traits can be recognized in other regions, the ceramics recovered from KAJ appear indigenous to the area with the closest parallels found in Area M at KEN. A total of 113 diagnostic sherds from 1,158

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Figure 12.25 Installation L109 abutting Wall 112 of Structure 276, Khirbat al-Jariya.

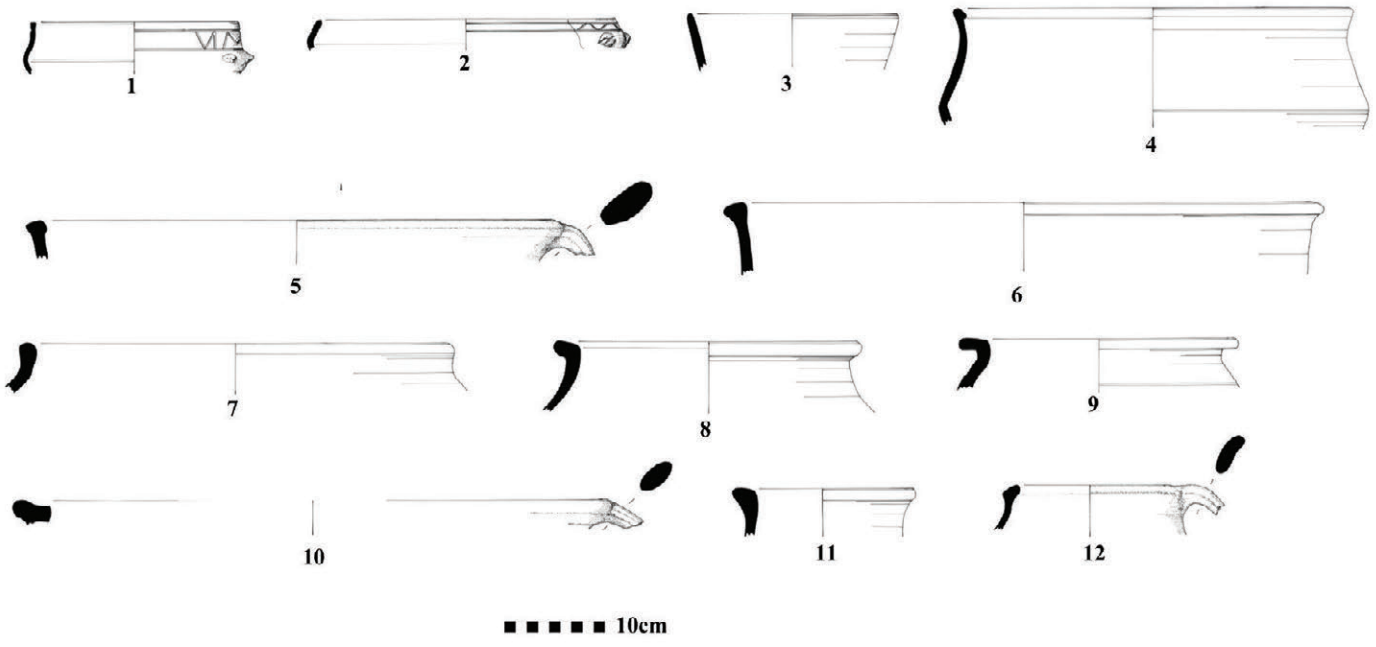

Figure 12.26 Some representative ceramic types of the copper smelting site of Khirbat al-Jariya, Jordan. The plate illustrates the predominant wheel-made vessel forms for depositional Layers A1 to A4 (plate compiled by N. G. Smith; see Table 12.5 for details).

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collected ceramic fragments were recovered from the sounding. Similar to the findings at KEN (cf. Smith and Levy 2008), a significant proportion of the ceramic assemblage was handmade (25.5 percent). These sherds should not be confused with "Negevite" ware, the handmade vessels found at Iron I sites in the southern Negev (cf. Cohen and Cohen-Amin 2004; Cohen and Bernick-Greenberg 2007; Meshel 2002; Rothenberg 1988). Although petrographic studies and instrumental neutron activation analysis (INAA) have identified several Negevite sherds' origins in Transjordan (cf. Gunneweg et al. 1991; Haiman and Goren 1992), the handmade pottery found at KAJ uniquely contain slag inclusions, indicating they were produced on site. In addition, they do not share the shaping techniques used in Negevite wares (see especially a recent typological study of the Negevite wares from Kadesh Barnea by Cohen and Bernick-Greenberg 2007). Most of our diagnostic sherds are wheel made (n = 102) and possess a well-balanced distribution across vessel families (see Figure 12.26 for a representative sample of the wheel-made assemblage from the site. These are representative forms for this period in lowland Edom.).[8] Perhaps the most peculiar trait of the KAJ ceramic assemblage is the absence of pithoi, which figure so prominently in the ceramic assemblage at KEN—however, this may be due to the small sample size. The equal proportion of cooking pots (cf. Figure 12.26:12) and serving vessels (e.g., cups, bowls, and kraters; Figure 12.26:1–6) points to domestic activities practiced alongside metal production; debris of both activities often originated from the same context. There is a complete absence of painted sherds (including imported Midianite/Qurayyah ware), with only a few diagnostic sherds decorated with grooves and incisions or slip (n = 19); however, this also may be attributed to the small sample. These data are similar to the earlier phases at Area M (KEN). Unique to the KAJ assemblage is the presence of small fine-ware carinated bowls with an incised stanza and applied knob decoration (cf. Figures 12.24l and 12.26:1–2). Finally, a red horizontally burnished bowl was found in Layer A2/3 (cf. Figure 12.26:3). Thin-section analysis on this sherd indicates that it is made of loess soil originating from the northern Negev (Chapter 5, this volume). The evidence suggests that KAJ interacted with its western neighbors to some extent during the IA I/IIA period but was occupied by local potters.

Radiocarbon Measurements for Khirbat al-Jariya

The radiocarbon measurements of samples from Khirbat al-Jariya were processed in the Oxford Radiocarbon Accelerator Unit (Research Laboratory for Archaeology and the History of Art) by Thomas Higham (Ben-Yosef, Levy, et al. 2010).

Nine carbon samples from well-defined contexts at KAJ are presented here (Figure 12.27, Table 12.3). Modeling of the results using stratigraphic constraints and Bayesian statistics (Buck et al. 1996; Ramsey 1995) indicates that occupation of Area A started between 1092 and 1017 BCE (68.2 percent probability; 1147–1007 BCE, 95.4 percent) (start of A6) and ended between 1002 and 933 (68.2 percent probability; 1016–904 BCE, 95.4 percent) (end of A1–2) with an overall occupation span of 20.5 to 133.5 years (68.2 percent probability; 0–206 years, 95.4 percent).

Similar to the situation in KEN, there is a conspicuous absence of acacia charcoal in the archaeological record of KAJ (Table 12.3), which is in accordance with the general pattern of the Iron Age record in Faynan (e.g., Engel 1993; Hauptmann 2007:50–53; Steinhof 1994) and was recently interpreted as reflecting the value system of the local semi-nomadic tribal society rather than any significant ecological change (Ben-Yosef 2009). This issue is discussed in Chapter 13, this volume).

Geomagnetic Archaeointensity Investigation Correlating KAJ and KEN

Absolute determinations of the rapidly changing geomagnetic field intensity may refine the correlation between archaeological horizons by complementing data sets of material culture and radiocarbon dates from different locations (e.g., Ben-Yosef, Tauxe, et al. 2008 and Chapter 4, this volume). Following the procedure of Ben-Yosef, Tauxe, et al. (2009), we obtained two new determinations from KAJ Layers A5 and A3 in addition to the one published by Ben-Yosef, Ron, et al. (2008) for a sample collected from the upper portion of the same slag mound (Table 12.3, Figure 12.20a,b).

The archaeointensity data published here contribute supporting chronological data for correlating the radiocarbon evidence from KAJ Layers A3–A1a and KEN Layer M3, probably to its early phase (Chapter 2, Area M), and also for correlating Layers A5–A6 with KEN Stratum M4. As more absolute archaeointensity determinations become available, Table 12.3 will

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Table 12.5 Representative types of ceramic vessels from Khirbat al-Jariya, Area A.*

Figure.	Reg#	EDM	L.	B.	Layer	Vessel	Type	Description
1	394	20116	106	3105	A2/3	Bowl	BL18	Very pale brown (ext./int.) with red and black core; Incised Stanza and Applied Buttons
2	1451	20241	0	3212	A1a	Bowl	BL18	Very pale brown (ext./int.) with red and black core; Incised Stanza and Applied Buttons
3	938	20210	105	3196	A2/3	Bowl	BL16	Red (ext./int.) with redish brown core; Interior/Exterior Red Slip with irregular horizontal burnish lines
4	937	20210	105	3196	A2/3	Krater	KR27	Reddish Yellow with very pale brown core
5	928	20269	121	3231	A5	Krater	KR27	Reddish Yellow (ext.)/light red (int.) with very pale brown core
6	978	20227	118	3205	A3	Krater	KR26	Reddish Yellow (ext.)/light red (int.) with very pale brown core
7	929	20210	105	3196	A2/3	Jar	JR	Reddish Yellow (ext.)/light red (int.) with very pale brown core
8	975	20227	118	3205	A3	Jar	JR	Reddish Yellow (ext./int.) with very pale brown core
9	903	20125	107	3014	A2	Jar	JR	Light brownish gray with gray core
10	908	20081	107	3072	A2	Jar	JR6	Pale Yellow (ext./int.) with white core
11	962	20244	119	3213	A4	Jar	JR	Pale Yellow (ext./int.) with pinkish-white core
12	974	20227	118	3205	A3	Cooking Pot	CP20	Light gray (ext./int.) with gray core; Cooking pot fabric

*Table prepared by N. G. Smith (cf. Figure 11.26 for details). L = locus; B = basket; Type = numbered vessel types represent parallel vessels found at Khirbat en-Nahas (cf. Smith and Levy 2008; Smith 2009b).

provide a useful reference for correlating KAJ and other sites in future research. The extremely rapid changes in field intensity values, or "spikes," during the IA (Ben-Yosef, Tauxe, et al. 2009; Shaar et al. 2011) suggest that two statistically identical determinations from different sites indicate contemporaneity (up to a resolution of a few decades in certain time intervals).

Khirbat al-Jariya—Summary and Discussion

After the collapse of Late Bronze Age state-level societies in the eastern Mediterranean (e.g., Bachhuber and Roberts 2009), new socioeconomic opportunities arose in lands on their periphery. A window on this process is provided at KAJ in the marginal Faynan copper ore district of southern Jordan. The stratified excavations there show that the site was first occupied around the mid-eleventh century BCE and abandoned sometime during the mid to late tenth century BCE—earlier than previously assumed. The sounding suggests that the substantial architecture visible on the site surface dates to the first half of the tenth century and that earlier settlement was probably based on a more ephemeral use of the site. KAJ was established to exploit the copper sources in the nearby mines, and metal production developed gradually and opportunistically from the use of simple technologies

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for small-scale production to mass production with sophisticated large-scale installations. The peak in Iron Age copper production in Faynan, however, is evident at nearby KEN (e.g., Strata M3–M1, tenth to ninth centuries BCE) without a parallel record at KAJ, demonstrating a different and more complex social organization of production extending into the ninth century BCE—but no later.

Radiocarbon dates from three Faynan sites, including KEN, suggest small-scale copper production activities starting already in the Late Bronze Age (with dates as early as the fifteenth century BCE; Table 12.2). At Timna, although there are fewer high-precision radiocarbon dates and sample contexts are not always secure, there is evidence for small-scale copper production throughout the IA I–IIA sequence, *after* the end of twentieth dynasty Egyptian hegemony in the region (Ben-Yosef 2010:Table 6.2 and Chapter 12, this volume). The resumption of copper production along the length of the Arabah Valley during the Early IA should be seen in light of "global" economic and political changes, especially the disruption of commercial connections between Cyprus and the Levant at the end of the thirteenth century BCE (Fantalkin and Finkelstein 2006; Finkelstein and Piasetzky 2008; Knauf 1995) and the vacuum in political power in the region after the decline of Egyptian influence (Levy and Najjar 2007; Levy et al. 2008) that occurred in the Late Bronze Age to IA transition. Still, the questions of who or what triggered and organized this enterprise, what was the destination of its products, and what social and political processes brought about the recorded technological changes within the IA remain open.

There is no evidence in the early stages of IA copper exploitation (before the end of the tenth century BCE) for Egyptian or any other external control. The ceramic assemblages demonstrate local vessel types that later evolved into the Late Iron Age (eighth to sixth centuries BCE) "Edomite" wares known from the highlands of Edom and the Negev desert (see Smith and Levy 2008 and above). In our

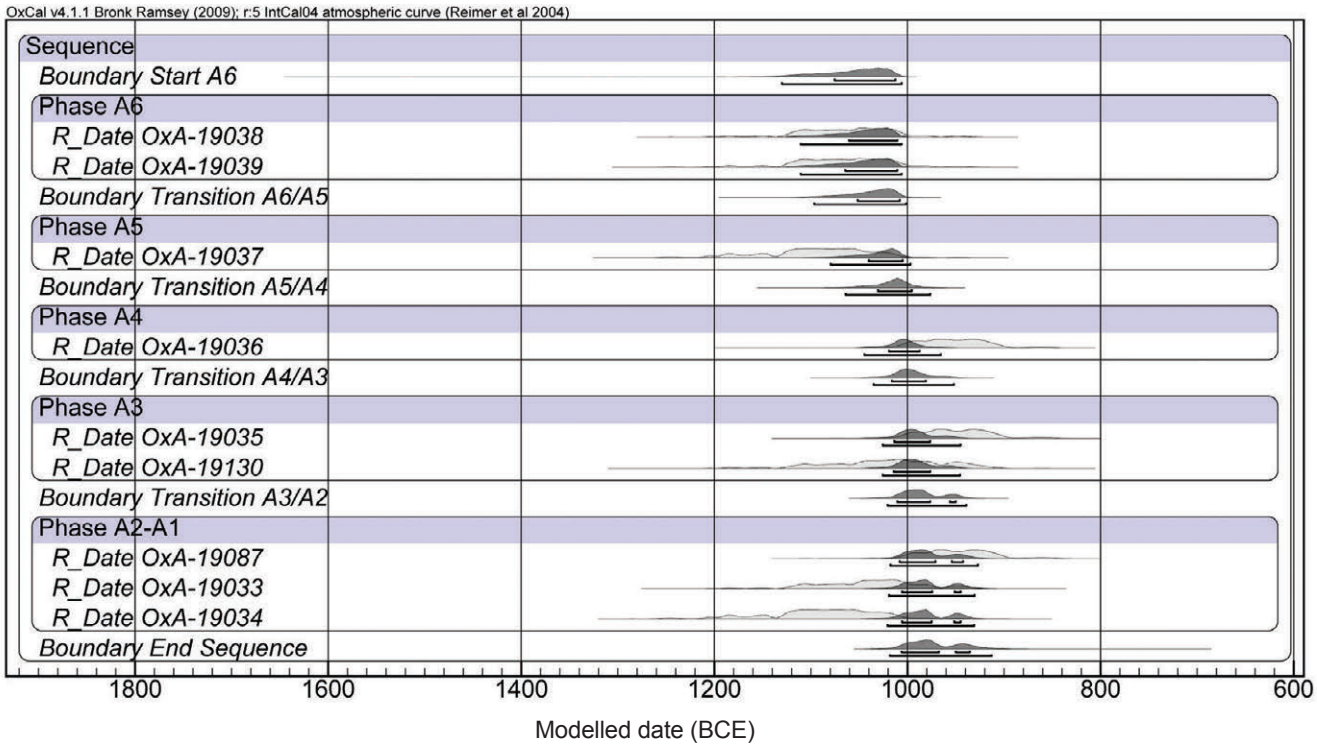

Figure 12.27 Bayesian age model of radiocarbon date distribution for Khirbat al-Jariya (see Table 12.3 for the uncalibrated and calibrated laboratory dates). The site spans the eleventh and tenth centuries BCE (see text for details and Ben-Yosef, Levy, et al. 2010).

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view, the evidence from Faynan indicates that the resumption of copper production at the very end of the Late Bronze to Early Iron Age was opportunistically initiated by local semi-nomadic tribal societies. These may be the "Shasu" tribes mentioned in ancient Egyptian documents and suggested as having been responsible for the tenth-century BCE cemetery at Wadi Fidan 40 in the Faynan district (Levy 2009b; Levy, Adams, and Muniz 2004). Moreover, although the resumption of copper production may be related to the wider phenomenon of settlement intensification in the Negev highlands, particularly interaction with the so-called Tel Masos chiefdom (Fantalkin and Finkelstein 2006), we do not consider both regions to represent the same political or social entity. Rather, these Negev sites may have played a role in the copper exchange network emanating from Faynan. Thus, during the IA I, Faynan was part of the lowlands of biblical "Edom" and provided the natural resources that enabled the beginning of processes that led to a local complex society such as a kingdom (Avishur 2007) or chiefly confederacy (Levy 2009b) described in the biblical accounts.

The geographical extent of Edom is poorly delineated in historical accounts (Chapter 1, this volume). Most scholars agree that during the Late IA (seventh to sixth centuries BCE), Edom's borders extended to the west of the Arabah Valley, and according to Edelman (1995) and Zucconi (2007), the earliest references to "Edom" may already encompass this larger area. Our IA research indicates that its borders oscillated through time with Faynan as its core during the eleventh to ninth centuries BCE and the highland plateau site of Busayra, most likely in the eighth to sixth centuries BCE.

KAJ was abandoned in the second half of the tenth century BCE, possibly coinciding with the date of the military campaign of Pharaoh Sheshonq I (biblical Shishak) in the region (Kitchen 1986:292–302). Levy et al. (2008:16465) ascribe the disruption marked by the M3–M2 boundary at KEN (Area M) to the impact of this campaign on the organization of copper production at the site, while Fantalkin and Finkelstein (2006) attribute the prosperity evident in Tel Masos II and other changes in the archaeological record of the Beersheva valley to this event (contra, e.g., Fritz 2002). These researchers view the Egyptian endeavor as a

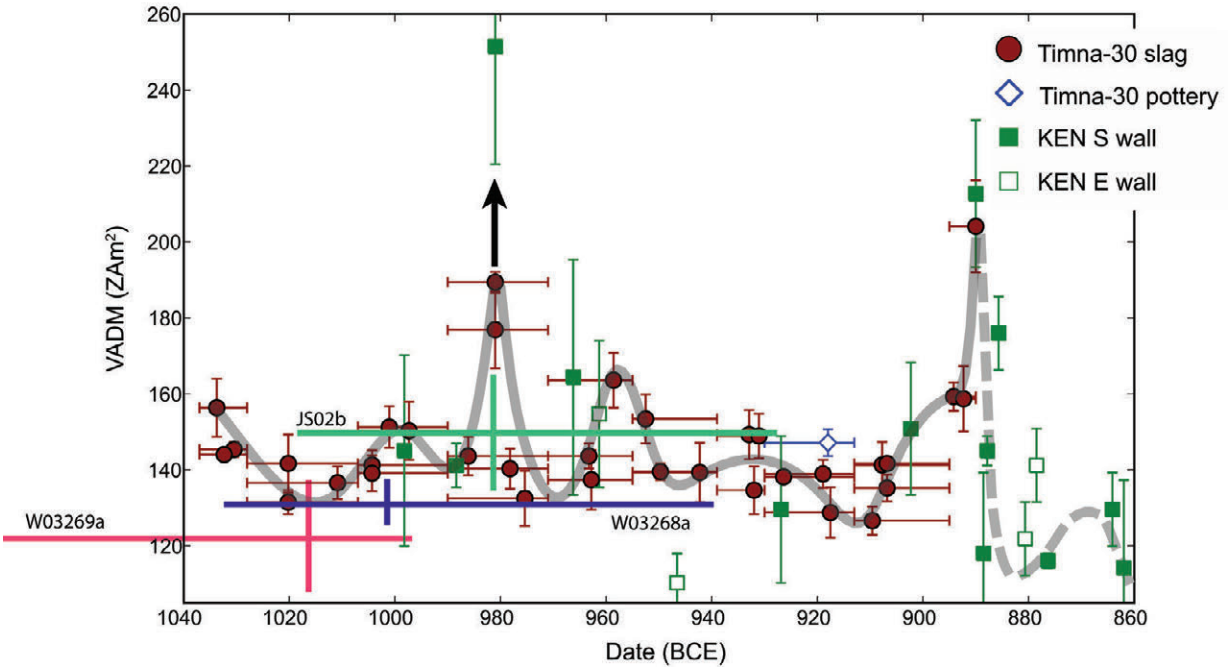

Figure 12.28 The geomagnetic intensity curve for the Iron Age IIA based on KEN-M and Timna 30 (see Shaar et al. 2011 and Chapter 4, this volume) and the archaeointensity results from Khirbat al-Jariya. Horizontal bars indicate modeled ^{14}C age of the stratigraphic layer; vertical bars are located in the highest probability of ^{14}C age and represent error range of intensity results. The oldest sample may represent intensity value not indicated on the present curve.

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positive intervention, fostering the copper industry and trade (and definitely not related to the end of IA IIA in the region). Although no definitive evidence of deliberate destruction was found at KAJ or KEN, the abandonment of the first and the reorganization of the second (which may have occurred decades after the year of Sheshonq's campaign itself) may suggest that Egypt attempted to strangle or simply disrupt the incipient industry, which eventually was revived in greater intensity by the local political powers independent of Egypt (Kitchen 1986) by the early ninth century BCE. Nevertheless, we do not think that a decisive answer regarding the Egyptian role in the copper industry is currently at hand. Other explanations for the cumulative archaeological data are possible; for example, the abandonment of KAJ may relate to exhausting the local mines and focusing on the large copper ore-filled colluvial fields of Jabal al-Jariya (Ben-Yosef, Levy, et al. 2009c), closer to KEN (see below).

Ras al-Miyah Archaeological Complex (مجمع راس المية الأثري)

Ras al-Miyah (Arabic for "Head of the Spring"[9], the area around 'Ain al-Ghuwayba oasis (Figure 12.29), is abundant with archaeological sites, mostly dated to the Iron Age II (Figures 12.1 and 12.30, Table 12.6). The largest site is Khirbat al-Ghuwayba, a dense, around 7-ha scatter of Iron Age slag located on both sides of Wadi al-Ghuwayba near the spring. Interestingly, the smelting activities at Khirbat al-Ghuwayba are dated to the Iron Age I to IIA (see below), and thus they seem to represent a different occupation phase than the copper mines and fortresses recorded in this region (see discussion below).

The area of Ras al-Miyah was investigated by the Deutsches Bergbau-Museum team, who in addition to Khirbat al-Ghuwayba reported two Iron Age fortresses ("hill forts") located near Iron Age mines (Hauptmann 2007:132; Weisgerber 2006:13). As part of ELRAP field seasons, we conducted a small probe in one of those fortresses (in Ras al-Miyah East, 2006) and a detailed survey (part of FBRS 2007; see Chapter 6, this volume). The results of ELRAP investigations are published in Ben-Yosef, Levy, et al. (2009b) and Ben-Yosef et al. (in press).[10]

Ras al-Miyah is the closest Iron Age mining area to Busayra. It is located on the main road between the highlands of Edom and Faynan (Chapter 6, this volume). In the Iron Age IIB–C, the heyday of Busayra as a regional administrative center (e.g., Bienkowski 2002), Ras al-Miyah was a center of various activities—probably all related to the mining operation in the cliffs above 'Ain al-Ghuwayba spring. Blocked mining shafts and tailings are visible on the lower slopes of the Umm Ishrin formation, and numerous small structures are located nearby (Figure 12.30). The most prominent architectural features are the fortresses, also located immediately in front of the mining complexes. Our detailed survey of both fortresses (Ras al-Miyah West and East, or FBRS Sites 2 and 3 respectively) revealed a surprisingly high density of archaeological remains. Dense scatters of ceramic sherds indicate that both fortress sites date to the Late Iron Age. In addition, our investigation shows that the construction of the massive structure of Ras al-Miyah East was never finished. The evidence concerning the fortresses and other archaeological features in their close vicinity stimulates new questions regarding the Iron Age human activities in Faynan in the Iron Age IIB–C.

The area has abundant pottery sherds, in places as dense surface scatters. They are of typical Edomite forms and clearly distinct from the common ceramic finds at Khirbat al-Ghuwayba, al-Jariya, and en-Nahas. The representing assemblage is presented in the sections below, associated with the FBRS site numbers.

Ras al-Miyah Fortresses—Geographic Setting

The two fortresses are located in the area of 'Ain al-Ghuwayba, a small oasis and the site of Khirbat al-Ghuwayba (see Hauptmann 2000:89; 2007:132). Together with the surrounding remains of copper mines, small smelting sites, ancient road constructions, ancient encampments, and numerous small installations, the area of 'Ain al-Ghuwayba comprises a rich archaeological complex, situated in the upper basin of Wadi al-Ghuwayba, in the northeastern edge of the copper production district of Faynan (Figure 12.1 and 12.30). The main road connecting the region of Faynan in the lowlands of Edom with the late Iron Age administrative center of Busayra (Bozra; Bienkowski 2002) in the highlands passed through Wadi al-Ghuwayba, taking advantage of a relatively passable topographic path in an extremely rough terrain. The eastern fortress and its surrounding copper mines are the closest copper production–related site to Busayra, some 12 km to the northeast (as the crow flies) and approximately 800 m

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higher than Ras al-Miyah East. It is reasonable to assume that this distance could have been traveled in one long day and that 'Ain al-Ghuwayba spring complex served as a major gateway, offering the first source of water in the desert environment of the Faynan district and an efficient control point guarding both sides of the narrow valley. For those arriving from Busayra, the area of 'Ain al-Ghuwayba also presents the first outcrops of copper-bearing layers, exposed on the northern slopes of the wadi. The permanent spring still enables limited agriculture, practiced today by the Bedouins of the al-Man'ajah tribe with small orchards of olive trees and pomegranates located further downstream from the spring. This is the major water source for the entire basin of Wadi al-Ghuwayba and probably one of the water sources for the largest Iron Age copper production site of Khirbat en-Nahas, located around 4 km (as the crow flies) to the east–southeast.

The fortresses are located on a distinct plateau of the Burj dolomite-shale formation (for the geological settings of the region, see, e.g., Hauptmann 2007:55–84; Rabba' 1994) to the north of Wadi al-Ghuwayba (Figures 12.31 and 12.32). The plateau is a result of erosional processes that swept away the soft sandstone and shale of Umm-Ishrin and Burj formations, thereby exposing the hard dolomite layers and creating a well-defined topographic step in the area's landscape. This step is located several meters below the contact line between Umm-Ishrin and Burj formations. The contact line itself, well defined by the colored shale of the upper unit of the Burj formation, forms a breaking point in the steep slopes and cliffs that enabled the construction of an Iron Age path connecting the upper Wadi al-Ghuwayba basin, the two fortresses, Wadi al-Jariya and Khirbat al-Jariya (Figure 12.33). In close proximity to the fortresses is the copper ore–rich shale unit of the Burj formation, also referred to as the dolomite-limestone shale (DLS) unit where we identified Iron Age mines (Figure 12.32a and see below).

The oasis of 'Ain al-Ghuwayba and the main road leading toward Busayra along Wadi al-Ghuwayba are visible from both fortresses, as well as the wide valley connecting Khirbat Faynan and Khirbat en-Nahas via Ras en-Naqb. Due to the wide vista available from the elevated location of the fortresses' towers, guards could have been alerted for dealing with any unwelcome travelers or invaders approaching from the northeast or southeast. However, caravans traveling from Busayra



Figure 12.29 An overview of Khirbat al-Ghuwayba (FBRS Site 1) and 'Ain al-Ghuwayba (Arabic for "Spring of the Grove") from the fortresses area (the cliffs above the wadi). This is the head of the principal road to Busayra and a large Iron Age copper production site.

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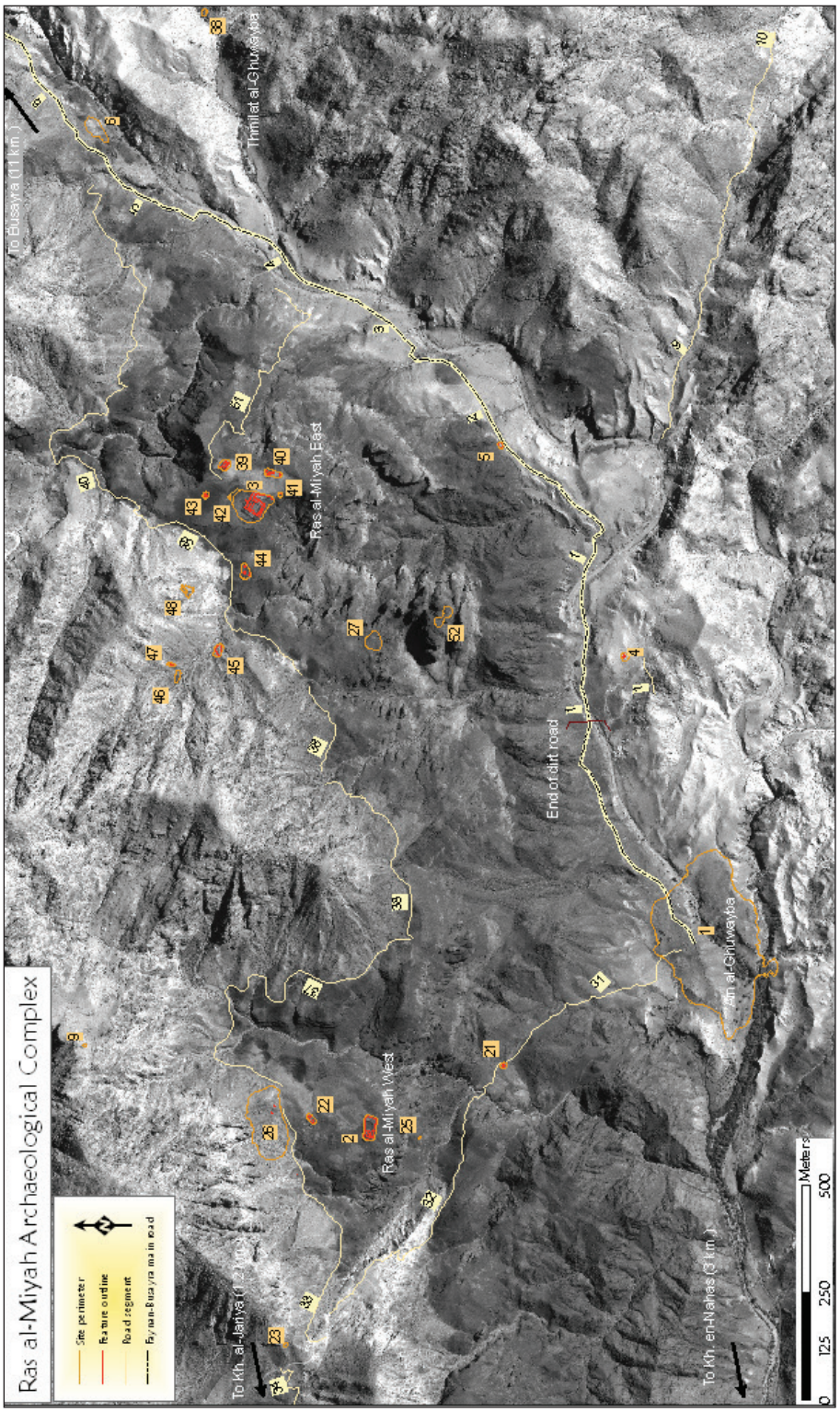

Figure 12.30 Sites and road segments recorded by the FBRS at the Ras al-Miyah Archaeological Complex (high-resolution satellite image, Ikonos, Geoeye). This area is the head of the principal road between Faynan and Busayra. The road climbs along the bank of Wadi al-Ghuwayba (Road Segments 1–6). All of the sites, except Site 52, are Iron Age or unidentified (Ud) (cf. Table 12.1, this volume; see Chapter 6, this volume).

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Table 12.6 Ras al-Miyah archaeological complex: sites recorded by FBRS (Chapter 6, this volume) (cf. Figure 12.30).

Site*	Details**	Location	Description	Comments
1 7/7/2007 Ghuwayba 737153/3398 285 175	Kh. al-Ghuwayba Archaeological complex/smelting site 70967 Iron Age, Nabataean (?)	Extensive archaeological complex sprawling on wadi terraces on both sides of Wadi al-Ghuwayba near the spring.	Small fragments of slag are scattered all over the site; structures and installation are visible on the surface. Modern Bedouin campsite is located in the middle of the north bank portion of the site.	The site was surveyed as part of SGNA (MacDonald 1992:76, Site 161, "Iron Age II") and by the German expedition (e.g., Hauptmann 2007:132, "Iron Age"); more precise dating is needed, especially in regard to the mining complex of Ras al-Miyah. A few sherds were identified by our team as Roman.
2 7/7/2007 Ghuwayba 736692/3399 076 319	Ras al-Miyah West Fortress 1656 Iron II	On the edge of the Burj dolomite plateau,ca. 150 m above ‘Ain al-Ghuwayba.	Fortress built out of local dolomite stones.	See detailed description in Ben-Yosef, Levy, et al. (2009b).
3 7/7/2007 Ghuwayba 738148/3399 341 350	Ras al-Miyah East Fortress 5119 Iron II	On the edge of the Burj dolomite plateau, ca. 175 m above ‘Ain al-Ghuwayba.	Massive unfinished fortress built out of brown sandstones from the nearby vicinity.	See detailed description in Ben-Yosef, Levy, et al. (2009b); a few sherds were identified as Nabataean.
4 7/7/2007 Ghuwayba 737799/3398 483 215	Campsite 264 Iron II	On a plain of a wadi terrace, ca. 30 m above Wadi al-Ghuwayba and about 800 m from the spring.	Elliptical courtyard (41 × 72 m inner dimensions) and a large concentration of collapsed stones (local brown limestone, brought from nearby the terrace plain). In the surrounding area, there are other small stone features such as semi-circles and small cairns 1 m in diameter. The site seems to be directly related to the nearby Kh. al-Ghuwayba and may have had a role in controlling the access to the smelting area from the east (the main road to Busayra)	There is no direct view from the site to either the wadi or the spring. Pottery sherds are scattered in the courtyard and the site vicinity; copper ore was also collected. To the north, near the wadi bed, there are extensive remains of recent Bedouin occupation.
5 7/8/2007 Ghuwayba 738291/3398 771 240	Campsite 168 Ud	On a granite bedrock, adjacent to the main road of Naqb al-Ghuwayba, where it crosses a local saddle ca. 120 m from the wadi bed.	Circular structure made of local lime/sand/dolo stones, 16 m in diameter, one course, roughly built. One wall may be partially covered/destroyed by the old dirt road.	
6 7/8/2007 Ghuwayba 739041/3399 726 283	Lithic scatter 1652 Ud	On a flat plain above Wadi al-Ghuwayba.	Dense concentration of flint tools and flakes. There are also small stone structures scattered in an area of 20 × 20 m.	Flint nodules are available only in the wadi gravel, or outcrops of Cretaceous formations far from the site.
9 7/11/2007 Jariya 736888/3399 743 437	Leopard trap 46 Ud	On a saddle in the high MB sandstone ridge separating Wadis al-Jariya and al-Ghuwayba.	Small leopard trap build of local stones.	
21 7/18/2007 Ghuwayba 736841/3398 764 211	Fortlet 194 Ud	On a granite bedrock in a small valley between the spring of ‘Ain al-Ghuwayba and the fortress of Ras al-Miyah West.	A small fortlet (5.2 m^2) built of local stones (granite, dolomite, sandstone). Each wall consists of ca. 10 to 13 stones; only lower courses were preserved.	
22 7/18/2007 Ghuwayba 736712/3399 212 314	Structure complex 314 Iron II	On the top of a plateau made of the dolomite shale unit, just north of Site 2.	A small rectangular structure made of the local shale-dolomite stones, fairly well preserved. Nearby there are remains of a small circular structure.	
23 7/18/2007 Ghuwayba 736190/3399 275 348	Smelting site 69 Ud	On the slope ca. 20 m above and to the northeast of the saddle separating Wadi al-Ghuwayba and Wadi al-Jariya.	A copper smelting site with a concentration of solid small pieces of slag, but no discernable structure or installations; small pieces of slag are found all along the slope from the site center to the saddle below.	

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Table 12.6 *(continued)*

Site*	Details**	Location	Description	Comments
25 7/21/2007 Ghuwayba 736672/3398 960 238	Retaining wall 15 Ud	On the Salib sandstone slope to the south of Site 2 (below Ras al-Miyah West).	A small retaining wall built of massive dolomite stones; the construction characteristics seem to indicate that the site is not recent Bedouin (part of a route up to the fortress or part of a local terrace for other purposes?).	
26 7/22/2007 Ghuwayba 736718/3399 319 318	Mining complex 11991 Iron II	On the lower slope of the massive brown sandstone formation, in the vicinity of Site 2.	The slopes are covered with ample amount of archeological remains related to copper mines. The location of the shafts can be identified by the black tailings (residue of the shale unit). Below the tailings and other mining debris (which create artificial piles and shape the current slope), there are some constructions—small structures made of black dolomite in the lower part of the slope (not well defined in shape, maybe simple shelters for the miners). Above what seems to be the main shafts, there is a line of holes (about 18 and 12 cm in diameter) carved into the sandstone, probably part of the installation that helped with carrying out the dug material. Abundant ceramics all over the slope with concentrations near the mine shafts.	
27 7/22/2007 Ghuwayba 737832/3399 069 312	Cultic 1287 Iron II	On a ledge in the cliffs above Wadi al-Ghuwayba overlooking the fortress of Ras al-Miyah East and ca. 20 m below the route connecting the two fortresses of Ras al-Miyah.	Extensive pottery scatter, no architecture. More than 100 fragments were collected; more than 80 are identifiable. A small male figurine was found trapped in a crack between rocks.	GPS location of figurine—EDM 8000. The prominent sandstone dome facing the site (Site 52) does not have clear Iron Age remains.
38 7/27/2007 Ghuwayba 739303/3399 463 255	Thmila 168 Ud	In a small tributary of Wadi al-Ghuwayba (200 m from Wadi Ghuwayba itself). It is visible from Ras al-Miyah East.	A built thmila under a ficus tree. Except for small constructions near the spring itself, there are no significant other ancient remains and no pottery.	Site center was recorded 6 m west of the spring due to the tree. Spring seems to be intensely used by local Bedouins. The wadi from the spring downward is rich with water vegetation.
39 7/27/2007 Ghuwayba 738243/3399 415 350	Structure complex 534 Iron II	Structures located about 50 to 60 m from the fortress of Ras al-Miyah East (Site 3).	A small complex of dolomite structures composed of four rectangular spaces, the biggest of which is probably a courtyard. A small circular feature is adjacent to the northeast of the structure complex. In the courtyard, there is a broken sandstone slab. In some places, the walls are preserved up to five courses.	
40 7/27/2007 Ghuwayba 738223/3399 307 357	Structure complex 581 Iron II	Situated on shallow residue of brown sandstone formation in the middle of the Dolomite plateau (Burj formation).	Structures constructed mostly of poorly built and ill-defined walls. Most of the buildings are of dolomite rocks, but in the center there is a structure composed mostly of sandstone. Most of the space of the complex/line of structure was hard to define. The main complex is composed of four to six connected spaces. Ten meters to the south, there is a smaller complex composed of two spaces. Abundant ceramic sherds. Manganese nodules were also collected from nearby the site (they are scattered all over the dolomite plateau).	
41 7/27/2007 Ghuwayba 738174/3399 285 351	Structure 108 Iron II	In close vicinity to the fortress of Ras al-Miyah East (Site 3), on the edge of the cliff above Wadi al-Ghuwayba.	Structure is probably rectangular (we could identify some wall lines in its western and southern boundaries) and is rich with pottery. On the other side of the line feature of fortress Site 3, there is another structure/pile of dolomite stones.	
42 7/27/2007 Ghuwayba 738170/3399 403 342	Tumulus 33 Ud	Located in a very shallow wadi in close vicinity of fortress Site 3; seems to represent a different period than the fortress and structures.	A grave/tumulus consists of a pile of massive sandstones. Robbery dig has exposed a rectangular grave chamber well defined by sandstone slabs on at least two sides.	Note the hidden location of the tumulus, uncommon with a similar structure in the survey area.

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Table 12.6 *(continued)*

Site*	Details**	Location	Description	Comments
43 7/27/2007 Ghuwayba 738174/3399 458 343	Structure complex 182 Iron II	On the dolomite plateau (Burj formation), close to the fortress Site 3.	A single structure with a room complex made mostly of local small dolomite stones. The walls are preserved up to three courses. A few of the dolomite slabs are massive (up to 1 m in length).	
44 7/27/2007 Ghuwayba 737997/3399 364 329	Structure complex 647 Iron II	On the Burj dolomite plateau.	A complex of three small structures made mostly of small dolomite stones and small sandstones in some places. The central structure is the largest and is preserved up to 10 courses in some places.	
45 7/27/2007 Ghuwayba 737812/3399 431 332	Structure 508 Iron II	Located on the western bank of a small tributary of Wadi al-Ghuwayba and in close vicinity to copper mines (Site 46). Around the site there are many small archaeological features.	Massive rectangular structure (enclosure) of local large brown sandstone.	From Road Segment 39 to the site and the mines (46, 47), there are many small archaeological features, retaining walls, and stone piles, probably related to the mining activities in this region.
46 7/27/2007 Ghuwayba 737754/3399 525 346	Mine 304 Iron II	On the western side of a small tributary of Wadi al-Ghuwayba, a mine dug into the lower part of MBS formation.	This is the most visible mine shaft in the local tributary—blackish tailings visible from a long distance. Other mines may be present nearby buried under the sandstone talus. Abundant ceramic.	
47 7/27/2007 Ghuwayba 737781/3399 537 347	Mine 121 Iron II	On the eastern side of a small tributary of Wadi al-Ghuwayba, a mine dug into the lower part of the MBS formation.	Copper mine shafts, including a possible mine tailing as well as two circular rock constructions (may represent shaft locations).	Around 15 m above the site, there is a small cave where an Edomite painted pottery sherd and a base with wheel markings were found, as well as a large mortar carved into the local sandstone.
48 7/27/2007 Ghuwayba 737952/3399 500 359	Archaeological complex/watchtower 443 Iron II	On a hanging shelf overlooking the fortress of Ras al-Miyah East. In the lower parts of the cliffs of the MBS formation.	Massive structure stretching from the edge of a cliff to the cliff face, probably rectangular. A few meters of a straight wall (the western side of the "tower") are visible beneath the collapse and composed of two courses of stones. On an upper rock shelf, there are smaller constructions in front of a natural rock shelter/shallow cave. To the east of the massive structure carved into the sandstone cliff face, there is a slightly curved line of seven holes, 10 to 15 cm in diameter (about 3 m above the shelf, "Feature 1" in GPS recording). Below the holes line, a large sandstone block is etched with 22 notches about 2 cm apart (decoration?). This area was the source of the building stones of the unfinished fortress at Ras al-Miya East. There may also be some copper mine shafts buried beneath the collapse, although no clear tailings are visible. The whole area has abundant pottery, especially in the collapse and along the slope below the building and cliff. Many diagnostic, extremely rich.	The holes line feature is similar to the one observed in Site 26. Unique building whose purpose is not clear.
52 7/30/2007 Ghuwayba 737895/3398 895 328	Pottery scatter 902 EB?	On a prominent rock dome (Salib Sandstone) above Wadi al-Ghuwayba, facing both Site 27 and Ras al-Miyah East. The access to the peak (including some rock climbing) is extremely hard and is possible only from the northeast side.	The site is mostly a scatter of pottery sherds in some pockets near the peak itself and to the east and south of it. There are some small cairns on the top of the peak; most seem to be recent. Small stone features to the northwest of the center point might be part of the old occupation.	We survey this peak because of a possible relation to the nearby unique Site 27. The peak suffered extensive erosion and the site may have been more extensive. Body sherds seem to be Early Bronze.

*Site column contains (in the following order): site number, date visited, Wadi basin, map reference (in UTM WGS 1984 36N), and elevation (in meters above sea level).
**Details column contains (in the following order) toponym (if any; Kh. = Khirbat [in Arabic, "ruins of"]), site type, site area (m^2), and age (by ceramic identification; Ud = unidentified).

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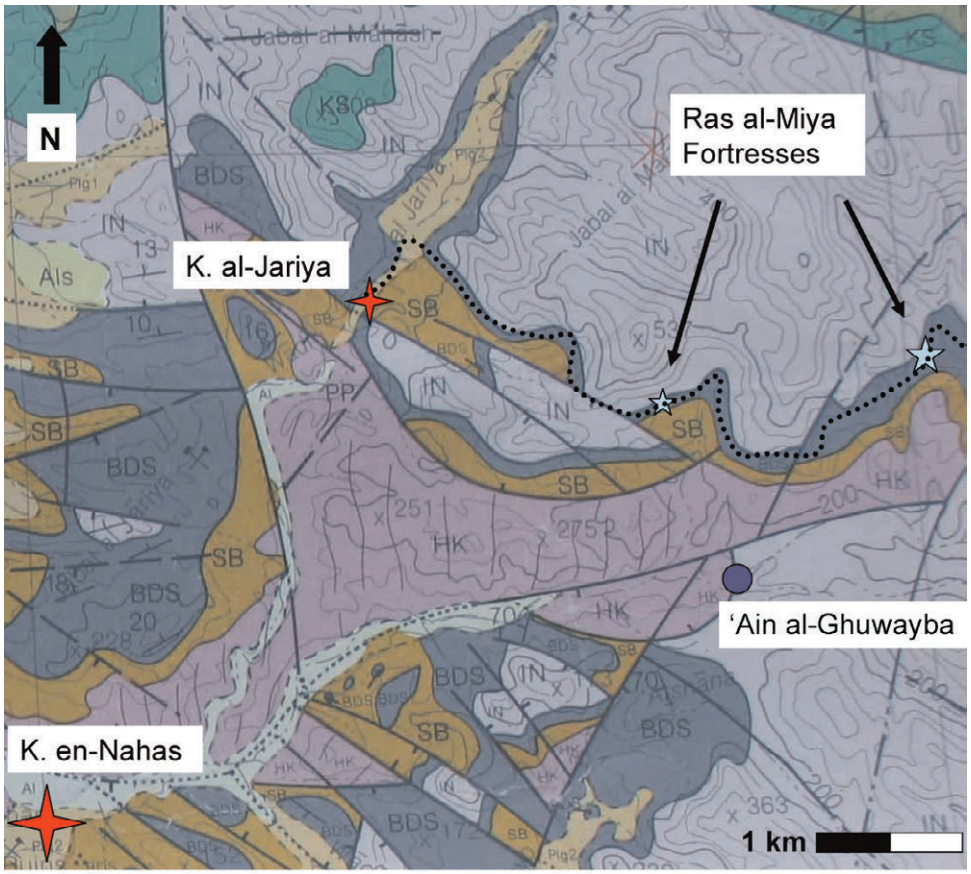

Figure 12.31 Geology map of Ras al-Miyah Archaeological Complex (after Rabba' 1994). HK = Hunayk monzogranite; SB = Salib formation (arkosic sandstone); BDS = Burj formation (dolomite-Shale; this is the main copper ore–bearing formation in the Faynan district); IN = Umm-Ishrin formation (sandstone). Note the location of the fortresses and the local trail that connects them on the narrow outcrop of the Burj formation (see text).

to Khirbat en-Nahas do not have to pass through the fortresses themselves, whose location does not indicate immediate concern with the road. Rather, it seems that the main interest in building the Ras al-Miyah fortresses had to do with the exploitation of the copper ore deposits surrounding them. The position of the western fortress is 1 km north of Khirbat al-Ghuwayba and around 150 m above the spring. The position of the east fortress is around 1.4 km northeast of the spring and approximately 170 m above it. This fortress is locally positioned for having a view toward the valleys in the west and not toward the road from Busayra, to the northeast.

The water supply for both fortresses was provided by the nearby oasis at 'Ain al-Ghuwayba but demanded considerable effort to haul water from the spring up to the fortresses. An additional small water source is located around 3 km upstream from the main spring, in a small eastern tributary of Wadi al-Ghuwayba ("Thmilat al-Ghuwayba" ثميلات الغويبة, UTM 739302/3399462, FBRS Site 38). This is a small oasis with a dug pool that holds water permanently and currently has a garden consisting of fig and palm trees and local vegetation indicating the high water table. Its proximity to the fortress of Ras al-Miyah East (ca. 1 km as the crow flies) suggests that this was the primary water source for the fortress's occupants, assuming that a same pattern of springs prevailed in the area during the Iron Age. Building cisterns in the immediate vicinity of the fortress would require the use of mortar because the local rock does not hold water. With the exception of a possible incomplete attempt to construct a water drainage system in Ras al-Miyah East (see below), no signs of any cisterns were found in our surveys around the fortresses.

Ras al-Miyah West *(راس المية الغربي)*

The fortress of Ras al-Miyah West (FBRS Site 2) is located at UTM 736691/3399076, around 320 m above sea level and 500 m from the saddle separating Wadi al-Ghuwayba and Wadi al-Jariya (Figure 12.1). The fortress is built out of local black dolomite stones, roughly cut into small slabs from the layered Burj formation (Figure 12.24). The structure is composed of two architecturally separate parts, a massive square tower and a rectangular enclosure divided into two

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main spaces (Figure 12.35). The enclosure and the tower represent distinct construction phases, as the enclosure walls abut those of the tower and do not constitute a continuous construction. The collapse walls of the tower rise around 4 m above the ground surface, surrounded by a massive collapse that gives it a circular layout (Figure 12.36). However, some of the inner walls are still visible, revealing a rectangular chamber, around 4 × 8 m.

The enclosure walls are preserved up to 10 to 12 courses of stones and to a height of more than 2 m. These walls incorporate the tower, forming a large rectilinear enclosure space (ca. 23 × 45 m) oriented as a west–east elongated shape. The tower dominates the northwestern part of the enclosure and does not protrude out of the rectilinear layout. The area to the south of the tower is divided into small spaces and consists of the highest remaining walls in the enclosure. This part might have been roofed, indicating several small chambers adjoining the wide open enclosure to the east. The main gateway to the fortress appears to be located on the western side, between the walls of the tower and those of the enclosure (Figure 12.35).

Although the fortress is roughly built from the local stones on a high and isolated plateau, it does not show similarity in its architectural plan to the other Late Iron Age "Edomite strongholds" such as Baja III (Lindner and Suleiman 1987), Jabal al-Qseir (Lindner et al. 1996), and others (e.g., Ben-David 2001).[11] An interesting parallel is found in neighboring Moab, with an Iron Age fortress reported by Parker (1987:56, Figure 25, Site 232; 2006:60, Site 57). The fortress is called by the local Bedouins "Rujm el-Abed" (Figure 12.34).[12] The orientation, dimensions, and architectural design of both fortresses are notably similar. They are both located on a leveled plateau on the edge of a cliff; their elongate axis is in a west to east orientation; the towers are situated mostly on the northwest side of the courtyard and do not protrude from the rectilinear enclosures associated with them; enclosures on the eastern side have somewhat rounded corners; and finally, both structures are built from the local stone (in the case of Rujm el-Abed, it is roughly cut basalt stones). The "Moabite" fortress is located on a cliff above one of the southeastern tributaries of Wadi al-Mujib (biblical Nahal "Arnon"), far from the track of the King's Highway (located to the west), the principal north–south route along the Jordanian highland plateau. The massive structure is positioned on the edge of the eastern desert, not far from the location of the Roman limes line of fortifications (Parker 2006) and probably on an ancient Iron Age road that crosses the topographic barrier of Wadi al-Mujib through an eastern alternative to the King's Highway (see Ben-David 2009). However, there are no remains of such a road or other fortification further east and north of the fortress. This suggests that the main objective of the site was to watch over the valleys below, where more plausible paths might have been in use for transportation between both parts of Moab (see especially Ninow 2002).[13] This suggests that Ras al-Miyah West may also be a watchtower that guarded indirect routes in the valleys below.

In close proximity to the Ras al-Miyah West fortress, around 115 m to the north and near the northern edge of the dolomite topographic step, there are two relatively well-preserved small structures roughly built from the local dolomite stones (FBRS Site 22, Figure 12.30; also Figure 12.37). One is rectangular, around 7.5 × 5.5 m, and the other, situated approximately 6.5 m to the northeast, is a tumulus-shaped circular pile of stones. Some 20 m to the north of the small structures is an extensive mining complex (FBRS Site 26; Figure 12.30), situated on the lower slope of the Umm-Ishrin formation and extending over an area of around 1.2 ha (Figure 12.37; for the mining technique, see also Figure 12.32a). Only a few of the blocked entrances to the mine shafts may be identified today; nonetheless, it is clear that many are buried under the collapse of the sandstone cliff, as evidenced by tailings. The mine shafts were dug into the lower part of the Umm-Ishrin formation, in order to approach the copper ore–bearing layer of the upper part of the Burj formation (Figure 12.32a) located below. From the location of one of the shafts entrances, we can reconstruct the approximate depth of the mines to be around 15 to 20 m. Based on the extent of tailings, we can presume extensive galleries were dug into the ore-bearing horizon as has been documented by the Deutsches Bergbau-Museum team in many Iron Age locales in Faynan (Hauptmann 2007). Iron Age copper mines with similar characteristics were reported from Wadi Khalid, in the vicinity of Khirbat Faynan (Hauptmann 2007:116–121). The depth of the mine shafts in Wadi Khalid was up to 50 to 60 m (Weisgerber 1989), and some of the excavated mines reveal long galleries (>30 m) along the copper ore–bearing layer (Weisgerber 1989).

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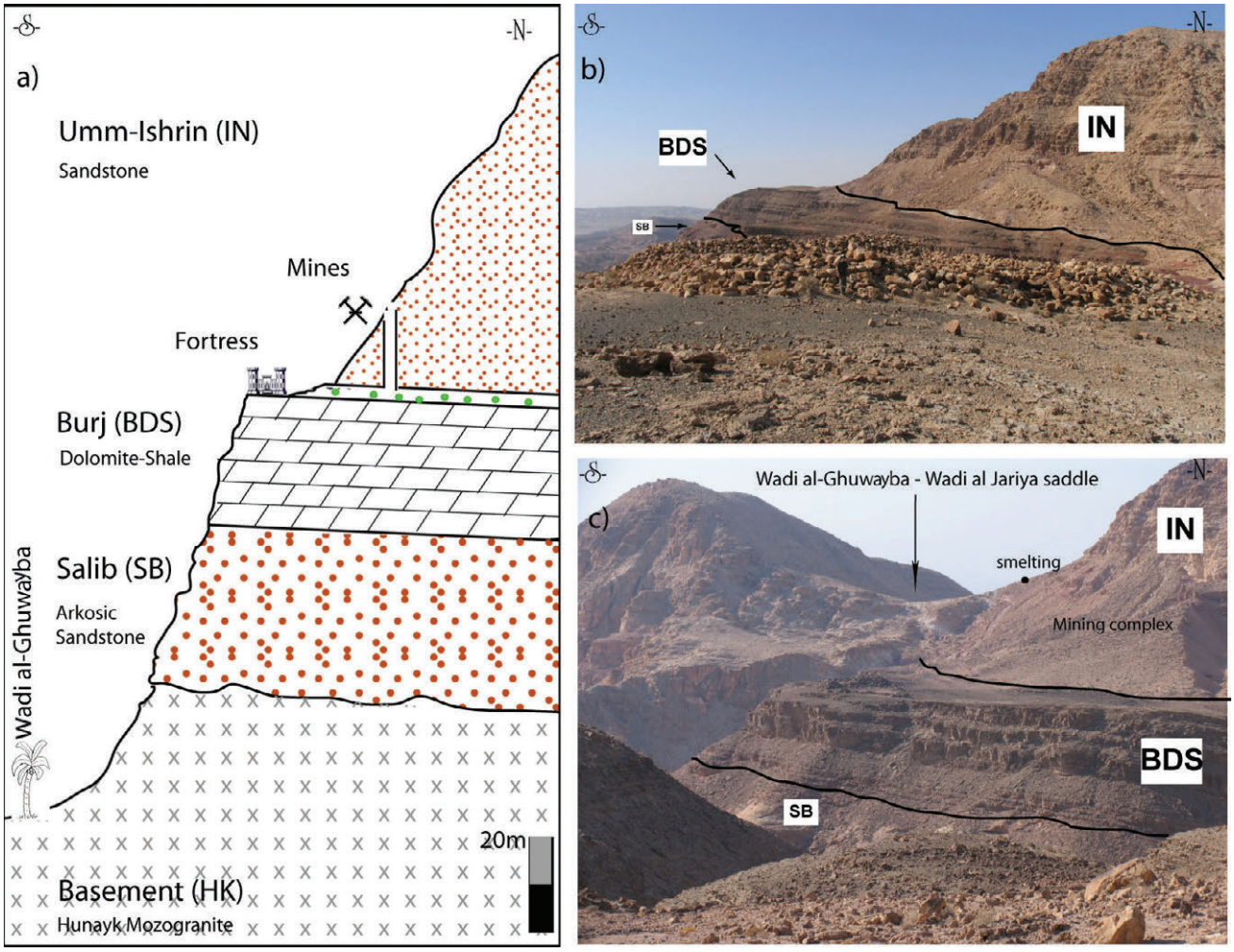

Figure 12.32 The geology of Ras al-Miyah: (*a*) a schematic section of the rock formations in the vicinity of the fortresses, looking west. Note the copper ore–bearing horizon of the Burj formation, the mining technique, involving shafts dug into the lower part of Umm-Ishrin formation and the topographic step caused by the erosion of the soft shale unit of the Burj formation; (*b*) Ras al-Miyah East and the geological formations, looking west; and (*c*) Ras al-Miyah West and the geological formations, looking west.

A double-shafts mine in the vicinity of Wadi al-Ghuwayba was reported by the Deutsches Bergbau-Museum team and not recorded by us (Hauptmann 2007:132–133; Weisgerber 2006:16). It is one of the best-preserved mines, with holes dug at the edge of the shaft for placing a wooden winch (Figure 12.38). The double-shaft mines are common in the Wadi Khalid–Wadi Abyad region and represent a common technology in the Iron Age of this region.

The extensive copper mining activities are recognized primarily by the distinct remains of black manganese-rich tailings that are highly visible on the bright sandstone slopes (Figure 12.37b). The tailings originate from the copper ore–bearing layer and were the result of removing rocks to create the shaft and galleries. They might also be the result of processing ore outside of the shafts after removing it from the ore body inside the hill. In addition, several small roughly built structures and installations located on the steep slope are another indication of Iron Age interest in exploiting the buried ore deposits. One particularly interesting installation is a horizontal line of rounded niches (ca. 10–15 cm in diameter) carved into the sandstone cliff several meters above one of the major blocked shaft entrances (Figure 12.37c). The niches might have been the base for wooden scaffolding used in the process of raising ores (and perhaps miners) through the shafts, with the help of ropes. A very

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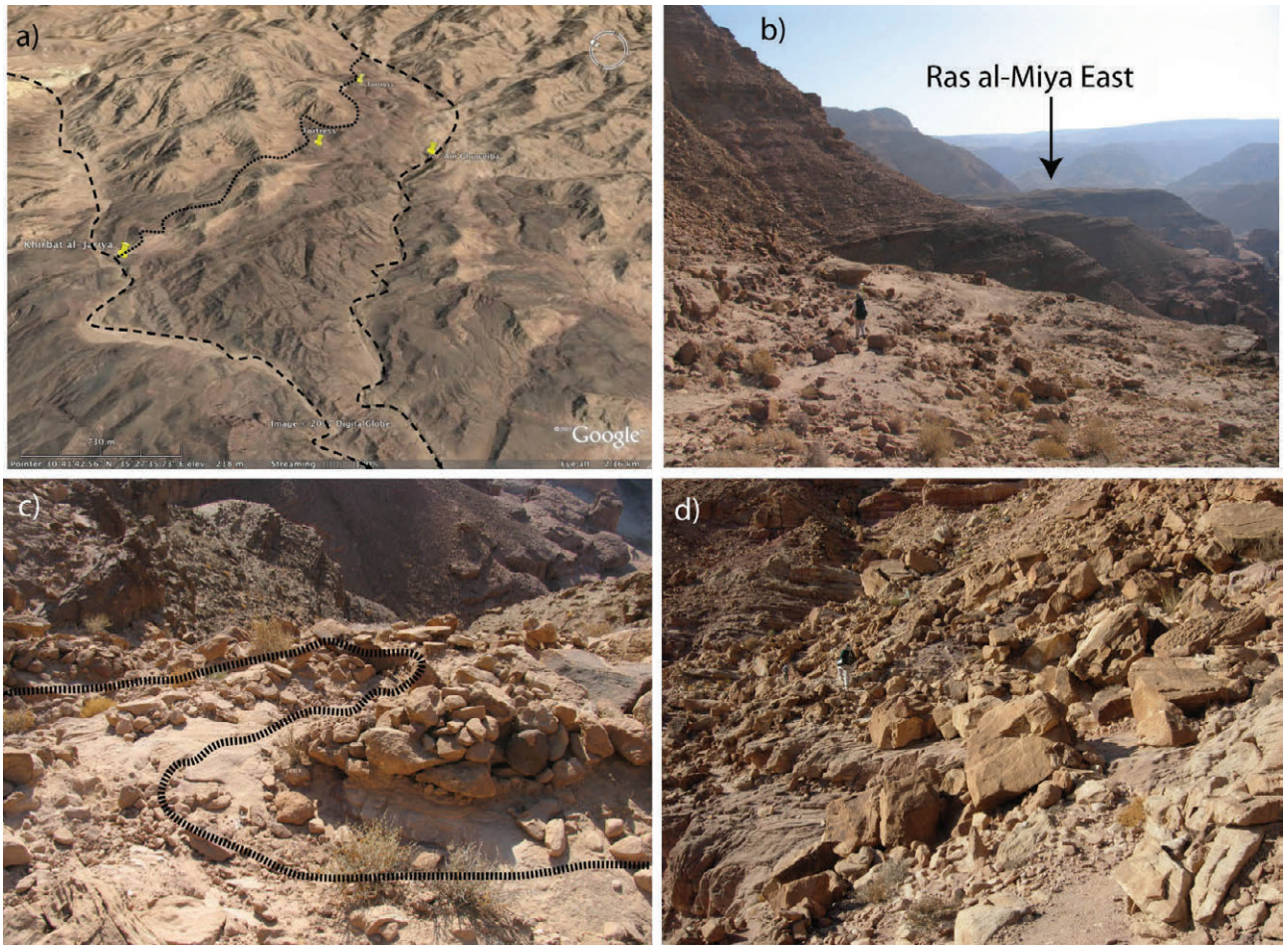

Figure 12.33 Local and principal trails in the area of Ras al-Miyah: (*a*) a multispectral tilted satellite image of upper Wadi al-Ghuwayba basin, looking to the northeast. The main road to Busayra passes through 'Ain al-Ghuwayba and Wadi al-Ghuwayba; the principal road to Wadi ed-Dahal passes through Khirbat al-Jariya and Wadi al-Jariya, and a local road connects the two fortresses of Ras al-Miyah with each other and with the basin of Wadi al-Jariya (image taken from Google Earth). (*b*) The local trail connecting the two fortresses takes advantage of the topographic step of the Burj formation (looking to the east). (*c*) This trail shows constructions, typically in difficult passages, and (*d*) the boundary between the sandstone of the Umm-Ishrin formation and the shale unit of the Burj formation is sometimes covered by sandstone talus. For scale, note the individual walking along the trail.

similar installation appears on the sandstone cliff near the fortress of Ras al-Miyah East (FBRS Site 48; Figure 12.37d), although there it could also be related to stone quarrying activities (see below). We do not know of any parallels for such installations in the copper mining districts of the southern Levant (constituting mainly Faynan region and Timna Valley), making this particular reconstruction speculative.

Two open shallow mining shafts were dug directly into the shale unit of the Burj dolomite-shale formation close to the boundary of the Umm-Ishrin sandstone and in close vicinity to the mining complex of the slope (not recorded by the FBRS). One of these was excavated by the Natural Resource Authority of Jordan (NRA), possibly in the location of an ancient shaft, and the other (the eastern) is probably a collapsed ancient mining shaft (Figure 12.37e). If the Iron Age date of these shafts is correct, these mines are evidence for exploiting, or an attempt to exploit, copper ores directly from the Burj formation without the need of deep shafts. The disadvantage of mining copper directly from the outcrops of the Burj formation without using the deep shafts described above is that these outcrops are stratigraphically located slightly below the richest copper-bearing horizon that was eroded in the region of the topographic step.

A strikingly large quantity of ceramic fragments, many of them identifiable, was recovered from the

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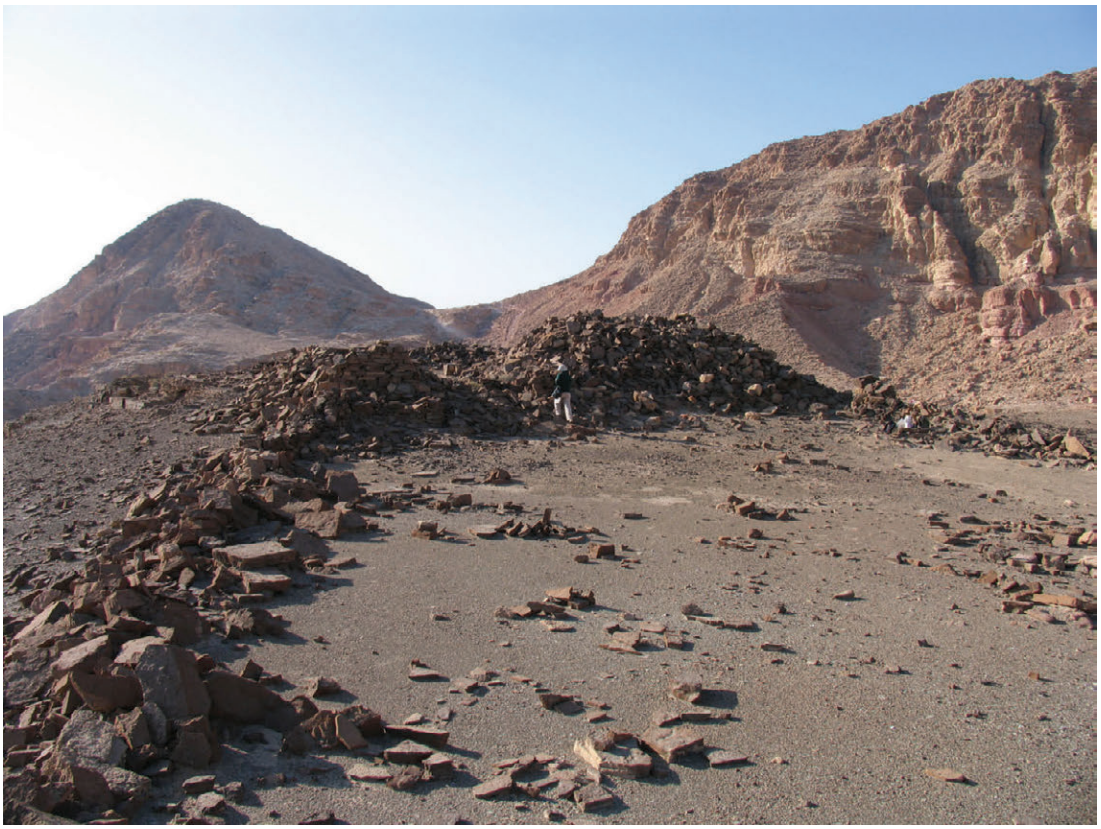

Figure 12.34 The fortress of Ras al-Miyah West (view toward the west).

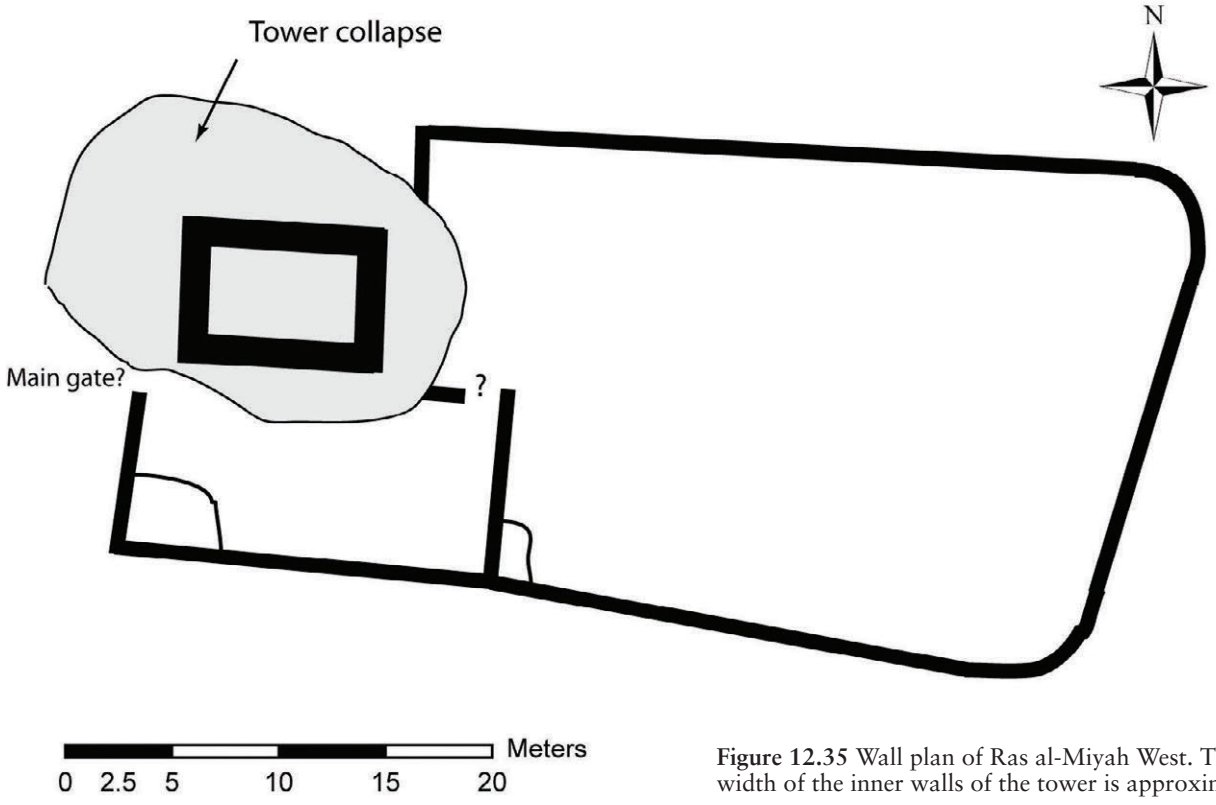

Figure 12.35 Wall plan of Ras al-Miyah West. The width of the inner walls of the tower is approximate.

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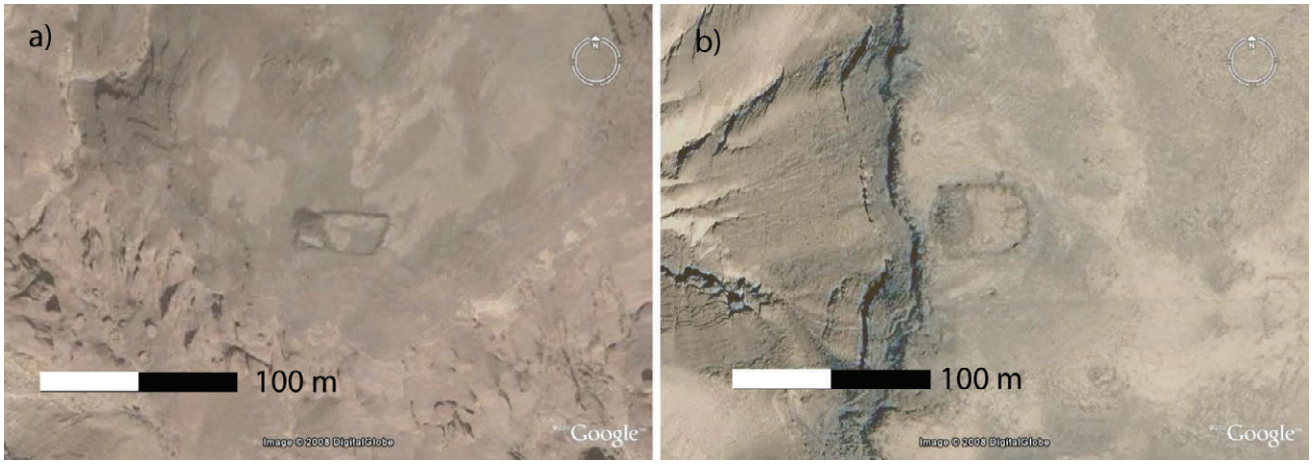

Figure 12.36 The Edomite Iron Age fortress of Ras al-Miyah West (*a*) and the Moabite Iron Age fortress of Rujm al-Abed (*b*) show marked similarities in the architectural plan (images taken from Google Earth).

fortress, the nearby structures, and the copper mining complex. The pottery sherds are scattered on the surface in a very high density relative to other Iron Age sites in the region. The large number of sherds may indicate a substantially long occupation phase and/or high intensity of activities in the last stage of the Iron Age II (probably the latter, see below; also possible is that the secluded location precludes constant collection of finds by archaeologists and travelers).

Four hundred meters to the west of the mining complex and around 20 m above the saddle between Wadi al-Ghuwayba and Wadi al-Jariya, there is a small deposit (ca. 70 m^2) of broken slag (FBRS Site 23; UTM 736190/3399275) (Figure 12.37f,g; see also Figure 12.30 for location). We could not find any ceramics associated with this site, and although the technology is relatively simple, we speculate that limited copper smelting took place simultaneously with the Iron Age copper mining activities in the area of Ras al-Miyah West. Technological typologies based on the slag cannot be directly used as a chronological marker (Ben-Yosef, Tauxe, et al. 2008; Ben-Yosef, Tauxe, et al. 2010) as simple industries could have been practiced even after more innovative technologies were introduced during the Iron Age. In the case of this slag deposit, its proximity to the archaeometallurgical complex of Ras al-Miyah may indicate dating the smelting activities to the Late Iron Age. The Iron Age smelters may have selected this location some distance from the Ras al-Miyah West fortress and nearby mines to take advantage of the high wind in the saddle. In the Faynan area, the wind-based furnaces are a common phenomenon in the Early Bronze Age II to III (Hauptmann 2007). Distinguishing between Iron Age and Early Bronze Age slag can be achieved by archaeomagnetic investigation of the slag samples themselves, similar to what we demonstrate for the slag at Khirbat Hamra Ifdan in the current research (see below and Ben-Yosef et al. in press). It will be interesting to test the slag of FBRS Site 23 in the future. Similar remains of small-scale smelting activities were found in the area of Ras al-Miyah East, although the samples collected there are probably manganese ore, and slag presence is not secure.[14]

Ras al-Miyah East

The fortress of Ras al-Miyah East (FBRS Site 3) is located at UTM 738148/3399340, around 350 m above sea level and approximately 100 m above the stream channel of Wadi al-Ghuwayba (Figures 12.30 and 12.39). The fortress is quite different from Ras al-Miyah West, both in building material and in architectural design. Ras al-Miyah East was not built out of the local dolomite stones, which can provide only relatively small slab blocks. Instead, the entire structure is built out of massive brown sandstone that originates from the nearby outcrops of the Umm-Ishrin formation. The thick layers of the sandstone in this formation can provide massive blocks of building stones with size limited only to transportation constraints and the architectural design. The fortress' walls and tower were built with huge, typically well-cut, sandstone blocks, sometimes exceeding 1 m in length (characteristic dimensions of stone blocks in the outer wall are ca. 80 × 40 × 30 cm, i.e., elongated blocks of about ca. 0.1 cubic meter) (Figure 12.40a). The distance to the quarry

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Figure 12.37 Archaeological features in the vicinity of Ras al-Miyah West: (*a*) small rectangular structure made of local dolomite stones (FBRS Site 22) and (*b*) overview of the mining complex (FBRS Site 26). Note the blackish color caused by tailings. (*c*) Horizontal line of niches, 10 to 15 cm in diameter, located above a blocked shaft in the mining complex. A similar feature was found in the quarry area near Ras al-Miyah East (*d*). (*e*) Open mining shaft dug into the shale unit of the Burj formation. (*f*, *g*) Copper slag deposit located near the saddle between Wadi al-Jariya and Wadi al-Ghuwayba.

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Figure 12.38 Double-shaft entrance of a mine recorded in the area of Wadi al-Ghuwayba by the Deutsches Bergbau-Museum team. This is one of the best-preserved Iron Age copper mines, with evidence of the use of a winch. Three centrally positioned postholes indicate that a thin central beam was used to haul ore (and people) from the mine (Weisgerber 2006:16).

located in the sandstone cliffs to the north is relatively short (ca. 200–250 m). However, moving the massive sandstone blocks required overcoming both the lower steep slope of the Umm-Ishrin formation (a descent of some 30 m) and the moderate but longer slope of the Burj formation (an ascent of about 30 m).

The outer dimensions of this fortress are around 42 × 35 m, with a northeast to southwest elongated axis. The walls are well preserved and the architectural plan is still clear, revealing small details of rooms and passages (Figure 12.41). The fortress has an inner courtyard of around 20 × 20 m, corridors on the northwestern and southeastern sides, a semi-casemate wall on the southwestern side, and a double corridor with a complicated maze of passages on the northeastern side. A massive tower (ca. 8 × 8 m, outer dimensions) protrudes from the fortress's eastern corner. Along the southern corner of the tower, a line of small stones follows the moderate hill gradient toward the south until it reaches the edge of the cliff. An additional shorter line of small stones is located between the southern corner of the fortress and the cliff. The pattern of these installations probably implies an attempt to collect seasonal rainwater, as they divert the runoff into a local topographic drainage channel. However, there are no remains of a cistern at the end point of this system, suggesting (a) an incomplete construction, (b) a channel that was used by placing a jar at the end point to collect water, and/or (c) a different use for these stone lines, such as diverting the runoff for protecting the foundations of the fortress walls.

The gate of the fortress is located in the middle of the northeastern wall. It has a unique shape with two protruding walls which extend around 8 m toward the northeast. The width of the protruding walls is significantly smaller than that of the fortress's external wall (ca. 0.5–0.8 m vs. 1.2–1.7 m, respectively), and their height decreases gradually toward the outside. The protruding walls seem to be part of a short ramp that was constructed to overcome the elevation difference caused by the down sloping of the bedrock surface toward the north (Figure 12.41). The inner width of the ramp changes from about 2.5 m on the outside and 3 m on the inside. A similar construction, also interpreted as a ramp used to overcome local elevation difference, is reported from the Iron Age I to IIA fortress near Quseima in the northern Sinai Peninsula (Meshel 1994). At that site, which is considered one of the so-called Israelite Fortresses of the Negev, the ramp's walls extend toward the inner part of the structure (Figure 12.42).

In the first corridor from the gate of Ras al-Miyah East, there are two small intrusive structures built out of small local dolomite stones. One is located in the northern part of the corridor and the other just in front of the gate area. Both of the structures have a circular, tumulus-like shape, which suggests that these are later graves. The inner walls of the fortress are massive but short, consisting of two rows of stones that stand up to a height of four courses (Figure 12.40f). There are almost no remains of collapsed stones in the close vicinity of these walls (see below).

The southwestern side of the fortress is the most fortified, consisting of an extremely wide semi-casemate

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wall (ca. 6.5 m wide, including the casemates and inner wall; Figure 12.40d,e). The confined spaces within the wall (the "casemates") are filled with a vast amount of rock and earth (excluding the central space, which has only partial remains of collapse). The fact that this side of the fortress is the most fortified is somewhat surprising giving the fact that it is the only side that is directly protected by the natural sheer cliff (dropping abruptly for more than 50 m) along the edge of the dolomite plateau (Figure 12.40e).

To gain more insights about the date and function of Ras al-Miyah East, we conducted two small test excavations in this fortress: Probe 1 at the northeastern corridor and Probe 2 in one of the casemate room spaces along the southwestern fortified wall (Figures 12.41 and 12.43). Probe 1 in the northeastern corridor was a narrow trench, around 1.5 × 6.15 m, and excavated between the outer wall and one of the inner walls of the fortress (Figure 12.43a,b). The higher surface elevation on this side of the corridor seemed to indicate the presence of occupational deposits and was one of the reasons for choosing this location. While excavating, it became clear that the higher surface elevation was a result of the natural slope of the bedrock and that there was virtually no archaeological accumulation besides collapsed stones. We defined three loci (2, 3, and 4; see Figure 12.41) that represent the inner wall's collapse and wall foundation, the exposed bedrock in the center of the corridor, and the outer wall's collapse and foundation, respectively (Figures 12.41 and 12.43). The inner wall's collapse is meager and represented in L2 by only two relatively small stones. It seems that the inner wall in this location is preserved to its original height (3 courses, ca. 1.35 m). Beneath the collapsed stones and directly above the bedrock was a thin layer of yellow aeolian dust with small amounts of ceramic sherds. This probe was excavated to bedrock (some Burj copper ore concentrations were found here) to expose the lower course of wall stones that was built into a shallow foundation trench (ca. 30 cm deep). The bottom of the trench was filled with relatively small stones (1,500 cm^3 or smaller) (Figure 12.43b). This rough fill might indicate an intentional construction design for creating a more earthquake-resistant wall, as the small stones would give more flexibility to the heavy wall they support. We exposed a similar foundation trench (ca. 20–40 cm in depth) beneath the outer wall, after removing a massive collapse of wall stones (15 large stones in an area of ca. 1.5 × 3 m, L4). Also here, a thin layer of yellow aeolian dust with few fragments of pottery was uncovered, and part of the trench was filled with relatively small stones. Between the collapsed stones of the two walls, as in the



Figure 12.39 An overview of Ras al-Miyah East, looking toward southeast. The fortress is located on the dark Burj formation plateau and built almost entirely of bright sandstone. Note some of the small structures and the arrangement of building stones in front of the northwestern wall of the fortress. The size of this fortress is indicated by the two people standing along the southern corner of the structure.

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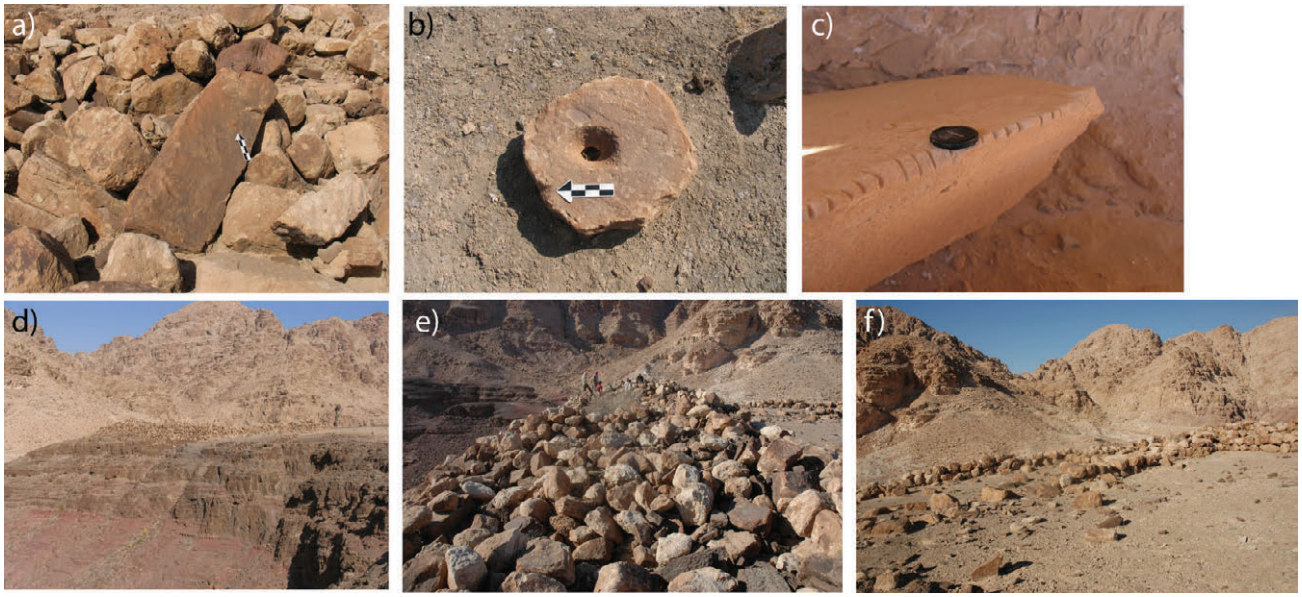

Figure 12.40 Details from the Ras al-Miyah East fortress: (*a*) massive sandstone ashlar is seen in the collapse of the eastern tower; (*b*) carved hole in a sandstone found in the fortress's courtyard, probably a door socket; (*c*) carved stone found in the nearby quarry, probably prepared the fortress; (*d*) southwestern wall of the fortress, just above the edge of the dolomite plateau; (*e*) southwestern wall of the fortress with semi-casemate rooms filled with rubble; and (*f*) northwestern inner and outer walls of the fortress (view from the courtyard).

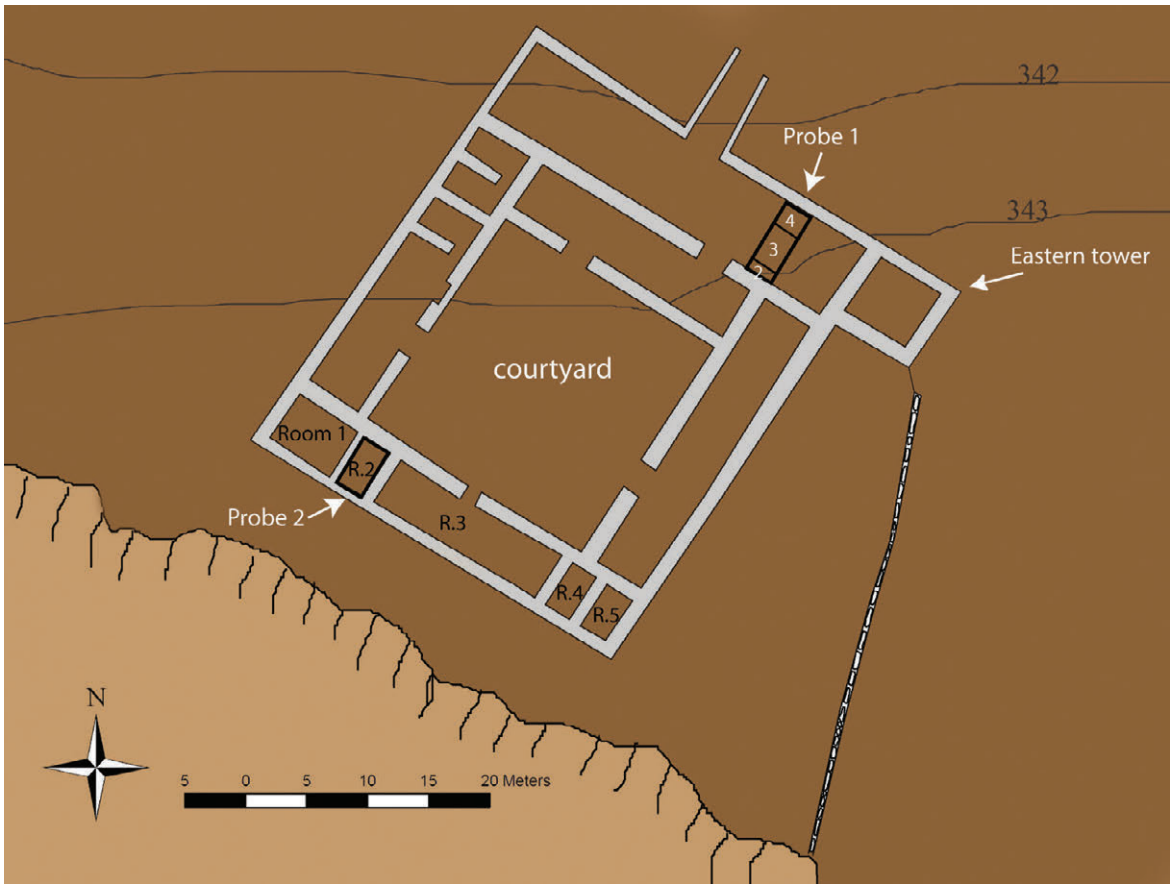

Figure 12.41 Wall plan of Ras al-Miyah East. The location of the sample excavations is marked with black rectangles. Contour lines are approximate.

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majority of the corridor's surface, the crumbly shale unit of the Burj formation was exposed (represented by L3).

Probe 2 in the southwestern wall of the fortress was aimed at exposing one of the casemate rooms (Room 2, Figure 12.31; Figure 12.43c,d) to reveal a possible occupation layer beneath the collapse. Although bedrock was not reached, the result of the excavation indicates that the so-called collapse is probably an intentional fill as part of the fortress's construction. Thus, the divided spaces between the inner and outer southwestern walls were probably planned as a frame for constructing a massive and wide wall with the use of a fill made of sediment and roughly cut stones.

The casemate room is an elongated space perpendicular to the fortress's external wall (ca. 4.6 × 2.5–m inner dimensions; see Figure 12.41). The outside wall of the fortress consists of two rows of stones, around 1.5 m in width, with a sharp bulge toward the outside of the fortress that was most likely the result of the massive pressure caused by the casemate's fill. The wall stands to a preserved height of around 1 m (the base of the wall is not exposed; Figure 12.43d). A massive stone collapse is found outside of the wall, on a narrow step between the fortress and the cliff of the dolomite plateau. The inner wall of the fortress, standing to a height of around 2 m, is made of two rows of stones, approximately 1.2 m in width. It has a sharp inclination toward the fortress courtyard, similarly the result of the intense pressure of the fill. The crudely built long walls of the room consist of one narrow row of roughly cut small stones (ca. 30–40 cm in thickness) with at least 10 unstable courses and some gaps of missing stones (the upper 2 m of these walls were exposed; Figure 12.43d). The poor building quality of these walls suggests that they had never stood by themselves and that they were erected together when the fill was poured inside the confined casemate spaces. A doorway between casemate Rooms 2 and 3 is represented by a gap of around 1 m between the southeastern long wall and the outer wall of the fortress. A similar doorway is located between the northwestern long wall and the inner wall of the fortress, connecting Room 2 with Room 1, although there the excavation is only 1.15 m deep and the gap is less clear.

Before the excavation of Probe 2 was carried out, the long walls of the casemate were visible in only a few places. The southwest side of the fortress appeared as a continuous and massive pile of stones, confined only by the inner and outer walls of the fortress (this excludes the central space that has much less fill; Figures 12.40d and 12.43c). The fill is a mixture of sandstone, dark dolomite stone, and a large quantity of fine earth (in places more than 0.5 m deep). The nature of this fill lends additional support for assuming an intentional blocking of the casemates: (a) the dolomite stones do not appear elsewhere in the construction of the fortress; (b) there is a mixture of two stone types, and both are roughly cut in a manner not suitable for quality building found in the rest of the fortress; and (c) the large quantity of sediment excavated here does not seem to be aeolian in origin.

The evidence from Ras al-Miyah East shows that the construction of the massive fortress was never finished. Although some of the indications are speculative, putting them all together presents a clear picture of an abrupt abandonment in the middle of the building process. The fortress's features that indicate unfinished construction are (1) a possible unfinished

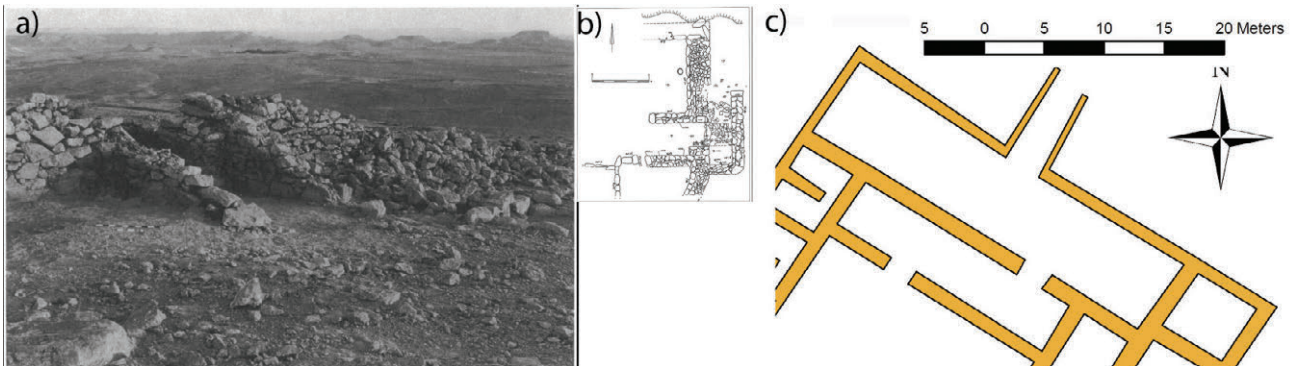

Figure 12.42 A picture (*a*) and a plan (*b* and *c*) of the gate complex of the so-called Israelite Fortress of Quseima (after Meshel 1994:Figures 7 and 8). The parallel walls are interpreted as being constructed for overcoming elevation difference and are similar to in shape and purpose to those found in the fortress of Ras al-Miyah East.

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Figure 12.43 The sample excavations in Ras al-Miyah East: (*a*) Probe 1 in the northeastern corridor. An area of ca. 1.5 × 6.15 m was opened between the outer and inner walls (view to the northwest). (*b*) Foundation trench beneath the inner wall. Excavations into bedrock exposed the base of the wall (note the small copper nodules and the brittle shale of the upper unit of the Burj formation). (*c*) An overview of the casemate Room 2 before its excavation and (*d*) the excavated casemate room at the end of excavation, view toward southwest. Bedrock was not reached in this probe.

water system, (2) a possible unfinished filling and fortifying the southwestern semi-casemate wall, and (3) the well-designed architectural plan of the fortress that suggests a symmetric layout, especially for the northwest and southeast corridors. However, only the northwest corridor is divided into inner spaces, and even this division seems to be incomplete. The intended construction might have been two similarly arranged corridors or even two blocked semi-casemate walls as the one found in the only naturally fortified side (southwest). (4) The inner walls are short, although their massiveness and foundation trench indicate an intention to build high walls, a building effort that never took place. In close proximity to these walls, there are almost no indications of collapse, and there is no evidence of robbing these walls. (5) No significant occupation layer or cultural debris was found in the probe (No. 1) in the northeast corridor. In addition, the surface finds in the entire area of the fortress are scarce, including ceramic sherds. This stands in sharp contrast to the abundant surface ceramic both in the nearby copper mining complex and in the fortress's satellite small structures (see below). The latter structures may have been the dwellings of the fortress's construction workers and/or the project management. (6) An almost "laid-out" arrangement of building stones outside the northwest side of the fortress and in the direction of the quarry (Figures 12.39 and 12.44) represents preparations for construction (that was never finished), rather than a collapse.

In close proximity to the Ras al-Miyah East fortress are abundant archaeological remains, most probably

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Figure 12.44 Multispectral satellite image of the fortress of Ras al-Miyah East and its vicinity (cf. Figure 12.76; image taken from Google Earth).

from the same period (excluding a small sandstone tumulus, ca. 40 m to the north of the fortress) (Figures 12.30 and 12.44). On the dolomite plateau, five groups of small, roughly built structures are located between 30 and 120 m from the fortress. Most of the structures have rectangular shapes, and some comprise several rooms. They are very similar in characteristic to the small structures near the Ras al-Miyah West fortress (Figure 12.37a), including dimensions and building quality. These also may have been associated with the Iron Age miners and/or builders responsible for the construction of the fortress.

A deposit of small black samples was found near the highest point of the dolomite plateau (Figure 12.44), possibly slag (some of the examined fragments were found to be nodules of manganese ore). The Iron Age II pottery fragments collected from the surface suggest a similar date for the smelting process (if such indeed occurred at this location), despite the simple technology that was practiced. A similar satellite site was found close to the Ras al-Miyah West fortress (there the presence of slag is secure; see discussion above). At both sites, we did not find any remains of furnaces.

A copper mining complex was found around 400 m northwest of the fortress, on both sides of a small valley and on the lower slope of the Umm-Ishrin formation (FBRS Sites 46 and 47, UTM 737754/3399525) (Figures 12.30 and 12.45). This area is directly related to mining activities and extends over an area of around 500 m^2. It includes several blocked mining shafts associated with black tailings (of the DLS formation) that are visible from a long distance (Figure 12.45b). The layout of the mining complex is similar to the one located near Ras al-Miyah West and discussed above. The mining shafts of Ras al-Miyah East appear to be deeper, as they are located in a higher stratigraphic elevation and the distance between their entrances to the boundary between the Umm-Ishrin and Burj

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formations is longer (more than 30 m). In the lower part of the valley, around 100 m southeast of the mines, a large trapezoidal enclosure was found (ca. 13 × 19 × 8 m) built out of massive local sandstone (FBRS Site 45; Figure 12.46). The pottery in the vicinity of this structure was scarce and its dating is insecure. It is important to note that the organization of mining activities at both fortresses is remarkably similar.

On a narrow step high in the brown sandstone cliffs of the Umm-Ishrin formation, a massive tower was found with adjacent small structures (Figure 12.47). The tower is located around 220 m (as the crow flies) northwest of the fortress and approximately 40 m above the dolomite plateau, in the vicinity of the sandstone quarry. The construction of this unique structure on the extreme location of the sandstone cliff is admirable even today. The layout of the tower, visible only in part beneath the massive collapse (Figure 12.47b), is probably rectangular. The western wall constitutes a straight line that can be identified for a length of around 8 m (Figure 12.47c). Thus, the dimensions of the tower might be 8 × 8 m or larger. The building stones comprise mostly the local sandstone, although blocks of black dolomite stones are also part of the collapse. The tower remains include numerous fragments of pottery, many of which are identifiable. The abundant pottery sherds all over the slope below the sandstone step are derived from the archaeological remains of the tower and the adjacent small structures. Between the collapsed stones of the tower, we found a fragment of a basalt grinding stone (ca. 35 × 20 × 10 cm) indicating food preparation activities or initial processing of copper ores (Figure 12.47d).

On a narrow shelf above the tower is a small roughly built structure in the opening of a shallow cave (Figure 12.47a,f). Below the tower and around 15 m to the northeast of its center is a line of rounded niches (ca. 10–15 cm in diameter) carved horizontally into the sandstone cliff (Figure 12.37d). A similar installation was found in the copper mining complex of Ras al-Miyah West (see above), although there it is associated with a copper mining shaft. We associate the niches near the tower of Ras al-Miyah East, together with other remains on the slope, with the sandstone quarrying activities that were part of the fortress's construction. However, even though there are no visible remains of mining activities on this slope, we cannot completely dismiss the possibility that such remains are buried under the eroded sandstone cliffs. Small installations, such as carved mortars located on the slope further to the west of the tower, suggest copper ore–related activities (crushing and grinding). Just below the line of niches, we found nicely carved cornice-like sandstone block with a line of grooves that might have been a simple decoration (Figure 12.40c).

Many ancient activities took place in the area of Ras al-Miyah East. Although scant amounts of pottery fragments indicate a limited ephemeral Nabataean presence at the site, the vast majority of the pottery indicates Late Iron Age II activities. However, we cannot discern whether the copper production activities (mining and possibly small-scale smelting) were done simultaneously with the project of quarrying massive sandstone and constructing the fortress or earlier (assuming that the abandonment of the fortress construction marks the end of the area's occupation). This question, together with revealing the exact function and date of the various structures and installations, stays open; however, a few speculative suggestions are suggested below.

Dating the Fortresses

In the current stage of the research, we consider the ceramic assemblage collected in both areas of Ras al-Miyah West and East to represent one period without subtle distinction into different occupational phases.[15] The ceramic assemblage in general is typical to Edom in the seventh and sixth centuries BCE (Iron Age IIB/C). A limited sample of indicative pottery sherds from the two fortresses and the nearby mines (including a fragment of an oil lamp) is presented in Figure 12.48. Pottery from various different sites of Ras al-Miyah is presented in Figure 12.49.

If the dating of the pottery sherds found at the two sites and their associated installations is correct, the Iron Age sites in the region of Ras al-Miyah were occupied approximately 100 years or more *after* the peak in early eleventh- to ninth-century BCE copper production activities in Khirbat en-Nahas and Khirbat al-Jariya (Higham et al. 2005; Levy, Adams, Najjar, et al. 2004; Levy, Najjar, van der Plicht, et al. 2005; Levy et al. 2008). There is no evidence of a large-scale sophisticated copper smelting industry such as that found at Khirbat en-Nahas and Khirbat al-Jariyeh associated with these Ras al-Miyah fortress sites. The organization of metallurgical activities around these fortress sites is quite different form earlier Iron Age metal production in Faynan. However, the interest in exploiting the copper ore in the region of

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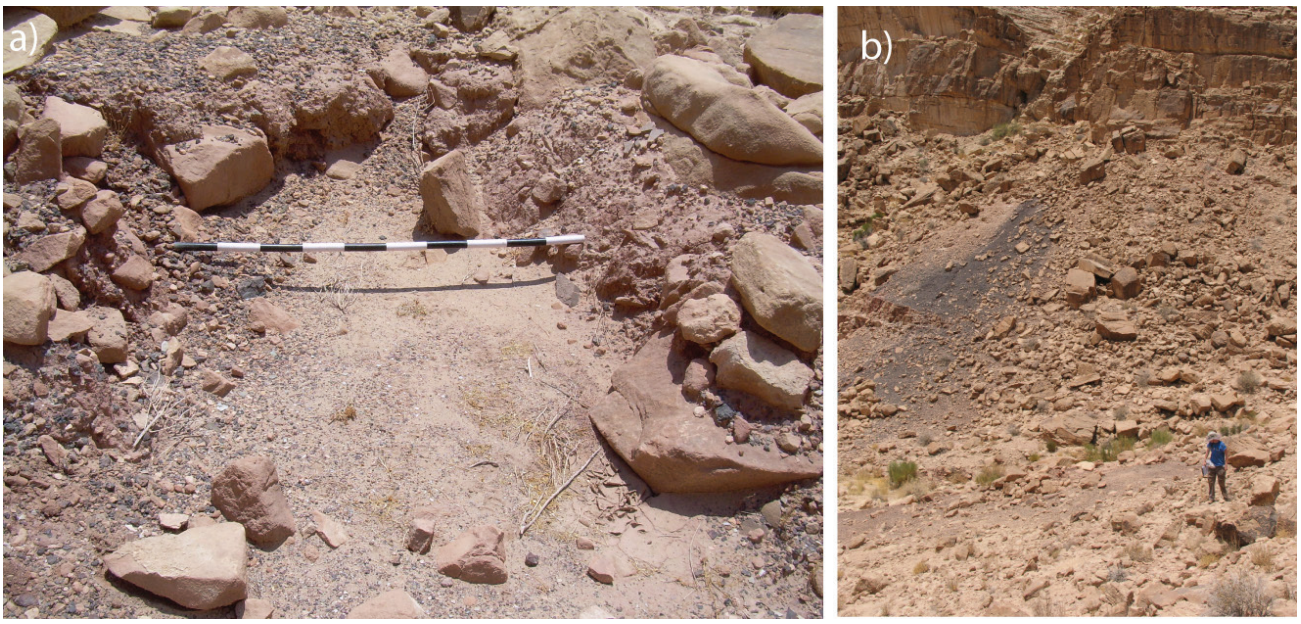

Figure 12.45 The copper mines near Ras al-Miyah East: (*a*) blocked shaft and (*b*) black tailings, easily visible on the bright sandstone slope, indicate the location of an ancient mining shaft.



Figure 12.46 A large (13 × 19 × 8 m) Iron Age enclosure made of the local sandstone in the vicinity of the copper mines near the fortress of Ras al-Miyah East.

Ras al-Miyah fortresses is evident, and the question is where the smelting process took place. A good candidate was the nearby large copper smelting site of Khirbat al-Ghuwayba. Until recently, this site was dated only generally to the "Iron Age" (Hauptmann 2007:132) without more precision. However, our recent excavations at the site indicate that this site was occupied only in the Early Iron Age, probably similar to the chronology of Khirbat al-Jariya. Thus, the major mining works of Ras al-Miyah have no appropriate smelting counterpart in the near vicinity and probably in the entire Faynan region. This observation corroborates the unsupported general claim of Weisgerber (2006:15) that "the mining

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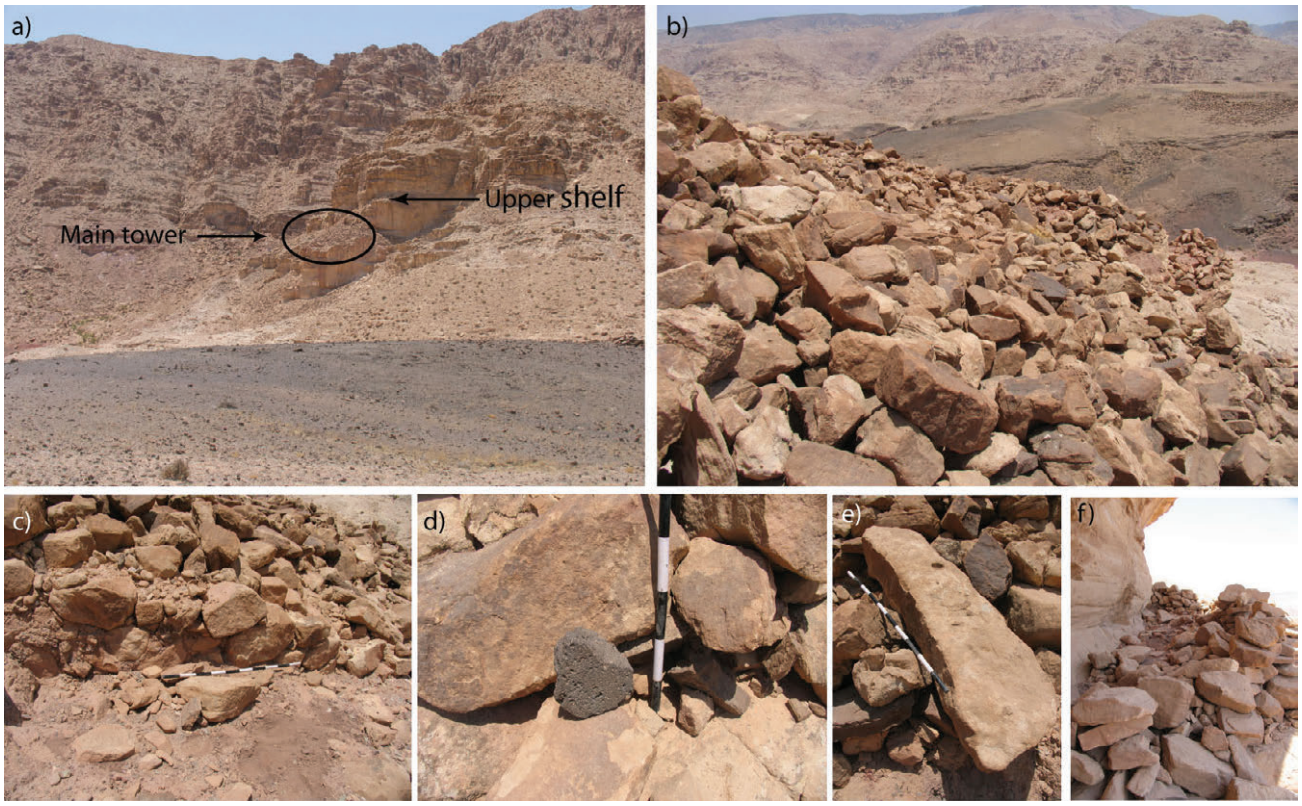

Figure 12.47 Ras al-Miyah East—remains of a tower on the sandstone cliffs: (*a*) overview, (*b*) massive collapse of the main structure, (*c*) face of the western wall of the tower, (*d*) basalt grinding stone found in the collapse of the tower, (*e*) massive sandstone building block in the collapse of the tower, and (*f*) construction remains on the upper shelf.

activities there [near the fortresses] seem to have been unsuccessful."[16] The implications of the archaeological evidence from Ras al-Miyah to our understanding of the organization of metal production in Faynan throughout the Iron Age are further discussed in the following chapters.

RAM Archaeological Complex—Summary

The archaeological complex of Ras al-Miyah is extremely rich in Iron Age remains. Two massive fortresses are associated with copper mining activities in the northern slopes of Wadi al-Ghuwayba. The fortresses were probably also connected with a defense system around the oasis of 'Ain al-Ghuwayba, which controlled the northeastern gateway to the entire region of Faynan. The rich ceramic assemblage of the Ras al-Miyah fortresses and associated complex of sites is dated to the Iron Age IIC. These complexes of Iron Age sites are situated on top of the Burj formation relatively high above the main Iron Age copper production sites of Khirbat en-Nahas and Khirbat al-Jariya that date mostly to the eleventh to ninth centuries BCE (Ben-Yosef, Levy, et al. 2010; Hauptmann 2007; Levy, Najjar, van der Plicht, et al. 2005). The Late Iron Age date for the newly described fortress complexes indicates perhaps the latest phase of Iron Age copper production activities in the Faynan district, which was considerably smaller in scale and probably much less successful than the industry of the Iron Age IIA in Faynan (and Iron Age I). The evidence may suggest that the advanced technology of massive production displayed in Khirbat en-Nahas and in Khirbat al-Jariya may have been forgotten, and/or the social organization in the Iron Age IIC was not adequate for organizing such industrial activities on a scale comparable with the earlier years of the Iron Age. However, more probable is that the area became a tense conflict zone over its natural resources and that none of the local polities could establish there a viable and permanent infrastructure of organization of production, and a large-scale exploitation of the copper ores could not have been achieved. This is

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supported by the need to build fortresses in association with the mining complex, evidence that the building process of one was never finished, and also the more general phenomenon of Edomite "strongholds" known in southern Jordan in the same period (e.g., Ben-David 2001). These "strongholds" suggest refuge shelters and strong defense strategy, indicating tension probably with the neighbors from the west, the rivals over the copper resources of the northern Arabah. During the Late Iron Age, the overland trade in commodities from Arabia and other regions probably was of much greater importance to the economy of Edom than was copper production. The flourishing of Arabian trade, probably at the expense of the former practice of copper production, is integrated with and related to the developments observed in Faynan.

As the Ras al-Miyah fortresses are located on a high plateau in a rough mountainous region, these defensive sites might be considered part of a Late Iron Age "Edomite pattern" of "high places" and "mountainous strongholds" sometimes associated with the biblical passage of Jeremiah 49:16 and sites such as Sala (السلع), Umm al-Biyara (أم البيارة), and other highland locales (e.g., Hubner 2004; Lindner 1992; Lindner et al. 1996). However, besides the location and the surrounding rough terrain, the architectural similarities between the Ras al-Miyah fortresses and other Edomite strongholds and high places are meager, probably because of the peculiar function of the former, having to do with copper mining. The defensive phenomenon is similar and suggests a time of regional conflict (see above).

The fortresses are distinct from each other in size, material, and architectural plan. Ras al-Miyah West is relatively small and has an interesting parallel in the region of Moab (Rujm el-Abed). This parallel should be taken into consideration when estimating the differences and boundaries between the Iron Age polities of Cisjordan. The fortress of Ras al-Miyah East is a massive, well-planned structure with no clear archaeological parallels. The huge labor effort manifested in the construction of the structure together with the details of the architectural plan suggests a centralized and well-organized society in Edom during the Late Iron Age. The fact that actual metal smelting activity was meager or nonexistent just when tremendous expenditures were invested in the construction of these fortresses is intriguing. The construction process at the Ras al-Miyah East fortress was never finished. It ceased abruptly, perhaps for the reasons discussed above.

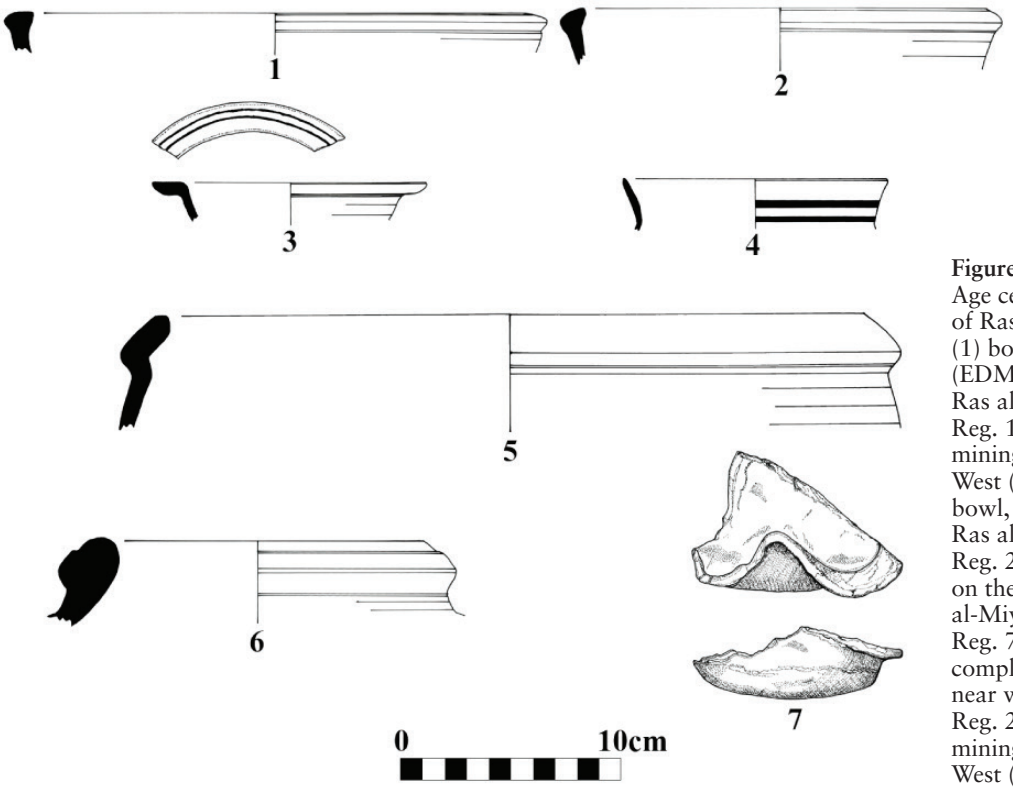

Figure 12.48 Representative Iron Age ceramics from the fortresses of Ras al-Miyah and their vicinity: (1) bowl, Ras al-Miyah East (EDM 8137, Reg. 56); (2) bowl, Ras al-Miyah West (EDM 5663, Reg. 160); (3) bowl, copper mining complex of Ras al-Miyah West (EDM 6549, Reg. 51); (4) bowl, copper mining complex of Ras al-Miyah West (EDM 6549, Reg. 268); (5) krater, the tower on the sandstone cliff near Ras al-Miyah East (EDM 11259, Reg. 73); (6) jar, copper mining complex of Ras al-Miyah East, near western shafts (EDM 11152, Reg. 211); and (7) lamp, copper mining complex of Ras al-Miyah West (EDM 6549, Reg. 52).

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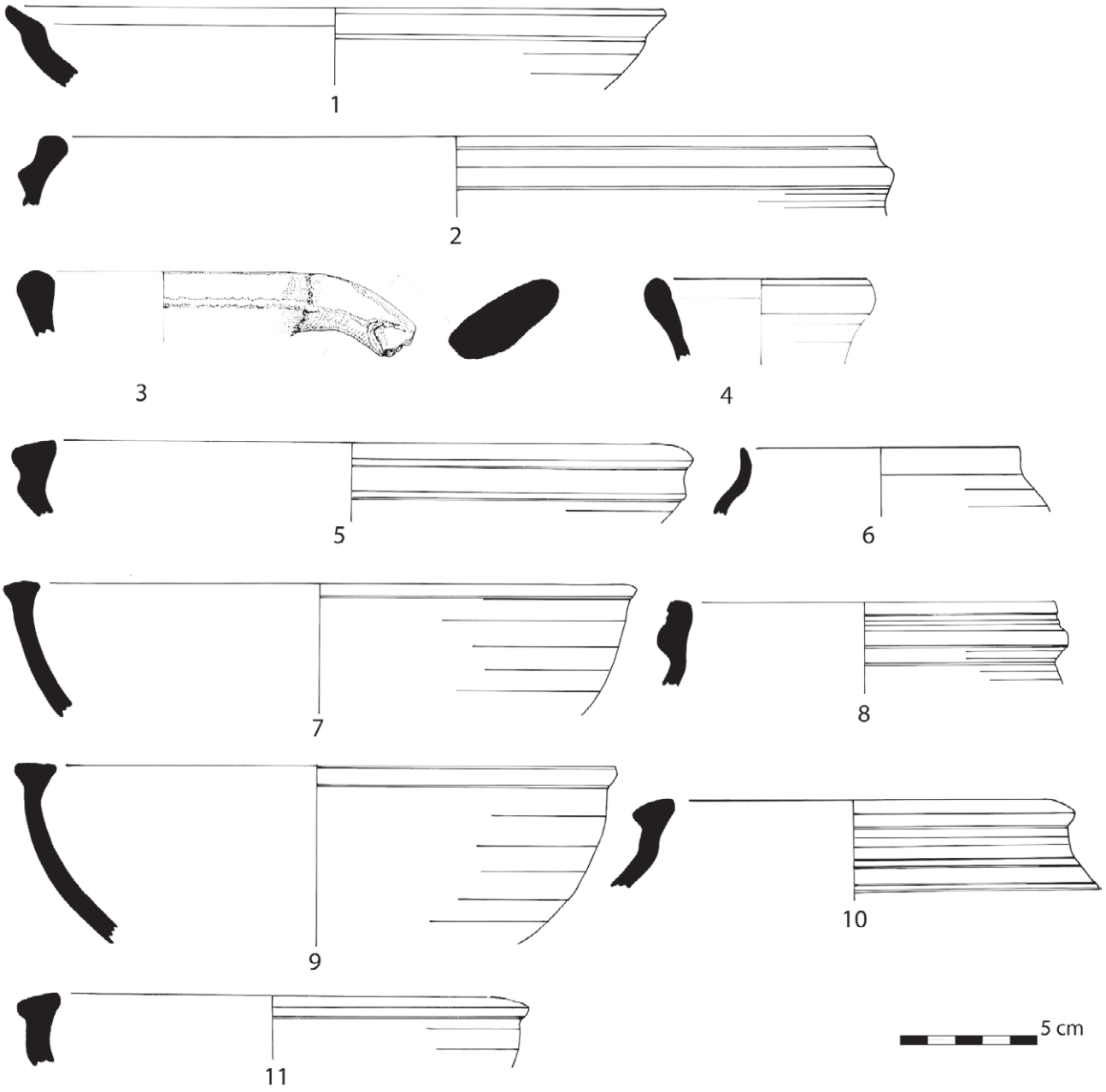

Figure 12.49a Iron Age IIB–C ceramic from the Ras al-Miyah Archaeological Complex collected by FBRS (cf. Figure 12.28 and Table 12.6 for the location and description of sites): (1) FBRS Site 2, Rg. 161; (2) FBRS Site 2, Rg. 131; (3) FBRS Site 3, Rg. 59; (4) FBRS Site 4, Rg. 4; (5) FBRS Site 22, Rg. 185; (6) FBRS Site 22, Rg. 176; (7) FBRS Site 22, Rg. 193; (8) FBRS Site 22, Rg. 167; (9) FBRS Site 26, Rg. 251; (10) FBRS Site 26, Rg. 54; and (11) FBRS Site 40, Rg. 224.

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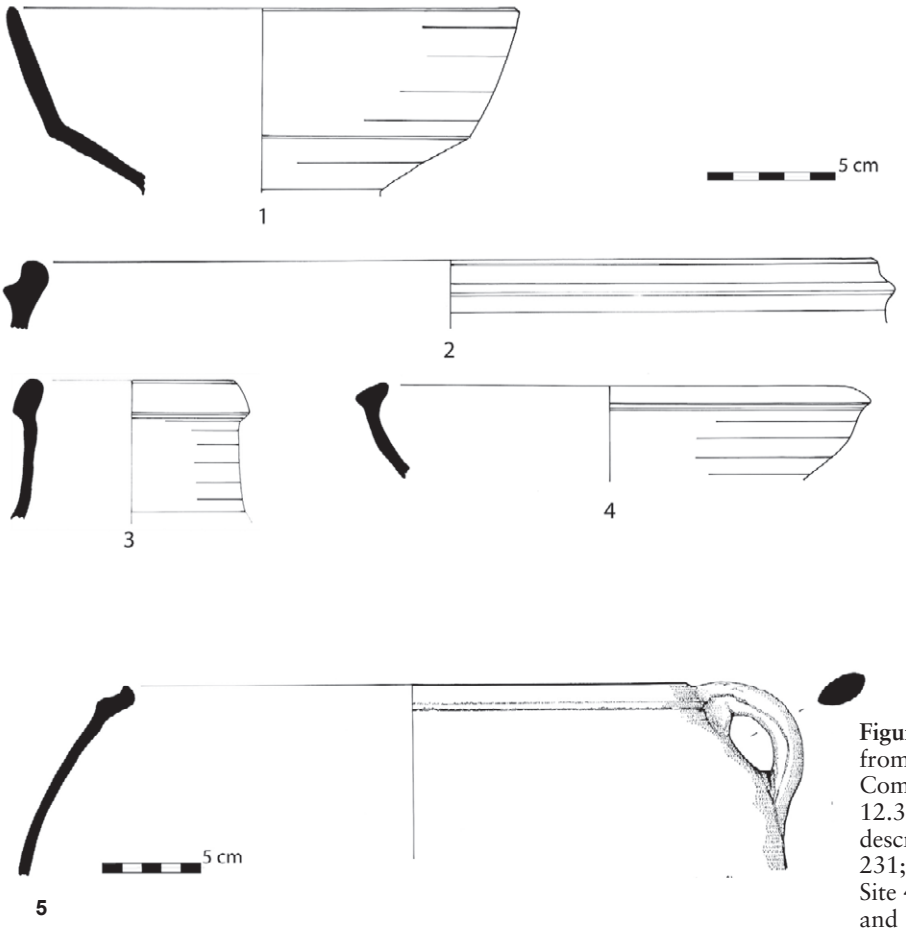

Figure 12.49b Iron Age IIB–C ceramic from the Ras al-Miyah Archaeological Complex collected by FBRS (cf. Figure 12.30 and Table 12.6 for the location and description of sites): (1) FBRS Site 45, Rg. 231; (2) FBRS Site 37, Rg. 281; (3) FBRS Site 48, Rg. 80; (4) FBRS Site 48, Rg. 78; and (5) FBRS Site 26, Rg. 233.

Khirbat al-Ghuwayba (خربة الغويبة)

The site of Khirbat al-Ghuwayba (Figures 12.1, 12.30, and 12.50) was first visited by Nelson Glueck (1935:22–23, 164 Plate 2) and surveyed as part of Southern Ghor and Northern Arabah Survey (SGNAS) (MacDonald 1992:76, Site 161), DBM Project (Hauptmann 2007:132-133), and ELRAP's FBRS project (Chapter 6, this volume, Site 1). Glueck (1935:22–23) dated the smelting remains at the site mostly to the Early Iron Age:

> On the surface of the site we found numerous sherds of rather coarse type belonging to EI I [Early Iron Age I] and to the first part of EI II. A few Nabataean sherds were also found. The considerable quantities of copper slag testify to intensive mining and smelting activities during the Early Iron Age. We did not actually find the copper bearing rock by *Kh. El-Gheweibeh*, but we did find large quantities of such rock a few kilometers away.

It is interesting to compare Glueck's observation with the comments of Weisgerber (2006:15): "Nearby at Khirbet el Ghuwayba was another, seemingly unsuccessful, smelting site. Perhaps the yield in copper ore there did not meet expectations." Indeed, the extensive scatter of slag on the surface is rather thin and less substantial than either KEN or KAJ. The large slabs of tap slag, abundant on the surface of KEN, are completely absent and there are no substantial "mounds" like in most of the other Iron Age smelting sites in Faynan.

As part of the ELRAP 2009 field season, we have conducted small soundings in Khirbat al-Ghuwayba to contextualize and date the copper production remains that dominate the site. The excavations took about three weeks and were conducted during November 2009. The fieldwork included a small team of UCSD students, local Bedouin workers, and a volunteer.[17] We applied the same excavation methodology and

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recording procedures as of the main project (ELRAP; see above), using a total station and a GIS-based database, with Microsoft Access forms for locus summary and ArcView for producing top plans and artifact spatial distribution maps (all materials are available in ELRAP's digital database).

The site extends over 7 ha (70 dunams) on both sides of Wadi al-Ghuwayba, just near the spring of 'Ain al-Ghuwayba that holds water year round and supports lush vegetation of tamarisks and other hydrophilic plants, as well as some orchards of the local Man'aja tribe. Although the site is quite extensive in area, the archaeological accumulation is rather shallow and in most places is composed of only a thin scatter of broken slag (especially on the southern bank). Some substantial structures are visible on the surface, and a few are concentrated on the northern bank just near a seasonal active Bedouin encampment (during this season of excavation, the encampment was vacant, although remains of the habitation and pens were visible).

We chose an area of relatively thick slag accumulation and some surrounding structures in the northern bank of Wadi al-Ghuwayba ("Area E"; Figure 12.51). The main goals were to date the copper production activities in the site, to characterize the technology (to the degree possible in a small probe), and to check the function of a nearby structure that may have been related to the copper production activities. Clarifying the chronology of the site was of a particular interest to our general investigation of the oscillation in copper production activities throughout the Iron Age. As the nearby mining sites of Ras al-Miyah were dated by abundant ceramics to the Late Iron Age (Iron Age IIB–C), we speculated that Khirbat al-Ghuwayba was the smelting counterpart of the mines and also dated to the Late Iron Age (Ben-Yosef, Levy, et al. 2009b). In the near vicinity of the mines, and probably in the Faynan region in general, there are no good other "candidates" for smelting sites associated with these mines.

Mapping Khirbat al-Ghuwayba

With the aid of ELRAP surveyor Fawaz Ishakat of the Hashemite University, we produced a topographic map of the site with the main architectural features (Figure 12.51). This general map helps to contextualize the excavated probe (Area E) and demonstrates the extent of the site. The map has topographic contours of less than half a meter resolution, emphasizing the topography and the location of the main structures (mostly on the north bank of the wadi). As clearly indicated by the map (cf. Figure 12.30 for general location and exact boundaries of the site mapped by FBRS), most of the slag scatter is not associated with



Figure 12.50 Khirbat al-Ghuwayba: an overview of the excavation area (Area E) during the 2009 excavation season.

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substantial structures, and the southern bank is almost completely vacant of architectural features (except small installations, not mapped). The spring of ʻAin al-Ghuwayba is located between the two banks of the wadi, a small cemetery is located to the northwest of Area E (not shown on the map), and the fortress of Ras al-Miyah West is visible from the site, located almost directly to the north of it (Figure 12.30).

KAG Area E: The Structure

The excavation of the small square structure in Area E concluded in the exposure of a room dated to the Roman-Nabataean period, based on the glass and pottery assemblages and small finds. The room contained several hearths, and abundant carbon samples were collected from the floor levels. The structure was initially filled with collapse and windblown loess to the top of the walls, a depth of less than 1 m (Figures 12.52–12.54). The truncation of the walls may suggest that the stones had been removed to use in later structures. Beneath the fill we found several hearths and ash pockets with large accumulations of charcoal, in addition to a large quantity of glass fragments, pottery sherds, and one playing die (Table 12.6).

The building technique is different from the Iron Age structures at Khirbat en-Nahas and Khirbat al-Jariya, reflecting the chronological difference. The construction of the structure at Khirbat al-Ghuwayba is finer and more regular, consisting of courses of large stones of uniform thickness with courses of small stones between the larger courses. In addition, we observed two walls to the north of the building abutting the walls of the structure and curving outward and to the north, creating a rectangular courtyard with rounded corners (Figure 12.51). Since these walls abut but do not interdigitate with the walls of the structure, we can conclude that they are from a separate (possibly later) building phase; the fact that they are also higher than the foundation of the structure walls suggests that the courtyard is indeed from a later period (Late Islamic?) (Figures 12.55–12.56). The courtyard walls probably abut another structure located to the north (Figure 12.51); this building is probably also from the Nabataean period, as well as the elongated structure to the west. There is a doorway in the northern wall of the structure, facing the courtyard (and from which we did not remove the blockage). We also uncovered a third curved wall to the south; its upper courses may have been accidentally removed during the excavations while removing the fill and collapse. This wall abuts the southern wall of the structure (although it ends abruptly to the south of the structure), and it may have been part of a wall that delineated a southern courtyard.

Inside the structure, we found several hearths and ash pockets (Figure 12.57). They were mostly located around the edges of the room, but some very thick deposits of ash, stones, and large charcoal were located near the center of the room. A single carved stone die was found in the northwestern corner of the room. Some of the well-defined hearths were recorded as separate intrusive loci (see Tables 12.6 and 12.7). The floor of the building was not more than compact dirt, but the finds, and mostly the hearths, made this level very distinct and well defined.

Both inside and outside the walls, we found several grinding slabs and hammer stones in the fill. Below the fill (both outside and inside), we found many fragments of pottery and translucent glass fragments of fine vessels dated to the Roman-Nabataean period (found in several different locations).

In the southeast corner inside the building, we penetrated below the floor level to check the relation of the wall foundation and the floor and to make sure there is only one floor level (L35). Just below the floor level, some copper production remains were exposed, and it was clear that the floor is in one main level, with some minor accumulations in areas where hearths were in intense use (Figure 12.58). The general characteristic of the floor indicates quiet abandonment of the building and not rushed or traumatic desertion.

In the southwestern corner outside of the building, we dug a small probe to virgin soil (Figure 12.59). There is distinct metallurgical layer just beneath the wall foundation and the collapse, but in contrast to the situation in the excavated square to the south, the accumulation here was very thin and mostly made of crushed slag ash and charcoals.

KAG Area E: The Probe in the Metallurgical Deposits

To the south of the structure, we chose an area that appeared to be a dense metallurgical layer for sounding (Figure 12.60, Table 12.8). In the center of the square was a stone feature that resembled an Iron Age grave documented in other locations in Faynan (Figure 12.61). The surface of this probe was a layer of slag mixed with a few sherds of (probably late) pottery, "floating" on a layer of windblown aeolian dust. The surface slag was black, matte, and relatively small, containing

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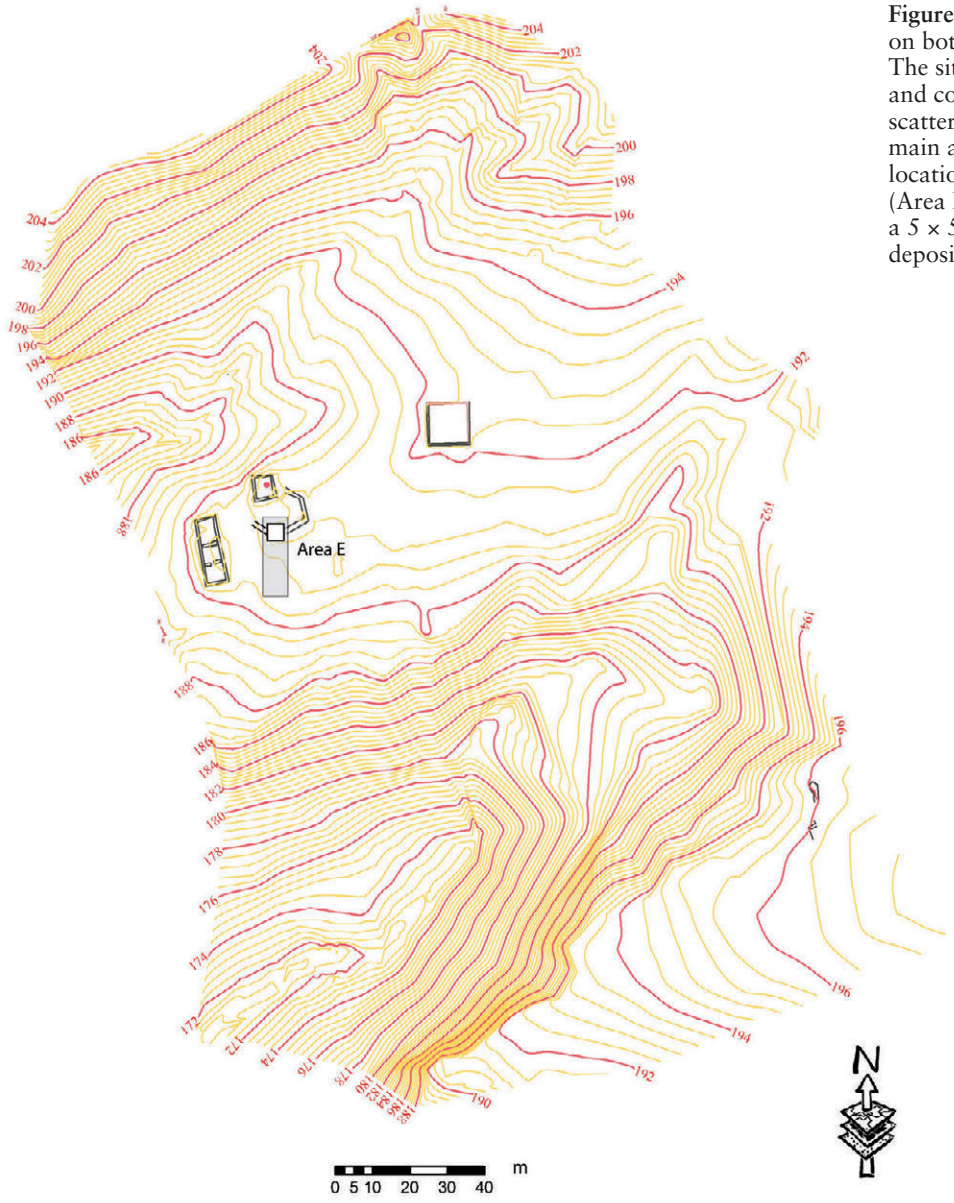

Figure 12.51 Khirbat al-Ghuwayba on both sides of Wadi al-Ghuwayba. The site extends over a 7-ha area and consists mostly of a shallow scatter of slag fragments. Note the main architectural features and the location of the excavation probe (Area E): a small structure and half a 5 × 5–m square in metallurgical deposits were excavated.

no charcoal or copper prills. Beneath the slag on the surface was a thick layer of accumulated ashy dust relatively sparse in finds. We found no charcoal in this layer but did find a few tuyère fragments, pottery, and ground stones. We also found one copper object that may have been an earring. No bone fragments were recovered from beneath or near the "grave," and there was no cist beneath the surface feature; most likely, it was either not a grave, or if it was, the remains have decomposed completely enough to leave no trace.

Below the fill, metallurgical remains became more predominant and the ashy dust less so. Additionally, there were patches here of compact clay containing crushed slag. In this layer, we also uncovered two round (possibly circular, although we uncovered only the portions contained within the square) stone features: one in the northeastern and one in the southwestern corner (Figures 12.62, 12.63). The northeastern ring was filled with crushed slag and metallurgical debris (tuyère fragments, some small charcoal, and a copper prill), but we could not excavate deeper than a few centimeters into this feature as only a tiny portion of the interior was exposed. The stone ring appeared to be only one course at first, but as we excavated deeper into

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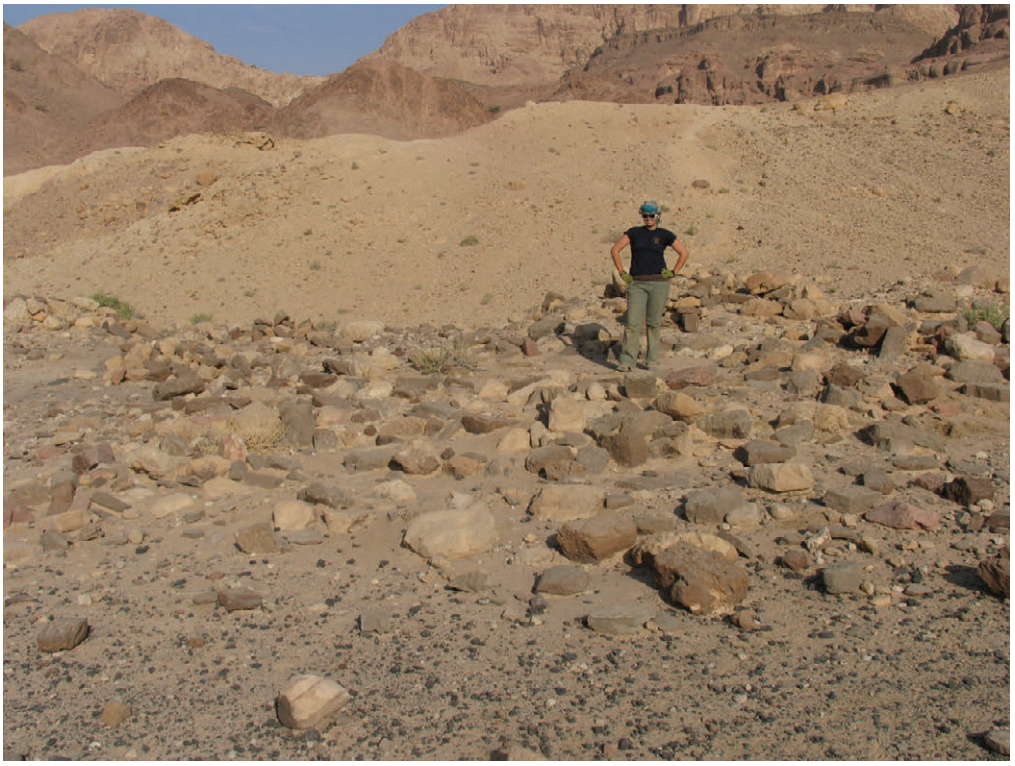

Figure 12.52 The Nabataean structure at KAG Area E before excavation.



Figure 12.53 The Nabataean structure at KAG Area E during excavation (L3—fill).

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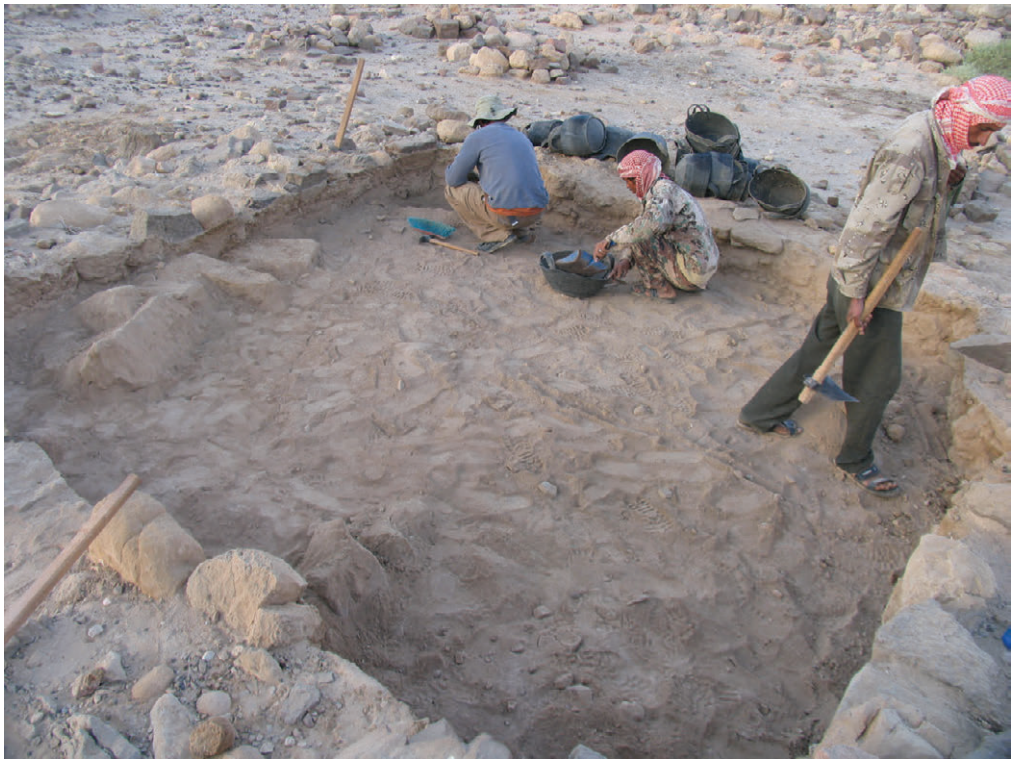

Figure 12.54 The Nabataean structure at KAG Area E during excavation, just below the fill (L5).

Table 12.7 KAG Area E: Harris matrix for loci associated with the structure.

Main Building				Building Walls	Probe Below Foundations	Courtyard(s) Walls
7	3	15	16		24	25, 26, 27
				18, 19, 20, 21, 22	28	
13	5				29	
	6	14				
	32 FL	33 FL	36, 37			
		35				

the square, it appeared to have several possible layers of stones below it; they were not arranged in clear courses and extended beyond the original ring, so they may have been a sort of support or possibly collapse. We did not excavate the southwestern ring, except to uncover the surface feature, although it appeared to contain crushed slag similar to the northeastern feature. It had one clear course of stones and may have more, but the outside remained almost entirely covered by a balk that was our entrance and exit to the probe once it was too deep to climb in and out. Finally, in this level, there was a small installation of stones to the north of the southwestern ring, which may have been contemporary or related to the same construction phase.

The deposits became richer in metallurgical related materials below the layer of mixed fill and slag; the slag became more prevalent, and tuyère fragments, pottery, hammer stones, and charcoal became abundant, as well as ashy pockets of sediments. Just below this layer, the metallurgical remains abruptly became very sparse, and the fill became characterized by orange and yellow wadi sands that represent the nature of the natural sediments in this location. However, although the metallurgical remains were very sparse here and may represent only very early phases of activity, this was not a level of virgin soil, as there were still some clear ash pockets and a large amount of charcoal. Below this level, the ash and charcoal decreased almost completely but did not disappear, and as there was a grinding slab in this level, it could not be called preoccupation. The lowest layer of the probe contains virgin wadi sands; it does contain a few ashy pockets, but they are likely the

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Figure 12.55 The courtyard wall abuts the eastern wall of the structure; its foundation is much higher, probably indicating that it was built in a later period (maybe with secondary use of the stones of the Nabataean structure).

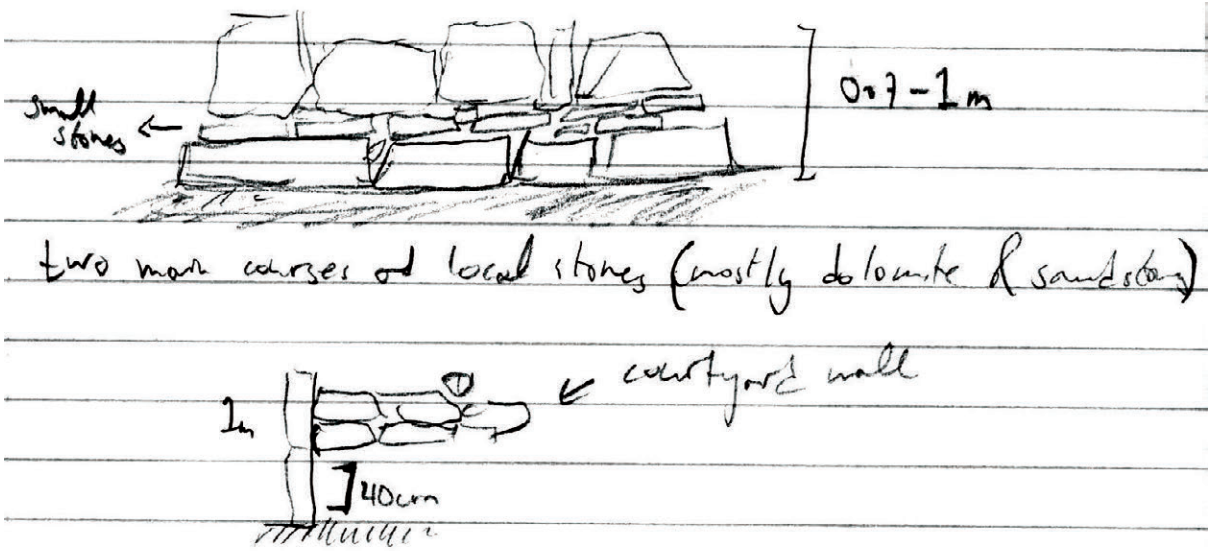

Figure 12.56 A sketch of the eastern wall of the building (top) and the relations between the courtyard wall and the eastern wall of the building (bottom) at KAG Area E.

result of animal burrows that can clearly be seen in the section drawing (Figure 12.64).

ELRAP's Excavations at KAG Area E: Chronology and Summary

The probe at Khirbat al-Ghuwayba Area E consisted of two main contexts: a small structure and a shallow slag mound. The excavated loci are summarized in Table 12.9, with indication of the areas as "metallurgical" or "structure." We exposed a small Roman-Nabataean structure, probably related to peasant activity near the oasis of 'Ain al-Ghuwayba or to some sort of military outpost in this region (maybe indicated by the arrowhead and the die found in the floor level of the structure). The adjacent structure (the courtyard compound) may be of the same period or

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Figure 12.57 Example of one of several hearths found on the floor level of the Nabataean structure at KAG Area E (L37).

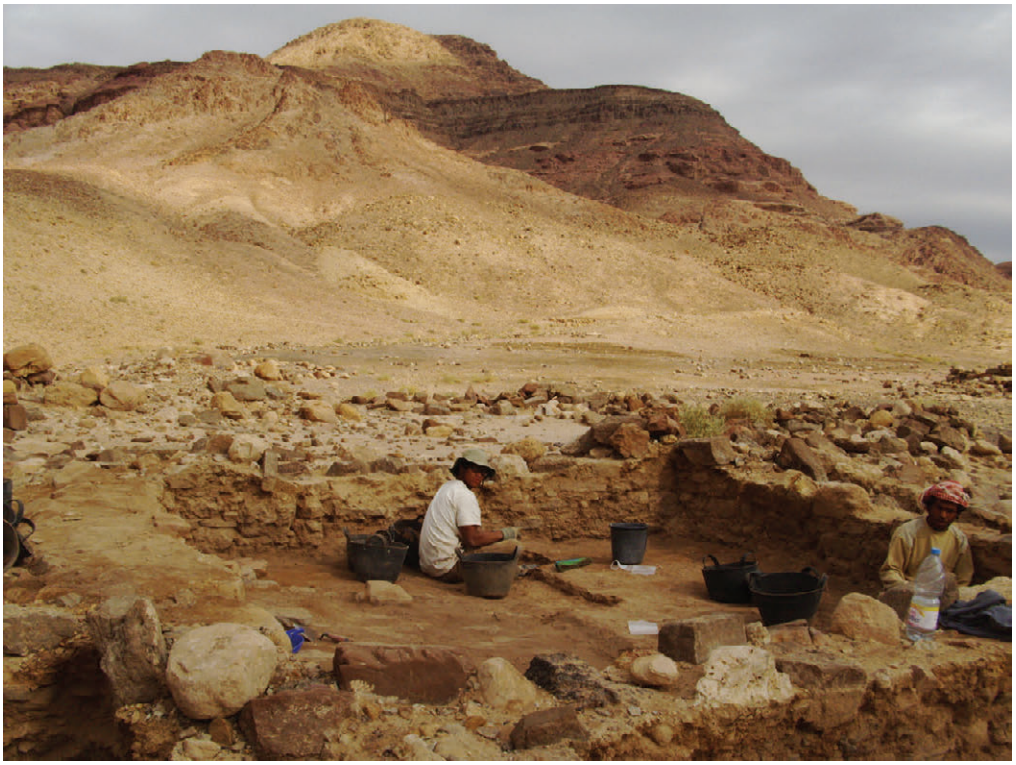

Figure 12.58 KAG Area E, excavating the floor level of the Nabataean structure.

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possibly later. It is not clear if there are any Iron Age structures at the site at all. Below the structure and stratigraphically older, there are remains of metallurgical activities of copper production, very thin under the structure itself, and more substantial to the south of it, where we opened half a square and excavated to virgin soil. The ceramic associated with the metallurgical context indicates Early Iron Age occupation, and the assemblage has some similarities to the pottery from KAJ (Figure 12.65). This also corroborates MacDonald's observations (MacDonald 1992; there the site is dated to Iron Age I). Radiocarbon samples processed at the Oxford Radiocarbon Accelerator Unit (Research Laboratory for Archaeology) indicate indeed an Early Iron Age date. Two charcoal samples were measured, one from L30 (OxA-23159, 2919 ± 29 BP, 1253–1016 Cal BCE, 95.4 percent probability; 1192–1051, 68.2 percent probability; OxCal2010, IntCal09, ©C. B. Ramsey) and the other from L23 (OxA-23159, 3288 ± 28 BP, 1632–1497 Cal BCE, 95.4 percent probability; 1608–1526, 68.2 percent probability; OxCal2010, IntCal09, ©C. B. Ramsey); three other samples from the excavations were identified as *Juniper* species, and thus it is probable that these numbers are affected substantially by the "old wood effect."

Table 12.8 KAG Area E: Harris matrix for loci associated with the probe in the metallurgical deposits.*

	1 (slag scatter)			2 (stone feature)	
9	12	4		11	10
		8	17		
		23			
		30			
		31			
		34			

*Blue indicates locus with radiocarbon measurements

The Early Iron Age date is also supported by similarities between the technological finds between KAG and Khirbat al-Jariya. In general, the copper production

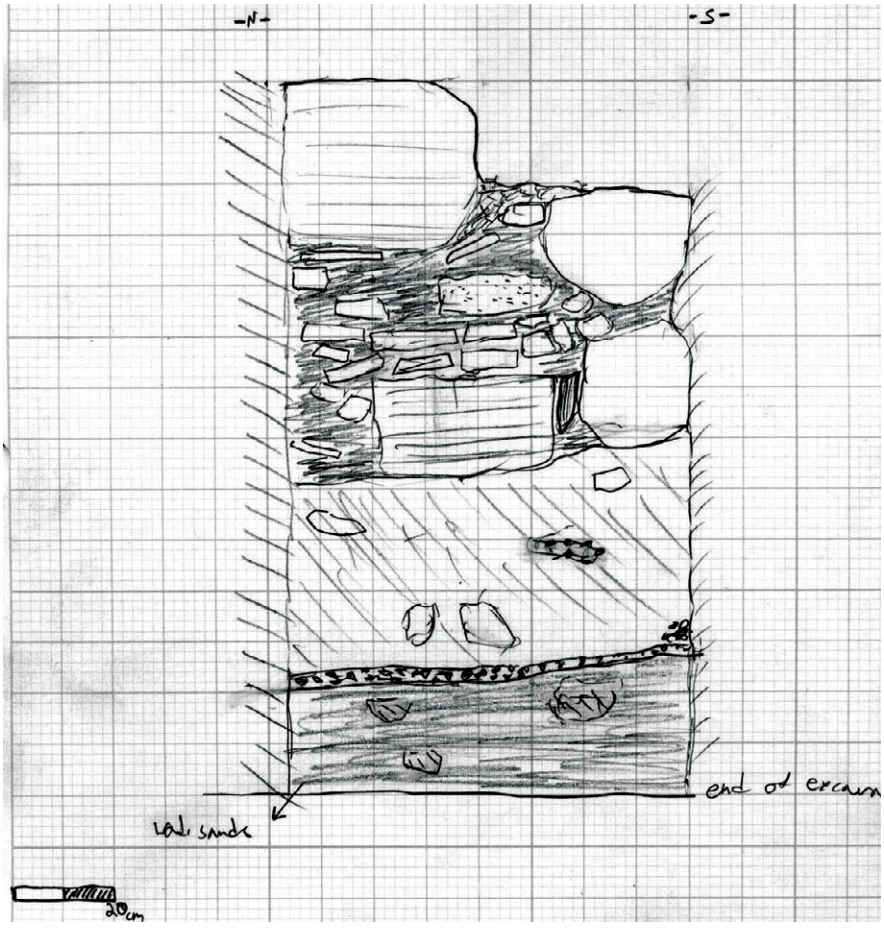

Figure 12.59 Drawing of the section of the southwestern outside corner of the Nabataean structure at KAG Area E. The Iron Age metallurgical layer is represented here mostly by a thin layer of fine-crushed slag (dotted horizon, second from the bottom). Scale bar is 20 cm.

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Figure 12.60 The slag mound at KAG Area E before excavation. Note the stone feature near the scale stick thought to be a grave (L2).

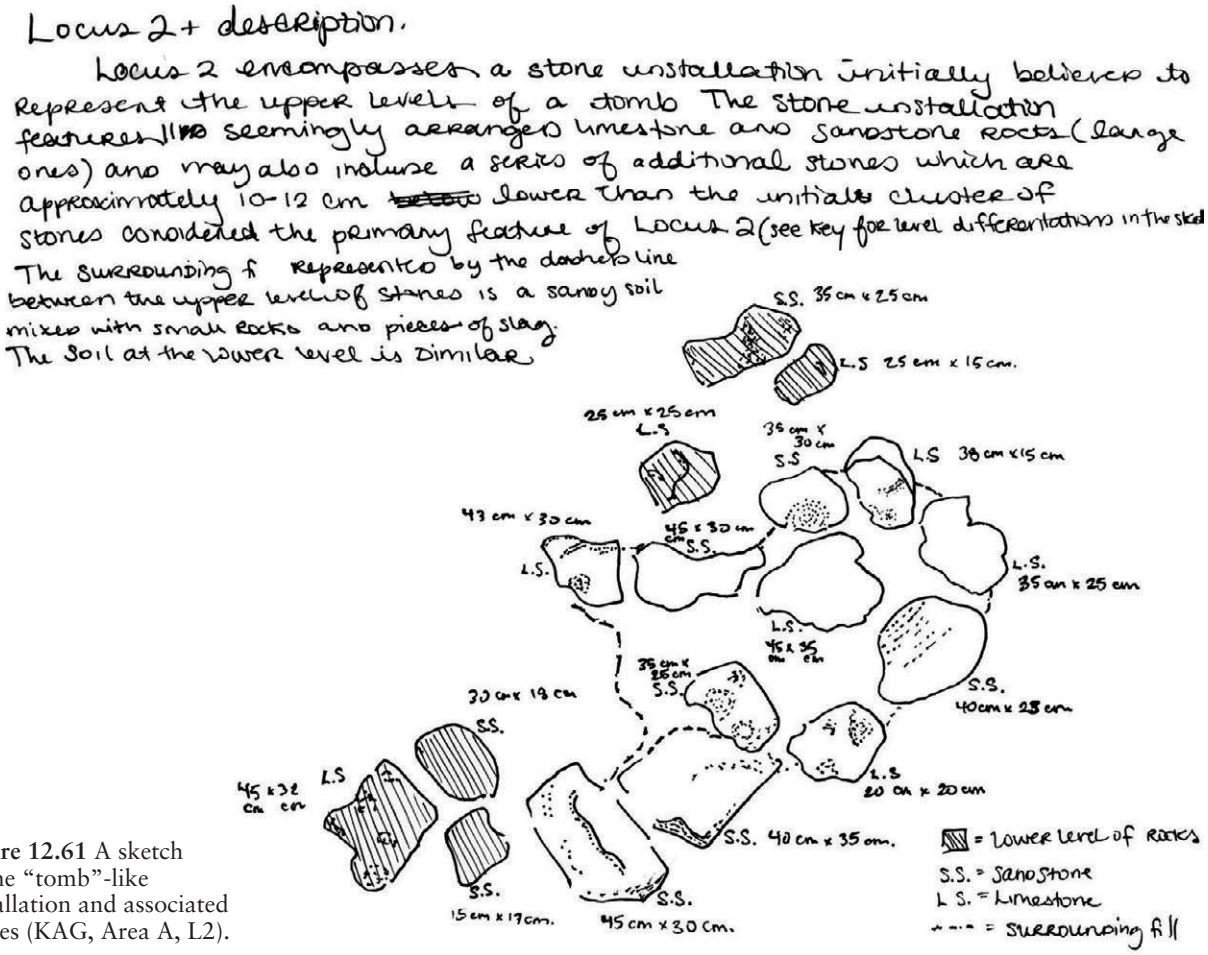

Figure 12.61 A sketch of the "tomb"-like installation and associated stones (KAG, Area A, L2).

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activities in KAG were lower in intensity than the peak presented at KEN in the tenth and ninth centuries BCE. Utilization of the most advanced technology recorded in KEN and represented mostly by large tap slag is not evident in KAG. Given the new dating of the smelting activities at KAG, the complementary production site of the Ras al-Miyah copper mines is still unknown or does not exist—these mines have ample ceramic sherds of the Late Iron Age (eighth to sixth centuries BCE; see above), and no substantial production site is clearly associated with them.

Khirbat Hamra Ifdan (خربة حمرة إفدان)

Khirbat Hamra Ifdan (KHI, WF 120) is located on the south bank of Wadi Fidan near the small oasis of ʻAin Fidan. It was investigated by various scholars, including extensive excavations of the Early Bronze Age settlement specialized in metal production by the Jabal Hamrat Fidan (JHF) project in 1999–2000 (Levy et al. 2002). In 2007, we conducted another season of excavations at the site, focusing, in addition to the EB remains, on the large slag mound on the southern side of the site (part of ELRAP field season, supervised by A. Muniz). The excavations of the slag mound were part of Area E, and the basic results, with emphasis on the Iron Age remains, are presented here. They are partially based on the field report of A. Muniz.

The goals of the 2007 excavations at Area E were twofold: elucidating the chronology of the slag mound and collecting slag samples for paleomagnetic studies. The typology of the slag visible on the surface of the site was the main reason for ascribing them to the Iron Age by previous researchers (e.g., Hauptmann 2007:134, there "Iron Age II"), although such a link is tentative at best (e.g., Ben-Yosef, Tauxe, et al. 2010). An Iron Age date for some of the archaeological remains in this area of KHI is also supported by a radiocarbon date from the 2000 excavations at Area L, located to the northeast of Area E in and near late (Roman?) square massive foundations of a structure visible on the surface. This date, published only recently (Levy et al. 2012), came from a mixed context of Early Bronze Age IV pottery, bones, and loose sediments, interpreted as a refuse disposal area (2910 ± 41 BP; 1192–1021 BCE, 68.2 percent and 1261–995, 95.1 percent probability; OxCal v.4.1, ©C. B. Ramsey 2010; Stratum IIIA, L3034, B45344, RC23, Table 12.2). The archaeomagnetic investigation of slag samples from Area E clarified the chronology of the slag mound and confirmed the Iron Age date of the uppermost layer at this location (below).



Figure 12.62 KAG Area E: metallurgical installations in the probe on the slag mound, looking south.

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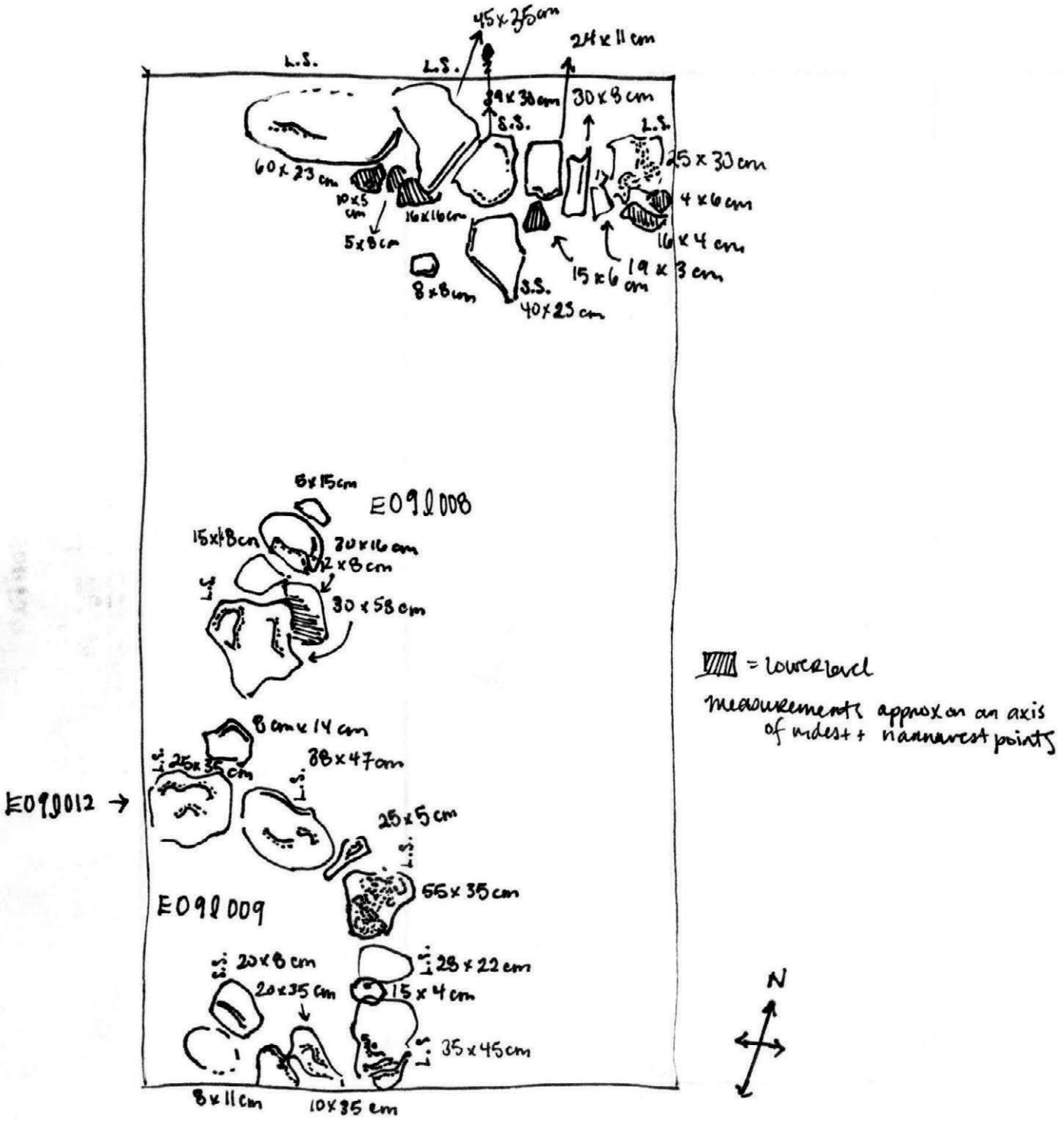

Figure 12.63 A sketch of the two installations exposed in the metallurgical deposits (cf. Figure 12.60).

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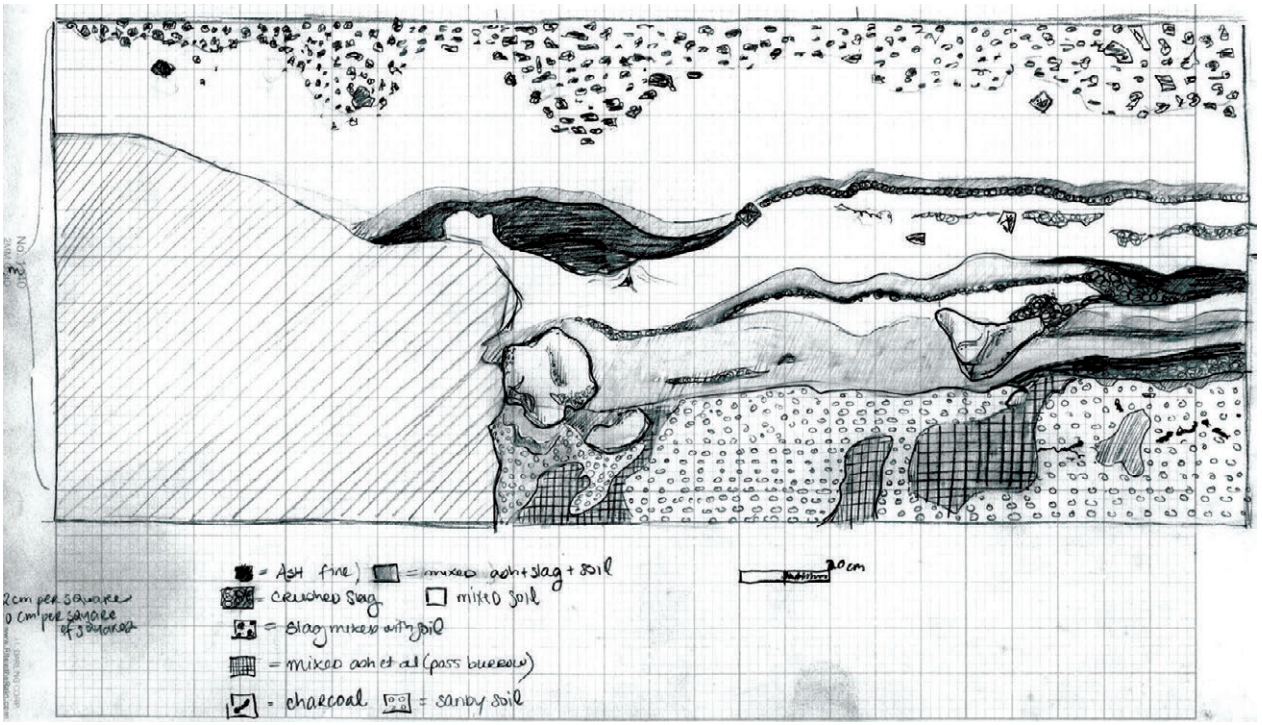

Figure 12.64 Drawing of the eastern wall of the excavation pit in the slag mound at KAG Area E.

Description of the 2007 Excavations of the Slag Mound at KHI Area E

During the five-week excavation season, the members of the excavations at Area E removed 2,036.88 kg of slag (most of which from the Iron Age occupation context) and approximately 48.99 m^3 of windblown sands and miscellaneous fills. The excavations followed the methodology applied by ELRAP (see above). The results (Table 12.10) indicate two phases of copper production were conducted at this section of the site. Furthermore, the probe revealed an Early Bronze Age occupation phase buried beneath the slag mound (only briefly discussed here).

Excavations for the 2007 season at Khirbat Hamra Ifdan centered on the southwestern center of the site. The area chosen for sampling represents the highest point on the slag mound. On the surface (Figure 12.66) throughout this area, varying sizes of tap and crushed slags are found. Removal of the surface material (L3002, L3050, L3074) revealed layers of windblown sediments mixed with ash resulting from embedded carbon in the slags and cultural materials from different time periods, including Roman and Islamic.

Immediately beneath the fills of filtered sand and ash, the layer representing the main smelting phase is found. These layers are recorded as L3005, L3004, L3053, and L3076. The layers consist of large-size tap slag and contain a large concentration of carbonized wood. Water and sand had filtered through the layers of slag, creating a conglomerate of slag, sand, ash, and other minerals throughout the layers (L3010, L3079, L3077, and L3078).

Directly below the conglomerate, a lens of light color fill (L3013, L3018, L3090) and ash was found. The fill layer is depicted in Figure 12.67 toward the bottom of the slag layer. The light color fill is composed of light-colored sands containing large traces of ash leached from the layers above. The accumulation of fill directly beneath the tap slag layer suggests two different production phases. Directly beneath this fill is a layer of crushed slag (L3017, L3019, L3056, L3100). The layer contains small pieces of slag but not the conglomerate found in the tap slag layer above, making it distinctly different.

With the exception of a few small walls found associated with the slag mound, most of the architectural remains at Area E belong to the Early Bronze Age III (three rooms and two courtyards). The profile seen in Figure 12.67 provides a detailed view of the stratigraphic layers at this part of the site, together with the section drawings in Figures 12.68 and 12.69. Appendix 12 presents the Harris matrix of Area E with preliminary pottery identifications.

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Table 12.9 Locus list of KAG 2009 Probe in Area E.

Locus	Square	Definition
1	metallurgical	Metallurgical layer / surface fragments
2	metallurgical	Stone feature
3	structure	Fill and wall collapse, surface finds from square structure
4	metallurgical	Ashy fill (accumulation of dust in a metallurgical context)
5	structure	Floor level (and slightly above), secondary?
6	structure	Hearth
7	structure	Wall collapse / fill
8	metallurgical	Metallurgical layer / fill
9	metallurgical	Fill
10	metallurgical	Slag layer
11	metallurgical	Stone feature / installation / wall
12	metallurgical	Wall / installation
13	structure	Ash layer
14	structure	Ash pocket
15	structure	Fill / wall collapse
16	structure	Fill / wall collapse
17	metallurgical	Stone feature (intrusive to locus 8)
18	structure	Wall (eastern wall of structure)
19	structure	Wall (southern wall of structure)
20	structure	Wall (western wall of main structure)
21	structure	Wall (northwestern wall, by the doorway of main structure)
22	structure	Wall (northeastern wall of structure)
23	metallurgical	Metallurgical layer
24	structure	Fill (some metallurgical layer)
25	structure	Wall
26	structure	Wall (part of courtyard wall, northwestern side of structure)
27	structure	Wall (southern courtyard wall?)
28	structure	Metallurgical layer
29	structure	Metallurgical layer (scant remains of the above locus) / fill / virgin soil
30	metallurgical	Fill
31	metallurgical	Fill / virgin soil
32	structure	Floor
33	structure	Floor
34	metallurgical	Virgin soil
35	structure	Fill (bottom of floor)
36	structure	Hearth
37	structure	Stone feature / hearth?

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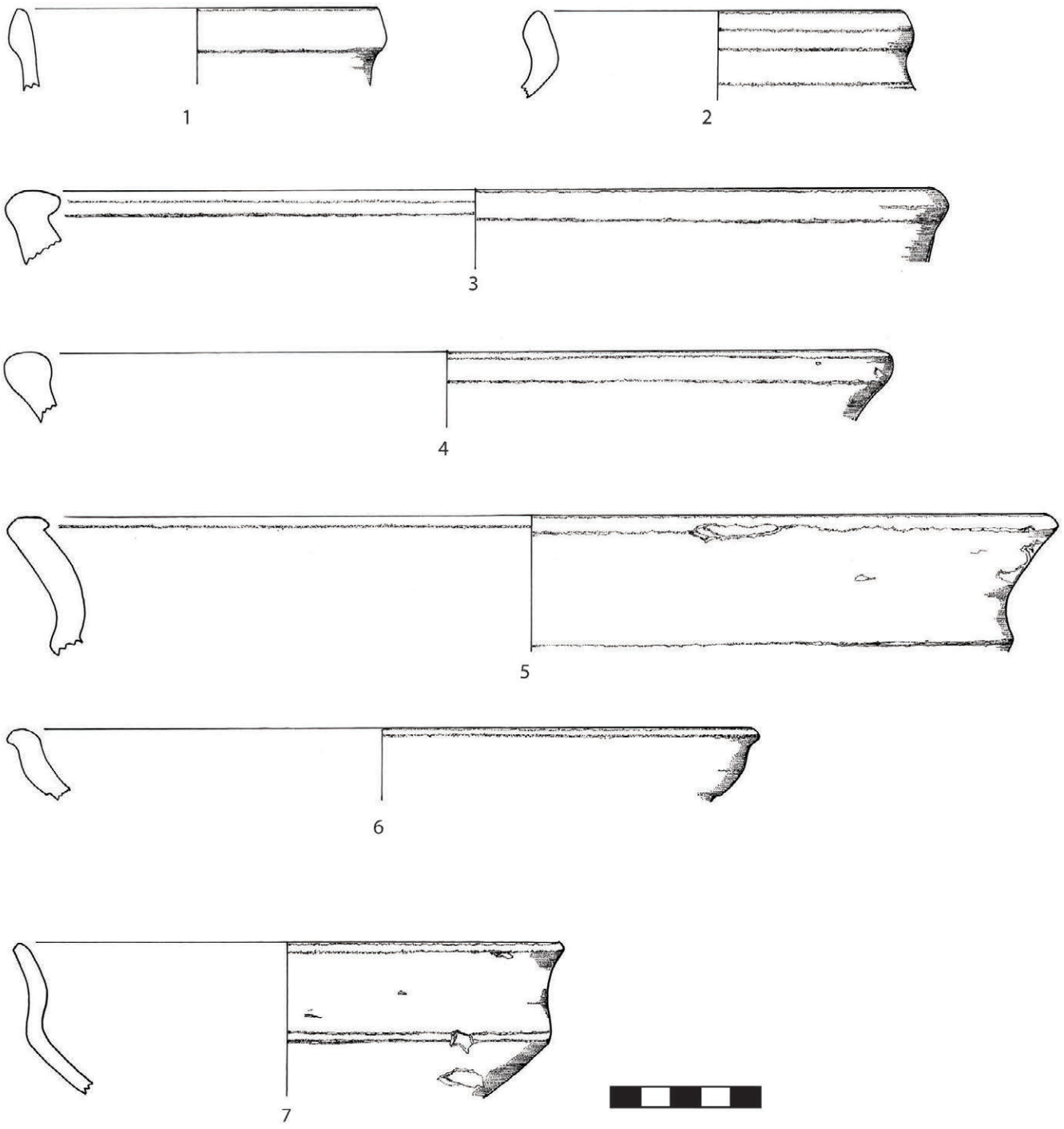

Figure 12.65 Some representative ceramic types from the metallurgical context of KAG Area E. The ceramic indicates Early Iron Age copper production activities at the site and shows similarity to the assemblage of KAJ. (1) EDM 0100, L008, B0087, R457; (2) EDM 0100, L008, B0087, R461; (3) EDM 0100, L008, B0087, R458; (4) EDM 0662, L008, B0051, R537; (5) EDM 0148, B0130, R474; (6) EDM 0181, L030, B0156, R470; and (7) EDM 0100, L008, B0087, R463.

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Dating the Slag Mound at KHI Area E

The context of smelting remains visible on the southern surface of KHI is not clear. Ceramic identifications from the 2007 excavations at Area E are mixed (Late Islamic, Roman-Nabataean), with no clear finds of Iron Age pottery. This situation makes it useful to apply a direct dating technique targeted at the slag fragments themselves (e.g., Ben-Yosef, Tauxe, et al. 2010).

Samples from both the Early Bronze Age and later metallurgical deposits were measured by us in the paleomagnetic laboratory at Scripps Institution of Oceanography (SIO).[18] We applied the IZZI protocol and the selection methodology of Ben-Yosef, Tauxe, et al. (2009). The results are summarized in Table 12.11 and Figures 12.70 and 12.71. For further background on the method, see Tauxe (2010).

The archaeointensity results strongly support an Iron Age date of the slag from the slag mound of KHI Area E (Stratum EI). There is an excellent agreement between stratigraphic location and geomagnetic intensity values (except from L3083, which probably represents a mixed context). The upper samples, associated with the main slag mound visible on the surface of the site, yielded high values while the lower samples (Stratum EIII) yielded lower values. Such high values are so far unique to the Late Bronze Age/Iron Age period in the southern Levant. Sample b62610a from L3077 yielded extremely high values that probably correlate with one of the geomagnetic spikes identified by Ben-Yosef, Tauxe, et al. (2009), during the tenth to ninth centuries BCE (based on slag deposits from KEN Area M, cf. Chapter 2, Area M, this volume). The discovery of this short-lived phenomenon is now supported by results from three *different* sites (KEN, Timna 30, and KHI), making this observation substantial and important for various geomagnetic models based on intensity. These extreme high values also indicate that the Iron Age activities at the site were prolonged and not an ephemeral incident of smelting. The prolonged Iron Age activities are indicated also by the presence of two different types of slag from this period (observed in the 2007 excavations), which may correlate with the technological change recognized in this research (Ben-Yosef 2010:Chapter 9; regarding slag material, cf. Figures 12.66 and 12.67). Further discussion on the Early Bronze Age metal production and correlation between KHI and other smelting sites in the northern Arabah, including the enigmatic Ashalim site, will be published in Ben-Yosef et al. (in press).

Conclusions—Iron Age Smelting Activities at KHI

The archaeomagnetic evidence from the slag mound at KHI, together with other indications (smelting technology not available prior to the second half of the second millennium, one radiocarbon date from a nearby context, some pottery fragments from mixed contexts), indicates Iron Age smelting activities at the site of Khirbat Hamra Ifdan, most probably during the early part of the period (twelfth to tenth centuries BCE; radiocarbon date and archaeomagnetic data). The fine stratigraphy of the metallurgical deposits indicates two phases of production within the Iron Age, with a break between them evident by a layer of aeolian deposits ("fill") and change in the stratigraphic layout (e.g., Figure 12.69). The younger phase is represented by tap slag and the older by crushed slag.

This small-scale production, not associated with any substantial architectural features, represents a more ephemeral smelting than the main production centers along Wadi al-Ghuwayba and Wadi Faynan. The site belongs to a wider phenomenon of small sites documented in the current research (additional sites in Wadi Fidan and in the southern Arabah; see Ben-Yosef 2010:section 9.1 and Chapter 10).

Table 12.10 Strata identified during the 2007 probes at KHI Area E

Stratum	Description	Date
Stratum I	Surface	Post Iron Age
Stratum IIa	Slag- Large Tap	Iron Age (?)
Stratum IIb	Fill	Abandonment
Stratum IIc	Slag-Crushed	Iron Age (?)
Stratum IIIa	Fill	Abandonment
Stratum IIIb	Architecture	Early Bronze Age III
Stratum IV	Bedrock	

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Figure 12.66 The slag mound situated on the southeastern part at KHI. *Photo: ELRAP-LAL.*



Figure 12.67 The profile of the slag mound found at KHI. *Photo: ELRAP-LAL.*

Jabal al-Jariya Mine Fields (جبل الجارية)

The Discovery of the JAJ Mines and General Observations

Vast pit mine fields were discovered by Erez Ben-Yosef and the team of the FBRS project in the summer of 2007 (for the survey, see Chapter 6, this volume) (Ben-Yosef, Levy, et al. 2009c). The striking similarities between these mines and the well-documented pits in the Timna Valley attracted our attention when visiting FBRS Site 37. The latter is a structure complex located on a narrow low ridge in the Jabal al-Jariya area; we found it by studying the UTM-IL topographic map (1:50,000) of the region, where the walls of the structure are indicated by black lines. After leaving the dirt road and climbing the narrow ridge, we could

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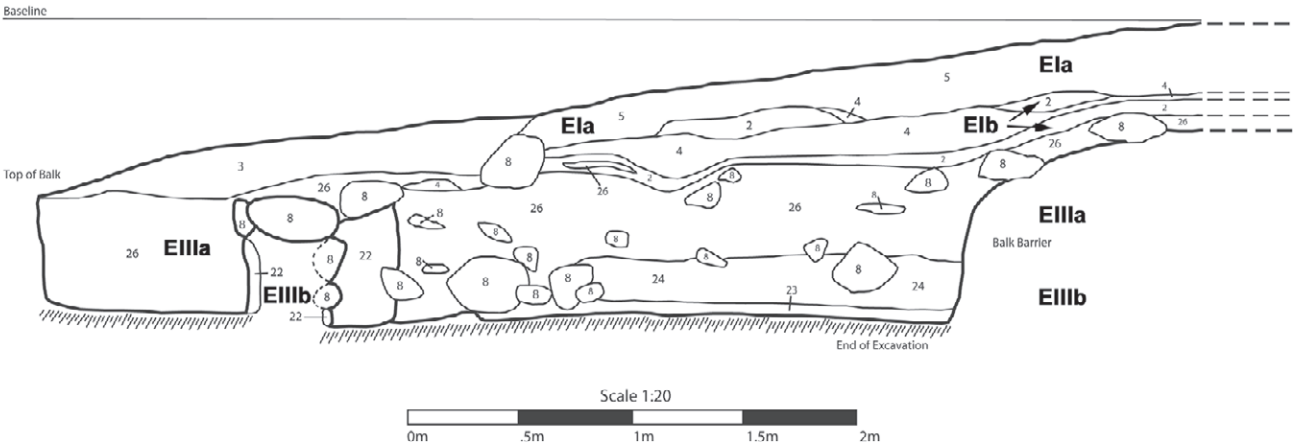
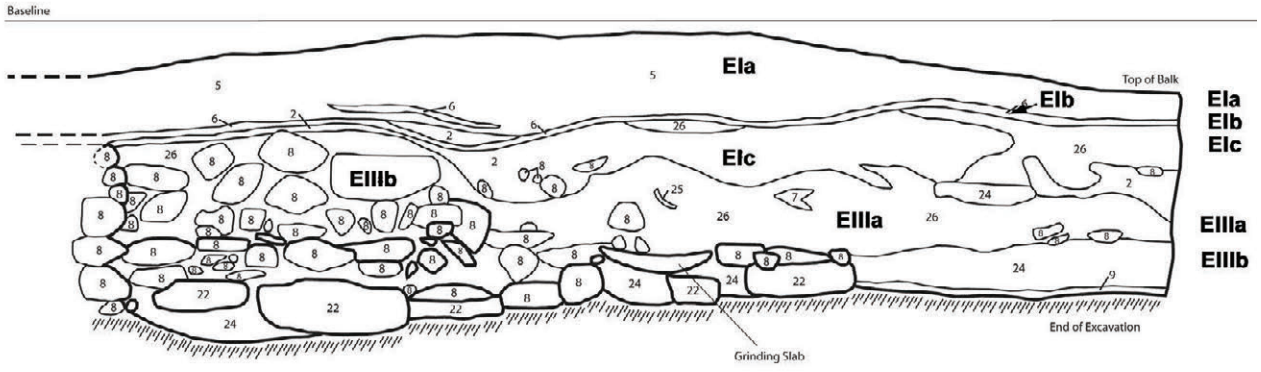


Figure 12.68 A drawing of the eastern wall of the excavation Square E2 at KHI Area E with clear stratigraphic division into the copper production deposits (EI) and the Early Bronze Age architecture (EIII) (drawn by A. Muniz). See Figure 12.69 for legend.



Legend

1	broken slag	10	silt/ clay	18	silt and ash with some crushed slag
2	fine crushed slag	11	furnace fragments	19	plaster
3	silt and ash	12	crushed and broken slag, poorly sorted	20	pottery
4	ash with some slag	13	broken slag with tap slag and furnace fragments	21	dark brown sediment
5	tap slag	14	yellow/ brown ashy loess with some slag	22	mudbrick
6	solid ash layer	15	tuyere pipe	23	surface
7	animal bones	16	red wadi sand	24	compact mud
8	stone	17	compacted crushed slag, weathered?	25	pottery
9	wadi sand/ bedrock			26	fill

Figure 12.69 A drawing of the eastern wall of the excavation Square E1 at KHI Area E with clear stratigraphic division into the copper production deposits (EI) and the Early Bronze Age architecture (EIII) (drawn by A. Muniz; UCSD ELRAP).

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observe the hundreds of pits below us, probably missed by others because when driving the road in the lower part of the valley, these features are not visible. Furthermore, the link between these shallow depressions and mines is not easily recognized. It took many years of research in Timna to correctly associate similar features there with mines (among other options, they were interpreted as designate locations for ore processing; see, e.g., Rothenberg 1967). The pioneering work of Rothenberg and the Arabah Expedition in the southern counterpart of Faynan has facilitated our investigations in the latter, including the interpretation of the Jabal al-Jariya mines.

The hundreds of plate-like depressions are approximately 7 m in diameter on average, densely scattered in an enclosed valley of around 30 ha that penetrated into an extensive gravel terrace at the base of Jabal al-Jariya (JAJ-1, 30.695°N, 35.430°E) (Figures 12.71, 12.72). They are similar to the mines found in survey Areas A, C, and G in Timna (Conrad and Rothenberg 1980; Rothenberg 2005), in which *placer* mining of copper ore nodules took place (Figure 12.73). In both contexts, the copper-bearing formation is located in a higher topographic location, and the ore was mined from the eroded material as already broken fragments (Figures 12.3, 12.74). Tracking the prominent signature of the Faynan mine scars on satellite imagery available on Google Earth (Figure 12.73), we located two similar mine fields approximately 0.5 km (JAJ-2, 30.701°N, 35.432°E) and 1 km (JAJ-3, 30.704°N, 35.435°E) to the north, sprawling over approximately 0.25 and 1 ha, respectively.

In the Timna Valley, the previously enigmatic depressions were, until now, unique in the entire landscape of the Levant. The scarcity of archaeological finds in such mine fields and the exhaustive exploitation of ore made the interpretation of the "plate-like" features in Timna difficult; even excavations of some of these features yielded very little artifactual evidence (Rothenberg 2005). The situation in the JAJ area is similar: surveying the mines yielded only a few fragments of ore (Figure 12.76), no pottery at all, and, surprisingly, no securely identified ground stone.[19] The absence of ground stones is possibly explained by the quality of ore in this location. Very limited evidence shows extremely high quality of ore in very small nodules or attached to small fragments of the host rock (e.g., Figure 12.76a), saving the need to further beneficiate the ore by dressing with ground tools. The lack of ore, even in the excavated area (see below),

Table 12.11 Archaeointensity results from Khirbat Hamra Ifdan, Area E (latitude: 30.663°, longitude 35.393°).*

Sample	Locus	*N*	Intensity (μT)	Intensity σ Percent	VADM (ZAm^2)	VADM σ
b62356a:b62391b	3053	2	77.9	6.7	151.0	10.1
b62448a	3056	3	84.5	4.2	163.8	6.9
b62492a	3062	2	53.5	25.9	103.7	26.9
b62610a	3077	2	116.5	3.0	225.8	6.9
b62610a:b62614a:b62628a	3077 [all]	3	79.3	41.3	153.6	63.5
b62015a	3079	2	58.6	4.7	113.5	5.3
b62425a	3079	3	48.5	2.5	93.9	2.3
b62015a:b62425a	3079 [all]	2	53.5	13.3	103.7	13.8
b62630a	3083	2	74.6	12.4	144.5	18.0
b62655a	3083	2	78.8	2.8	152.6	4.2
b62656a	3083	3	58.1	10.0	112.7	11.3
b62630a:b62655a:b62656a	3083 [all]	3	70.5	15.5	136.6	21.1
b62685a	3097	2	40.5	10.1	78.5	7.9
b62723a	3108	4	55.3	2.5	107.1	2.7

*Compare with Appendix 12: Harris matrix 2007 for stratigraphic location and Figure 12.71 for the Levantine archaeomagnetic intensity curve. Green = values corresponding to the Iron Age; orange = values corresponding to the Early Bronze Age; blue = mixed locus (?).

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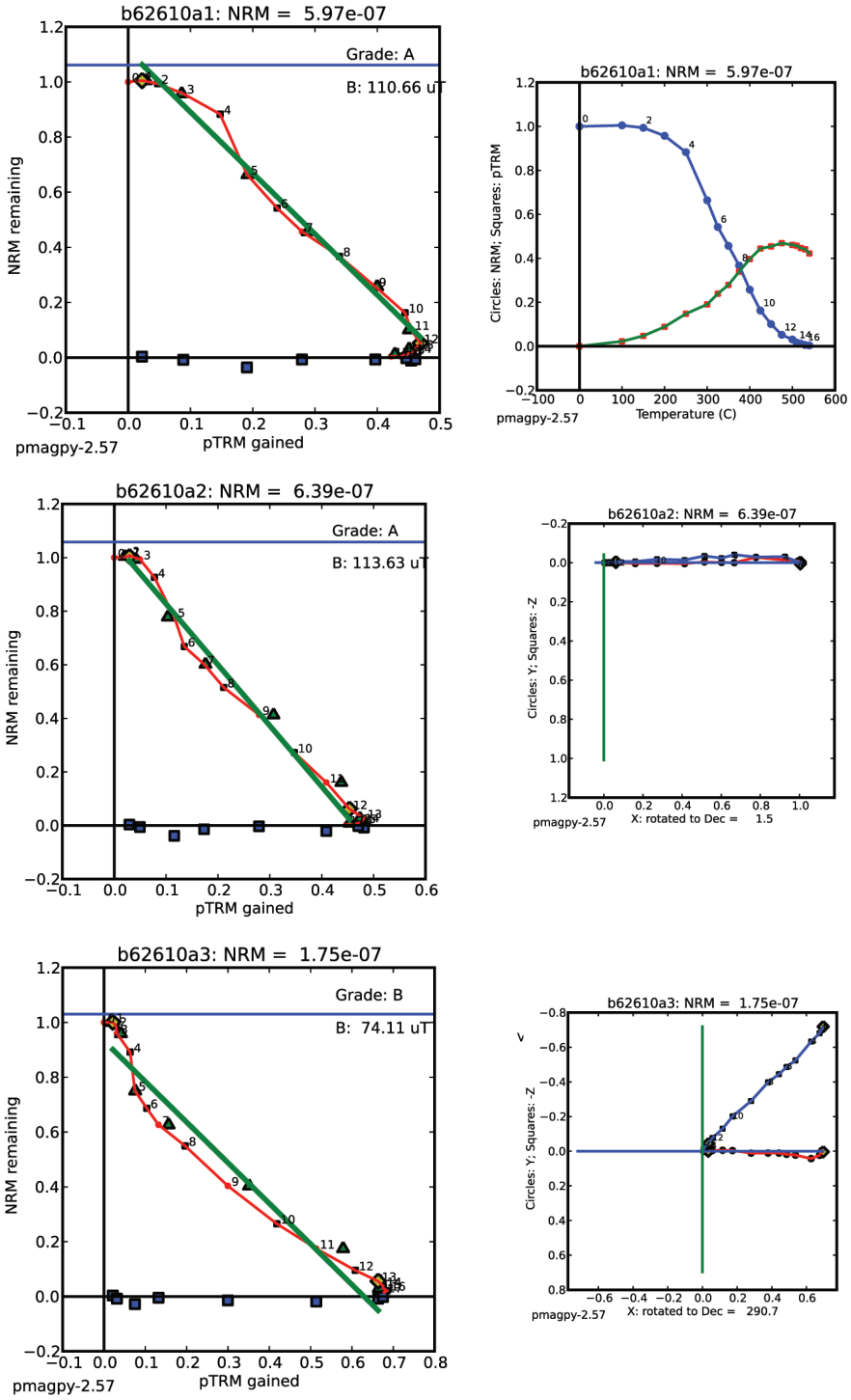

Figure 12.70 Example of results from archaeointensity experiments on slag sample from KHI. The three pairs of diagrams show results from three specimens obtained from one slag sample. The two upper specimens demonstrate excellent behavior throughout the experiment (Grade A), in contrast to the lower specimen that was rejected because of its low quality (Grade B). The two specimens indicate a very high intensity value (cf. Figure 12.71 and Table 12.11; in VADM units = 226 ± 7 ZAm^2), probably one of the two spikes identified by Ben-Yosef et al. (2009d) in the slag deposits of KEN Area M. These are the highest intensity values discovered so far in the paleomagnetic record of the Earth. The results are presented in Arai plots (left) and currently known only from the Iron Age and probably one of the geomagnetic spikes first identified. The left plots are Arai diagrams and the right plots are vector end-point diagrams. For details about the method, see Ben-Yosef (2010:Section 4.2.2); for explanation of these plots and their meaning, see Tauxe (2010); for key, cf. Ben-Yosef (2010:Figures 6.24 and 6.30).

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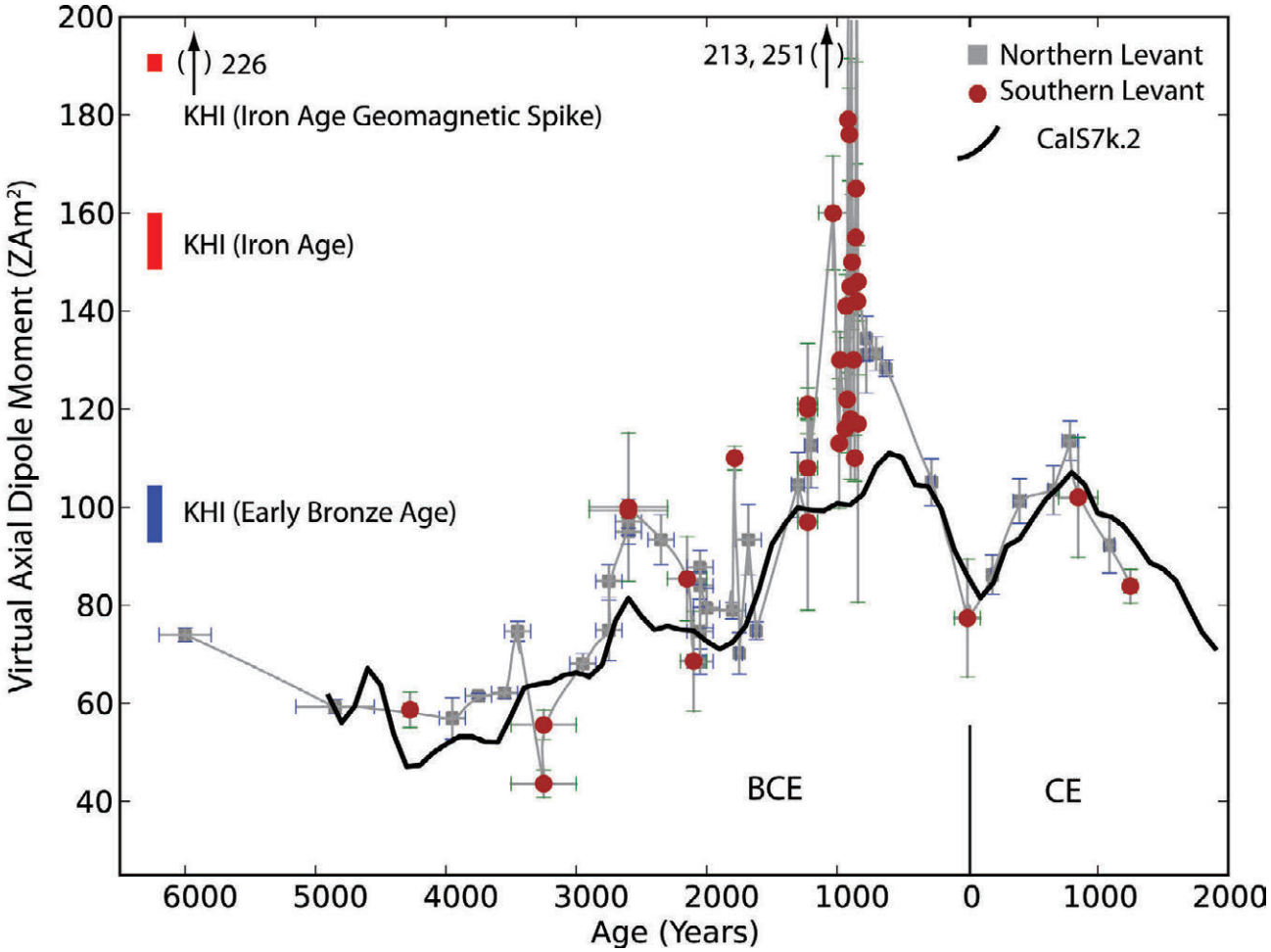

Figure 12.71 Archaeointensity results from KHI plotted against the Levantine archaeointensity curve (Shaar et al. 2011). Two distinct groups of intensity values correspond well to stratigraphic context and demonstrate metallurgical activities at the site both during the Early Bronze Age and the Iron Age (cf. Table 12.11). One sample (b62610a) yielded extremely high intensity values (cf. Ben-Yosef 2010:Figure 6.120) that most probably correlate with one of the geomagnetic spikes identified by Ben-Yosef, Tauxe, et al. (2009) in the Iron Age southern Levant (based on slag samples from KEN Area M).

indicates that this region was completely exhausted in antiquity. This situation is different from other mine locations in Faynan, where ore is still evident today and, according to Hauptmann (2007), probably represents the same quality available in antiquity. This supports our supposition that the ore of JAJ was of a higher quality than of other deposits in Faynan.[20]

The large plate-like depressions marking the location of the ancient pit mine have served as traps for bright windblown loess sediment that today enhance the visibility of the pits in contrast to the black dolomite rocks in the surrounding area (Figure 12.75). Some depressions are used today by the local Bedouins for limited horticulture (tobacco? Figure 12.77) by taking advantage of the natural trap for runoff water and the accumulation of fine soil (roughly dug channels are constructed to divert the water from the slopes in the few rainy days during the winter).

After we recorded the mines in 2007, we have suggested, tentatively, dating them to the Early Iron Age, based on their proximity to the well-dated copper smelting sites of KEN and KAJ (Figure 12.1) of the same period. In addition, the lack of significant copper-related sites from other periods in the close vicinity of the JAJ mine fields (Hauptmann 2007) and the "Iron Age landscape" identified by Levy et al. (2013) in this

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region added further weight to this interpretation. In 2009, we conducted excavations in one of the pits; OSL dating strongly supports the ascribed Iron Age date. These mines constitute one of the largest mining fields of the ancient Levant and most probably represent one of the most important Iron Age mining fields in the Faynan region.

The discovery of the JAJ mines provides an explanation for what has been until now a noticeable discrepancy in the archaeometallurgical evidence from Faynan and Timna: while Faynan has much more evidence of Iron Age smelting activities, Timna had, until now, many more recorded mines. The difficulty of interpreting the contrasting archaeological evidence is well indicated in Hauptmann (2006:128):

> At Faynan the situation is different [from Timna]. Neither a comparable number of filled shafts nor a large number of tailings seems to indicate extensive underground mining. But this does not mean that the extent of copper exploitation was less than at Timna. The contrary is the case. The amount of slag produced at Faynan suggests metal production on the scale of several thousand tons over the millennia. … At Timna, the slag heaps indicate considerably less than this amount. There are two main reasons for the less visible evidence of ancient mining at Faynan. The first is the exploitation of ores at a greater depth, which led to more extensive underground mining activities. The second is that the exploited parts of the mineralization were backfilled so that not much of the waste was unloaded on the surface.

Hauptmann attempts to explain the discrepancy by suggesting deeper and more elaborate mine shafts and galleries in Faynan; the lack of consequent enormous tailings is explained by the refilling of galleries and shafts after a mine was exhausted. The new mines provide the "missing link" as they probably were the most important copper ore source in Iron Age Faynan.

The ancient pit mine operations have dramatically changed the local landscape in this part of the Faynan district (Figure 12.75). Unlike the numerous Iron Age shaft and tunnel mines found by the DBM team (Hauptmann 2007; Weisgerber 2003) and the UCSD projects (Chapter 7, this volume; Levy et al. 2003) in the region, the new pit mines are remarkably different. The pits were excavated into the colluvial slopes of the valleys to extract copper nodules eroded from the Cambrian ore-bearing Burj dolomite formation that accumulated in the gravel (Figure 12.76). The open

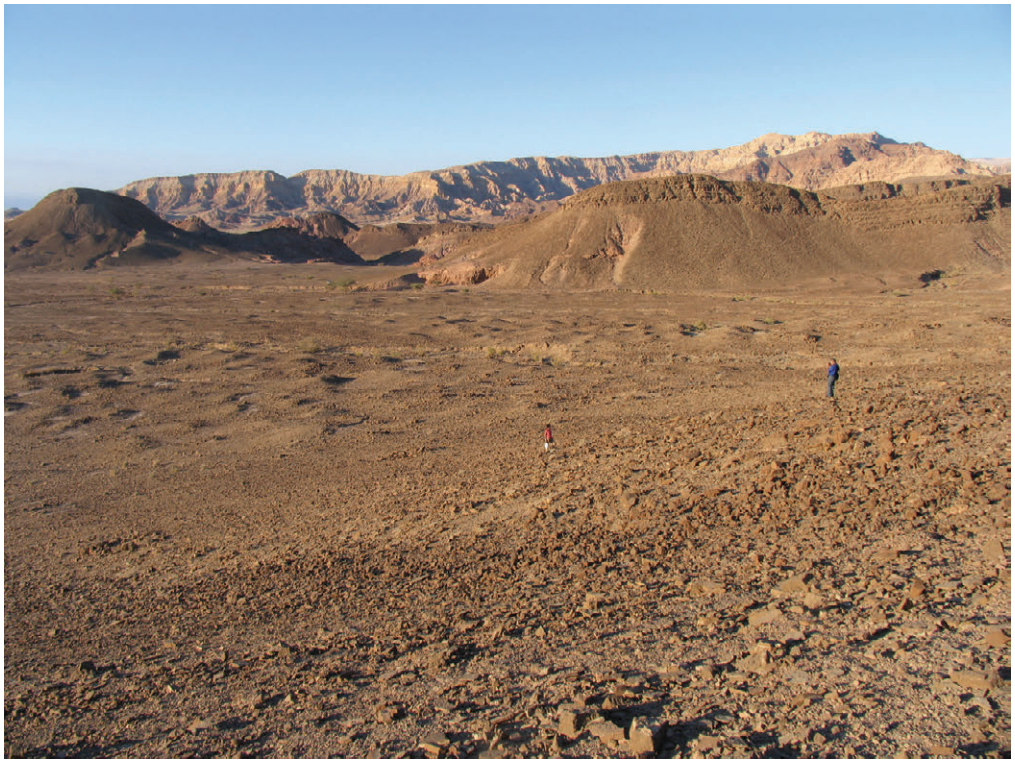

Figure 12.72 An overview of the large copper pit mine field (JAJ-1), view to the north. The disturbed surface is densely covered with depressions marking the location of the ancient mining pits. The depressions are identified as pit mines based on the comparison to the well-studied mines in the Timna Valley and their geological location.

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Figure 12.73 The "plate features" in the Timna Valley; more than 9,000 such features have been recorded by the Arabah Expedition. After years of research, the Arabah Expedition found evidence that most of these features are blocked mine shafts and that some are open pit mines (in Areas A, C, and G). The mines and resulting landscape are similar to the area discovered in the current research in Faynan (JAJ). *Photo: Rita Mendes-Flohr.*



Figure 12.73 Jabal al-Jariya, a view from Wadi al Ghuwayba. The JAJ mines are located in the valleys behind the mountain into which the ore-bearing upper horizon of the DLS formation has been eroded; the local dip of the formation and its exposure layout in this area provided a "natural trap" for ore with erosion processes functioning as a natural beneficiation mechanism.

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Figure 12.75 Satellite image of the eastern portion of the southern pit mine valley (JAJ-1). The three left arrows indicate the location of shallow rectangular encampments, two of which are possibly contemporaneous with the mining activities. The right arrow indicates the location of a magmatic plug, part of Phanerozoic magmatism exposed in the vicinity of all three mine fields.

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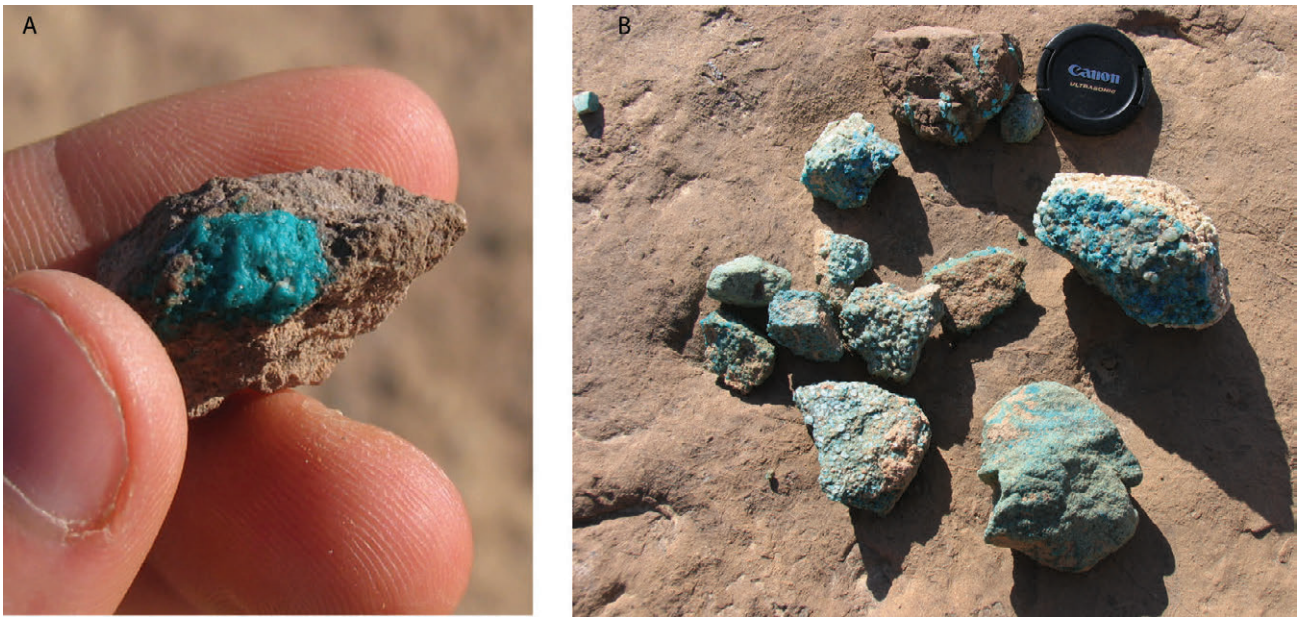

Figure 12.76 Copper ore from JAJ-1 (*a*) and JAJ-3 (*b*). The ore fragments are extremely rare today, and thus it is hard to evaluate the quality of ore available in the Iron Age. The lack of "leftover" ore at this area (in contrast to most of other mines in Faynan) and some very limited finds (such as the fragment in *a*) suggest exceptionally high-quality ore in this region, probably in the form of small nodules mined by hand from the colluvial deposits (similar to the fragment in *a*) (see text).

pits were refilled with the gangue of the adjacent active mines to maximize the exploitation of the exposed copper-rich colluvium—a well-delineated and easily accessible source of naturally broken copper ore. A nearby post-Precambrian magmatic plug and associated north–south dike of more than 1.5 km in length (Figures 12.75, 12.78, 12.79), the only Phanerozoic magmatism known in the Faynan region to date, may imply that the richness of the copper mineralization in this specific locale was influenced by this magmatic feature. The geological history of the secondary copper mineralization of the Arabah is directly related to magmatism at least in its later phase (Ilani et al. 1987), and the dike exposed near JAJ is probably part of this phenomenon (see Ben-Yosef 2010:Section 2.2.1).[21] Rock samples from the dike are currently being measured for Ar/Ar dating in the laboratory at Oregon State University (preliminary results indicate a relatively young age, ca. 7 m.a.). According to the regional geological history, the age of the dike is probably either Lower Cretaceous or Miocene and younger, and the results will help to correlate between field evidence in Faynan and Timna and to further understand processes related to ore formation and/or the rifting.

Contemporary small-scale mining activities in the Bisie region of Congo, recently reported on in the *New York Times* (Polgreen 2008), provide an important model for how pit mines may have functioned in Iron Age Jordan. Extraction of Congo tin ore was achieved from pits dug into gravel deposits. As seen in Figure 12.80, the disturbed terrace surface in the Congo shows similar features to the 3,000-year-old mine fields in both Faynan and Timna. The modern open pit mining in Congo is not limited to tin; in a recent visit to the country, the geologist Ram Ben-David recorded pit mines of copper in the country, resulting in a similar impact on the landscape as the one observed in JAJ region (Figures 12.81and 12.82).

The 2009 Excavations at JAJ-1 and Sampling for OSL Dating

As part of the ELRAP 2009 field season, we conducted a probe in one of the pits of the JAJ-1 mine field.[22] The goals of the probe were to find evidence of the mining activities and technology, to determine the shape and dimension of the original pit, and to expose deposits for OSL dating.

We used the same methodology and recording procedures of the main ELRAP project, using a total station and a GIS-based database. There were almost no finds, and most of the samples (soil samples, OSL samples, etc.) were taken directly from the walls of the

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Figure 12.77 A small "garden" taking advantage of the natural trap of running water created by the mine scars at the region of JAJ-1. A few of the depressions of the pit mines are used by the local Bedouin for growing plants, probably tobacco.

excavation pit and are indicated on the main section drawing. The excavations took five days in early November 2009, and the OSL sampling took place on November 24, 2009.

A well-defined and relatively small depression (or "plate-like" feature) was chosen for the excavations, as we wanted to make sure we were able to reach the original surface of the pit and to expose its entire middle section during the timeframe available to us (Figure 12.84). The area around the excavated pit was mapped by us during the excavation; it represents various sizes of pits and the small mounds of mine material ("bumps") between them. The flat part of the depression was an ellipse measuring around 3.3 × 5 m. We extended the excavation area itself outside of the flat ellipse by approximately 1 m on either side to expose the margins of the pit and define its boundaries. The section measures 5.51 m across and 1.6 m deep in the center (Figure 12.85).

Using the ELRAP digital archaeology system (based on total station measurements), we mapped the sampled mining pit and the surrounding depressions to contextualize the excavation probe. In addition to the exact dimensions of the excavated feature, the excavation limits, and the surrounding pits, the map demonstrates the density of the mining depressions. There is no undisturbed space between them; the mounds separating one from the other are the result of the sorted material dumped during the mining. The sampled pit and its vicinity can be seen using Google Earth images that can help to further contextualize the excavation probe. Near the excavated pits, two small stone features were recorded. These seem to be some ephemeral installations, but this may represent some activity connected to the last phase of mining in this area (Figure 12.86).

The bowl of the mine itself was filled in with relatively loose, horizontally deposited yellowish aeolian dust and some small stones (also lying horizontally), while the surrounding original margins of the pit consisted of condensed reddish clay with large fragments of dolomite stone, all inclined toward the center of the pit (Figure 12.85). We did not uncover any clearly anthropogenic finds inside the mine pit itself or on the surface, except for one fragment of flint (see below). Some small fragments of copper ores were found. These ores are in the shape of nodules and (usually) not attached to gangue (in most Iron Age mines in Faynan, the ore is embedded in the blackish dolomite or shale stones and requires further processing). The nodules seem to be composed entirely of bright blue copper minerals, with a high concentration of copper in them.

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Figure 12.78 The location of the around 1.5-km dike in the vicinity of the JAJ copper mines (on a Google Earth image). The dike is indicated by the white line; JAJ-1 is delineated near the southern end of the dike and JAJ-3 near its northern end; also indicted as pins are KEN (note the close proximity to JAJ-1) and KAJ, and in black the site of FBRS 37, located on a narrow ridge above the JAJ-1 valley.



Figure 12.79 A Phanerozoic dike located in the area of JAJ mines (cf. Figure 12.78). In this location, the usually narrow (in places less than 0.5 m in width) and single-segment dike has a multisegment appearance and a "jump" in trend.

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Figure 12.80 Pit mine in the Congo. Renegades are exploiting tin ore fragments from the gravel by digging large pits similar in shape (though larger) to the 3,000-year-old pits recently discovered in Faynan, Jordan. *Photo: Johan Spanner.*



Figure 12.81 Copper pit mines in the Congo. The disturbed landscape has similar characteristics to the pit mines in Faynan. *Photo: Ram Ben-David.*

This is a very important observation: the reason for the extensive mines in this location was most probably this type of ore, which seems to be especially rich in copper and without the need to dress it (separate it from the host rock). This observation may explain the lack of digging/cutting tools of any sort on the surface or in the excavated area: the ore was already in the form of small, easily transported nodules.

In an "air pocket," an area of loose sediments with relatively large rock fragments marked in the section as #3 (Figure 12.85), we found what appeared to be a flint flake. Flint cannot be explained by the local geology as naturally occurring in the colluvium, and it has to be anthropogenic. Its location indicates that the margins of the pit were also the result of human mining activities; it probably consists of the dump of a nearby pit after the ore was sorted out.

It was impossible to precisely separate Units 1 and 2 during excavation, and they should be regarded as part of the same locus. However, careful study of the section (Figure 12.85) reveals a significant and clear difference between these units; there were some areas

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Figure 12.82 Copper pit mines in the Congo. Note the great efforts done by sieving to exploit every ore fragment available. Same efforts were probably done in the JAJ mines, resulting in entirely depleting the area from ore. *Photo: Ram Ben-David.*



Figure 12.83 One of several tumuli located on the upper slopes of the JAJ-1 mine valley (not dated; may represent graves contemporaneous to the mining activity).

of intermixing, but overall we could see a contact line between the yellow layer and the reddish one. Unit 3 was also easily recognized in the section as a distinct area with large loose rocks on one side of the pit margins (Figure 12.85).

The excavation revealed three distinct units of sediments (Figures 12.85, 12.87, 12.88). The uppermost (Unit 1 in the section) is the yellowish dust with horizontally aligned small stones; the next unit, which we believe constituted the exposed surface inside the pit after it was abandoned, is reddish clay with larger fragments of stones with inclinations toward the center of the pit. This unit is the result of sediments transferring as part of the mining activity. The third unit is also part of the

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Figure 12.84 The "plate-like" feature, representing a mining pit, before excavation. Note the small stone feature to the right.

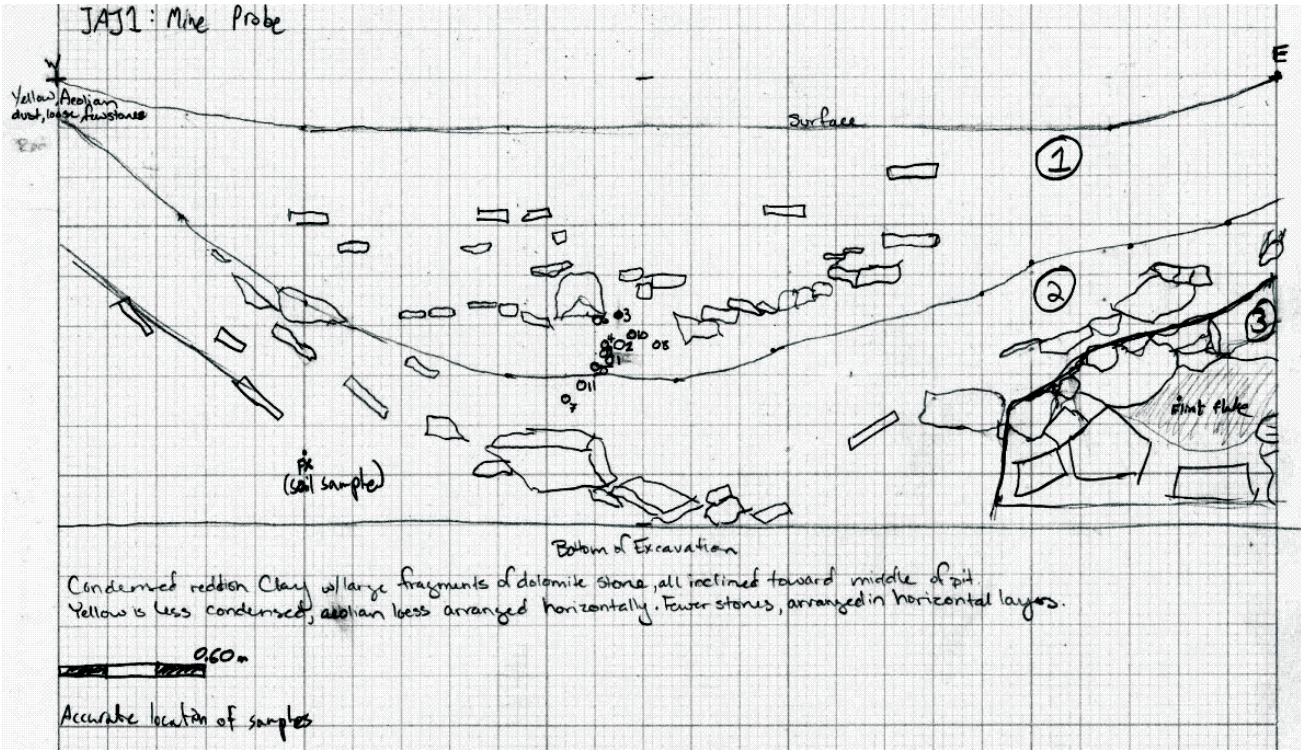

Figure 12.85 Drawing of the central section of the pit mine excavated in 2009. Three main units have been distinguished (marked as 1, 2, and 3; see text for details). Note the location of the OSL samples in the middle and the flint find in Unit 3. FX represents the location of a soil sample taken for further studies.

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Figure 12.86 Stone features on the edge of the excavated pit.



Figure 12.87 Excavating one of the "plate-like" features of JAJ-1.

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original margins of the pit and is exposed only on one side of the pit. It is composed of large rocks, held by loose soil with some "holes" in between them.

Once we had determined that we had excavated below the bottom of the original surface of the pit (i.e., all the sediments had turned red), we sampled the sediments above and below the Unit 1–Unit 2 boundary for OSL dating. The dating project was done with Naomi Porat of the Geological Survey of Israel (GSI), who provided instructions also for the sampling process. It is worth noting here that we probably did not penetrate "virgin soil"—colluvial sediments that were not interrupted by human activity, as indicated by the flint flake and the similar characteristics of the clearly artificial pit margins and the bottom of the excavation (however, it was not clear if we could find any clear boundary or indication of this elusive "virgin soil," and the pit was deep enough for characterization of the different sediments and for sampling it for OSL, since we were interested in the deserted surface and the accumulated aeolian dust just above it for dating the last activity phase in the mines). The samples for OSL cannot be exposed directly to sunlight or else they will become contaminated, so we worked before the sunlight directly hit the section and used foil-covered PVC pipe to contain them (ca. 30 cm in length and 5 cm in diameter). We chose 11 points from the lower levels of the pit (Unit 2) and the upper levels (Unit 1) of what we believed has naturally accumulated since the desertion of the mines. At each point, we used a hammer to insert a sharpened PVC pipe plugged at the outside end with aluminum foil (Figure 12.89). Once all 11 samples were inserted, we removed them, keeping both ends covered and making a map of where each came from (Figures 12.90 and 12.91). In addition, we took four soil samples from the region surrounding the OSL samples. All this was done before direct sunlight hit the section (on the morning of November 23, 2009).

The excavation probe in one of the pits of the JAJ-1 mine field has yielded the following observations:

1. The entire landscape of the valley is the result of human activity: the pits themselves as well as their margins.
2. The original bottom of the pits, as deserted after the mining activity, was approximately 1 m below the surfaces visible today. The pits were filled with aeolian dust and some alluvial deposits (stone fragments, silt), since they were deserted.
3. The miners were probably sorting out ore nodules of the kind collected by us: extremely rich, small, and easy to pick fragments of copper minerals. These did not need any further dressing and were collected without the need of any special tools. It is very hard to estimate the original richness of the mine field and the quality of the original ore, as probably the bulk of the ore was collected in antiquity and the finds are only the residues (a common problem in ancient mining sites). As noted above, it seems that we did not excavate any "virgin" or original colluvial area that may indicate the original ore content—the whole sediments, including those exposed at the bottom of the pit, seemed to be the result of human activity.
4. The flint flake close to the bottom of the pit (see Figure 12.91) is a strong indication that even the pit margins and the heaps in between the pits are the result of human activity.
5. Further investigation of the ore fragments collected in the survey and the excavation is needed for precise identification of the minerals and their quantitative quality. Moreover, these minerals visually seem to be richer in copper than do the common minerals exposed today in other mine locations in Faynan; a better characterization of this difference may help to identify the destination of the JAJ ore, tentatively assumed to be KEN (and maybe KAJ; see below).

Results of OSL Dating from JAJ-1, 2009 Excavations (E. Ben-Yosef, N. Porat, and T. E. Levy)

Five of the 11 OSL samples from the excavated pit of JAJ-1 were processed in the Luminescence Dating Laboratory at the Geological Survey of Israel by Naomi Porat,[23] the director of the laboratory (Ben-Yosef et al. in press). The material yielded results with relatively high precision (Table 12.12). They are in excellent agreement with their stratigraphic location (Figures 12.85 and 12.90), and in general, they corroborate our tentative interpretation of the mining activities at the site.

The three middle samples—JAJ-6, JAJ-5, and JAJ-11—are basically of the same age and average at about 2,540 ± 100 before 2010 (i.e., 530 ± 100 BCE). According to our interpretation, this age represents the first phase of sediment accumulation *after* the original pit was abandoned (mixed aeolian and alluvial deposits; see above, Unit 1). The uppermost sample,

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Figure 12.88 The excavated pit at the end of the excavations; units of sediments are visible (cf. Figure 12.85).



Figure 12.89 Sampling the section of the pit for OSL dating.

JAJ-3, represents a later phase of natural deposition in the abandoned pit (2,220 ± 90 before 2010; 210 ± 90 BCE).

The lowest sample, JAJ-7, came from Unit 2 (see above) and is more difficult to interpret. Given the low sample size (n = 1), it is possible that this sample is an outlier. Even if this age is *not* an outlier, there are still at least three possible interpretations. If our field observations are correct, the date represents the actual time of the mining activities. Based on the stratigraphy and finds, we interpreted the sediments of Unit 2 as representing a dump of gangue material after the

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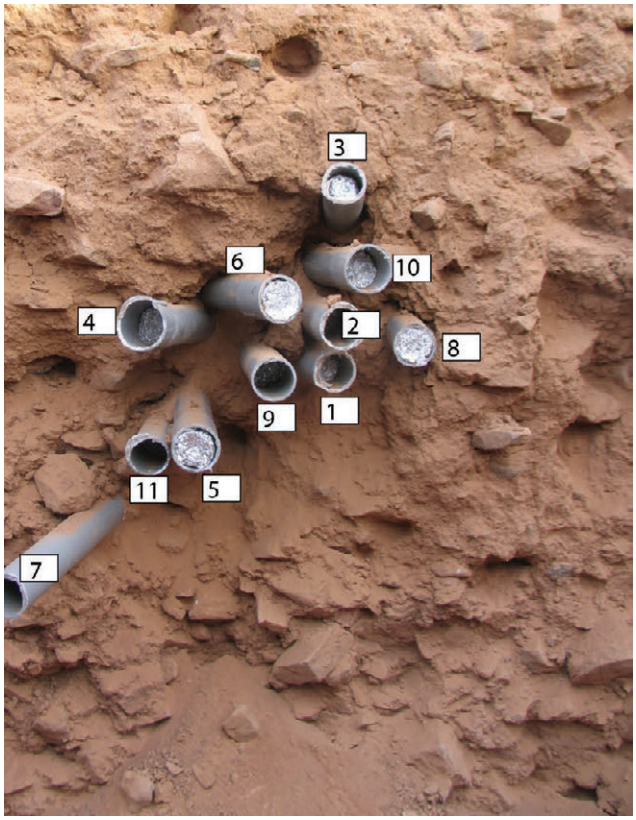

Figure 12.90 The location of the 11 OSL samples in the section (cf. Ben-Yosef 2010:Figure 5.137).

ore nodules were sorted out to be transported to the smelting sites; it seems that we did not penetrate an undisturbed "virgin soil," and thus we assumed that the original depth of the pit before it had been deliberately refilled could not be determined. However, the date of sample JAJ-7, coming from this context (3,890 ± 150 before 2010; 1880 ± 150 BCE), suggests Middle Bronze Age mining activities, but there is no corresponding smelting evidence in the entire Faynan district, unless considering the upper margins of this age and correlating these mines to the Early Bronze Age IV large-scale smelting evident in several sites in Faynan, including the large smelting site of Khirbat Hamra Ifdan (Levy et al. 2002) (although also here, the closest EBIV smelting site is located far from the vicinity of the mines, 3 km to the south or more). Two other interpretations should be considered until further data are available. One is that the date of JAJ-7 represents the age of the final stage of the colluvial deposits formation; thus, with mining activities that did not expose the sediments to enough light, the date of the mines should be between JAJ-7 and JAJ-6, 5, and 11, possibly the Early Iron Age. Another interpretation is that we did not expose the original abandoned surface of the pit and that the mining activities were earlier than JAJ-7, probably Early Bronze or even

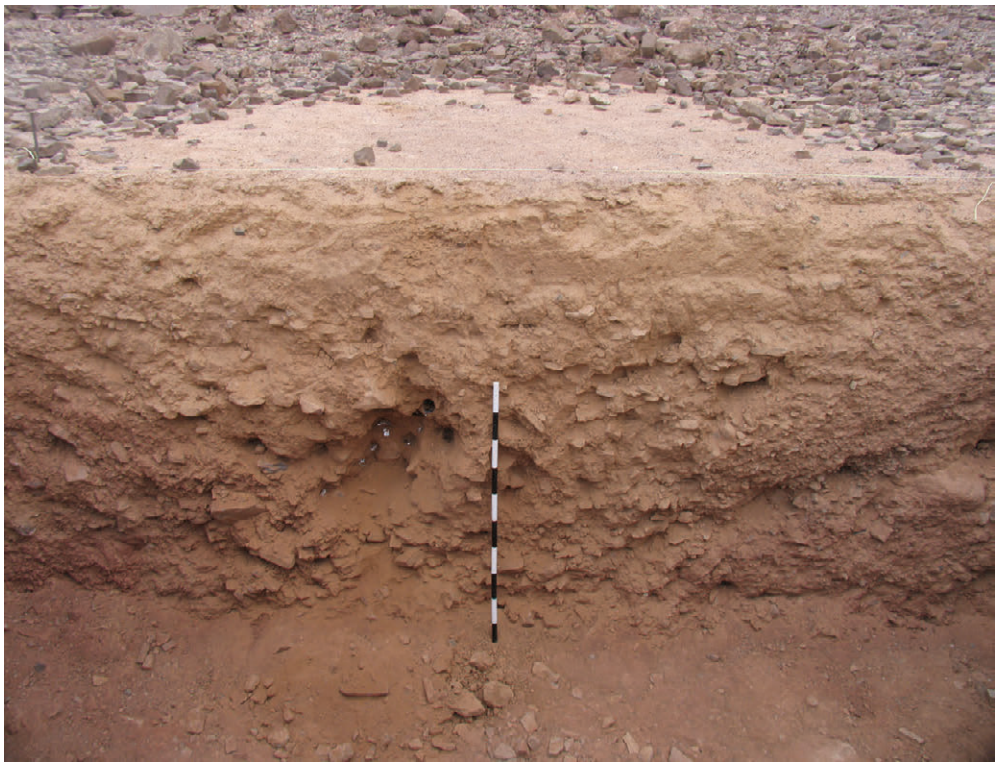

Figure 12.91 The section of the pit after sampling.

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Chalcolithic. These all are speculations, and as mentioned above, we cannot base any conclusions on one date only.

In the current stage of our OSL-based investigation of the pit mines, the bulk of the data suggests Early Iron Age mining activities. Nevertheless, this date is only tentative, and further research (more dates from the lower units of the excavated pits and more excavations in other pits) is required.

While the attempt to pinpoint the exact date of the JAJ pit mines is important, additional merit of the present research is the demonstration of the applicability of the OSL dating method to such mines. As far as we can tell, this is the first time the OSL dating technique has been applied to date pit mines worldwide. Our results show the great potential of this method, and we encourage its application to additional pit mines in not only the southern Levant but other similar ancient mines around the world. Given the chronological challenges that still exist in the research of Timna (Ben-Yosef 2010:Chapter 4), new excavations and OSL dating of the pit mines and the blocked shafts will be an important contribution to our understanding of the Iron Age copper exploitation history in this area. We believe that many of the so-called Late Bronze Age blocked shafts in the Timna Valley are in fact Iron Age (I–II) mines. Although the precision of the OSL technique may not allow dating in high enough resolution for distinguishing between two consecutive periods, it is worth trying as also in the Timna mines, the material culture remains are scant. Moreover, the few pit mine fields in the valley, dated to very early periods (see above), may also represent a later activity, as mining technologies are not good chronological markers (they might be used only as a *terminus post quem*).

Discussion—New Data and Perspectives on Copper Production and Iron Age Archaeological Sites in Faynan

The Faynan district provides extraordinary and well-preserved archaeological evidence of the history of copper exploitation technology and the organization of production *throughout* the Iron Age (ca. 1200–500 BCE). The evidence is based both on the spatial distribution of various types of sites, recorded in intensive surveys, and on technology-related materials from stratified contexts, exposed in large-scale excavations and several probes. Many of the surveyed and excavated sites have been recently dated with high-resolution radiocarbon measurements as part of the UCSD ELRAP research, providing a robust chronological framework to model the technological and social developments in the region that are presented here.

The Iron Age sites in Faynan spread over an extensive area, from Barqa al-Hatiya in the south and the mines of Wadi al-Jariya in the north, the cemetery of WF40 in the west and the mines of Wadi Dana in the east. The mining and smelting sites are concentrated in two main clusters, basically dictated by the spatial exposure of the main copper ore–bearing formation (DLS). One main cluster is located at and around Khirbat Faynan, with smelting sites at the Khirbah (ancient site) itself and its vicinity, as well as mining sites at the nearby wadis (Dana, Khalid, and Abyad). These mines are typical to the Iron Age, usually comprising double shafts dug into the Massive Brown Sandstone (MBS) unit and galleries in the DLS unit. The second cluster is along Wadi al-Ghuwayba and its tributaries. It includes three extensive smelting sites (KEN, KAJ, and KAG) and several mining areas (near KEN, at upper Wadi al-Jariya and at Ras al-Miyah) that also often present typical Iron Age mining technology. An additional nearby and extensive mining area is the recently discovered Jabal al-Jariya pit mine fields. These have been tentatively dated to the Iron Age, based on their proximity to Iron Age smelting sites and preliminary OSL results. If indeed these are Iron Age mines, they represent exploitation of a different ore source (a *placer*) and thus a different mining technology. Additional, minor Iron Age smelting sites were recorded along Wadi Fidan. The ore for smelting in these sites was probably dug at the nearby mines of Um adh-Dhouhur. Some of the Iron Age smelting sites of Wadi Fidan and probably also those reported for Barqa al-Hatiya present a simple technology, different and much less advanced than the one practiced in the main smelting centers of Faynan. This marginal phenomenon has been observed also in the southern Arabah and probably indicates social stratification and/or boundaries (see Ben-Yosef 2010:Section 6.2.3.3).

In general, the Iron Age smelting sites in Faynan are located a short distance from the mines (usually right near the mines and in some cases up to 3 km away), indicating an effort to reduce transportation costs. The other important factor in choosing a location for large-scale smelting operations was probably the availability of water and associated plants. Availability

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Table 12.12 Luminescence dating results from the 2009 excavations of the mine pit at Jabal al-Jariya 1 (measured and analyzed by Naomi Porat at the Geological Survey of Israel, 2010).*

Lab No.	Depth (m)	K (%)	U (ppm)	Th (ppm)	Ext. α (μGy/a)	Ext. β (μGy/a)	Ext. γ (μGy/a)	Cosmic (μGy/a)	Total dose (μGy/a)	Aliquots used	Over-dispersion	De (Gy)	Age (years)
JAJ-3	0.8	1.33	2.1	5.5	10	1320	804	190	2324±35	21/22	16	5.2±0.2	**2220±90**
JAJ-6	0.9	1.33	1.6	4.3	8	1226	693	187	2114±34	16/19	12	5.3±0.2	**2510±90**
JAJ-5	0.95	1.33	1.9	5.3	9	1289	773	186	2257±35	20/22	10	5.7±0.2	**2550±80**
JAJ-11	1.0	1.33	1.7	4.2	8	1241	699	185	2133±89	22/24	15	5.5±0.2	**2560±130**
JAJ-7	1.1	1.00	1.3	3.2	6	937	530	183	1656±32	15/18	17	6.4±0.2	**3890±150**

Notes: Grain size: 88-125 μm (samples 3,5, 6) or 74-125μm (samples 7,11). Dose rates were calculated from the radioelements and the cosmic dose estimated from burial depth. Water contents estimated at 2±1%. 'Aliquots used' is the number of aliquots used for calculating the average De from those measured. Over-dispersion is an indication of the scatter in the sample. Ages are in years before 2010. The central age model (Galbraith et al., 1999) (Galbraith, et al. 1999) was used to obtain the most representative De values and errors.

of water was crucial for any activity in the climate of Faynan, even if it took place on a seasonal basis (i.e., only during the winter). In addition, the fuel for Iron Age smelting was based mostly on hydrophilic plants that grow in oases. This factor explains the location of Khirbat Faynan (near the springs of Wadi Ghuweir), Khirbat al-Ghuwayba (around the oasis of 'Ain al-Ghuwayba), and probably also Khirbat en-Nahas (Chapter 13, this volume) and Barqa al-Hatiya, where current vegetation indicates a high water table.

In addition to sites directly related to mining and smelting activities, Iron Age Faynan includes three fortresses (Khirbat en-Nahas, Ras al-Miyah East and West), a "watchtower" (Rujm Hamra Ifdan), an extensive cemetery (WF40), and a large four-room building that may represent (part of) a road station or caravansari (Barqa al-Hatiya). Numerous small Iron Age sites have been recorded in several surveys and include possible evidence of agricultural activity near Khirbat Faynan, small cemeteries, and a large number of campsites along the wadis (mostly Wadi Jariya, Ghuwayba, and Fidan).

The recently established chronological timeframe for Iron Age Faynan reveals several major patterns: (1) there is (limited) evidence of copper production already in the Late Bronze Age (KEN, Khirbat Faynan, Wadi Dana 1, and Wadi Dana 13). (2) Many copper production sites were abandoned in the late tenth century BCE (KAJ, KAG, and associated mines; probably additional sites that are not yet radiocarbon dated). (3) All copper production sites were abandoned in the late ninth century (ca. 800 BCE, or some years before), with a possible exception of Khirbat Faynan (indicated by limited radiocarbon dates; Table 12.2). (4) A serious attempt to rekindle copper production in Faynan during the seventh to sixth centuries BCE is evident in the mines of the Ras al-Miyah Archaeological Complex (see also Weisgerber 2006:15 and detailed discussion above). This attempt was probably not successful since no smelting counterpart has yet been found anywhere in Faynan. There is also clear evidence of interruption and an abrupt stop in the construction process of the fortress of Ras al-Miyah East.

The new high-resolution dates from stratified contexts also enable, for the first time in the southern Levant, to estimate rates of accumulation of metallurgical debris in "typical slag mounds." Although the stratigraphy of metallurgical deposits is rather complex, superimposed high-resolution stratigraphic sequences have been exposed as part of the current research in slag mounds at Khirbat en-Nahas (Area M) and Khirbat al-Jariya (Area A; cf. Area S in Timna 30, Ben-Yosef 2010:Section 6.2.1).[24] The results confirm that the only way to estimate deposition rate in slag mounds is to base it on absolute dating methods. The dates indicate high variability in deposition rates, from about 2 m in 100 years (KEN Area M, tenth century BCE) to about 1.5 m in 300 years (Timna 30 Area S). Notwithstanding the rigorous data sets we have obtained from contexts of metallurgical deposits, extrapolation of the data for estimating *intensity of production* on a site (or a regional) level is not always valid. The spatial organization *within* a smelting site

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could have (and probably has) changed through time: areas designated as dumps of smelting debris are leveled to construct new buildings while architectural spaces that went out of use have been replaced by designated metallurgical dumps, areas of active smelting levels would demonstrate lower rates of material accumulation than would dumps, and so on. Although estimates of intensity of production are important for social and historical reconstructions, there is a real challenge in getting accurate values, and each stratigraphic context should be interpreted cautiously and with respect to its specific attributes. There is definitely no place for simplistic data manipulations, such as the one recently published by Finkelstein and Piasetzky (2008) for Khirbat en-Nahas. These scholars simply used the frequencies of radiocarbon dates from the site per each 50-year time interval throughout the Iron Age (I and II) as a direct proxy for the intensity of production, completely ignoring stratigraphic and contextual considerations. Variations in intensity of production throughout the Iron Age are evident in the archaeological record, but the evidence is more qualitative than quantitative in the current stage of research. Even the decrease in number of smelting sites that took place sometimes in the late tenth to early ninth centuries BCE is not an indication for the decrease in *intensity,* if this is measured by the scale of exported products. A new and more advanced technology is associated with the new spatial organization of production (Ben-Yosef 2010:Chapters 7 and 8). This technology was more efficient; the decrease in the number of sites may even stand for the increase in intensity of production, resulting from more centralization, standardization, and control over the smelting process. Certain measures like *intensity of specialization* (Ben-Yosef 2010:Chapter 1) are easier to estimate because they are technology dependent and not directly linked to comprehensive assessment of the entire archaeological record. These issues are further dealt with in Ben-Yosef (2010:Chapter 9).

The slag amount in the entire Iron Age smelting sites in Faynan is estimated to range from 100,000 to 130,000 tons (cf. 150,000–200,000 tons for all periods together and a few thousand tons for all periods in Timna), indicating production of about 6,500 to 13,000 tons (Hauptmann 2007:147). This numbers are based on field surface observations and rough estimation of slag represented in slag mounds at the Iron Age smelting sites. We have shown above that a typical slag mound consists of less than 40 percent of slag (Chapter 13, this volume). Thus, it appears that the total slag weight for Faynan is on the upper end of the possible range, but the copper estimates are on the lower range, given that the ore quality was probably more than 10 percent copper and that the smelting processes were rather efficient and exhaustive. As mentioned above, estimates of quantities of slag and copper products for different phases *within* the Iron Age cannot be directly derived from the materials excavated so far. As demonstrated here, there are temporal and technological parallels between Faynan and Timna, the other (smaller) copper ore district in the Arabah, located around 105 km to the south. To complement the study of the Iron Age Faynan, Ben-Yosef (2010:Chapter 6) presents data regarding Timna and the results of the recent Iron Age excavations at the Timna 30 smelting site.

Notes

1 This chapter is partially based on Ben-Yosef (2010:Chapter 5).

2 The Deutsches Bergbau-Museum has an extensive collection of unpublished material from fieldwork in the 1980s and early 1990s, some of it by the late mine archaeologist Gerd Weisgerber. The museum is currently making an effort to publish the material about the ancient mines of Faynan (A. Hauptmann, personal communication, 2010).

3 Recent in-depth studies of Iron Age ceramics of Khirbat en-Nahas and northern Edom are presented in Smith (2009) and in Chapters 4, 5, and 10 (this volume).

4 The archaeometallurgical recording system, developed by Ben-Yosef, was also applied during the ELRAP 2009 expedition.

5 The GPS antennas were connected to Recons (data collectors) with Interlock 1.0.2 software. Correcting the data was done using Spectra Precision 1.1. Thanks to Fawwaz Ishakat, Hashemite University, and the ELRAP digital surveyor for help in georeferencing the differential GPS system.

6 Kitchener reported rich archaeological remains near the springs, including "terraces of an old town of considerable extent," "numerous little mounds of artificial appearance," and "portions of an aqueduct" (Kitchener 1884:213). This area is yet to be properly surveyed, as it has not been included in the area of any of the modern research teams and has a great potential for archaeological discoveries because of its permanent water sources. In March 2009, the present author,

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together with T. Levy, visited the Buweirdeh springs in search of a possible Iron Age fortress buried under the dunes. Although no fortress was found in this visit, we recorded several sites, including a Roman-Byzantine small mound with remains of a short aqueduct (maybe the same as observed by Kitchener, UTM coordinates 72370/38545) and a condense scatter of Early Bronze Age slag and furnace fragments (UTM 72415/38650).

7 The main results of the ceramic analysis appear here with the kind permission of N. G. Smith.

8 The MNI count (minimum number of individuals) for each vessel family is as follows: cooking pot (n = 9), bowl (n = 19), jar (n = 25), jug/juglet (n = 20), and krater (n = 22).

9 When we visited the area in 2006, we could not track the local (Bedouin) name of the fortresses of the other ruins mentioned here, and thus we named the sites after the general local name of this region.

10 The test excavation at Ras al-Miyah East took place on December 4–5, 2006, and the FBRS survey took place from July to August 2007. Both were supervised by Erez Ben-Yosef and included archaeological students from UCSD and Bedouin laborers from the village of Quraiqira.

11 These "Edomite strongholds" are typically built on isolated peaks along the western slopes of the Jordanian plateau. They show a variety of layouts and construction features according to the local terrain and rock formation (usually sandstone outcrops but also other types of bedrock; see, e.g., Hubner 2004), and thus their common denominator is primarily their location.

12 We thank Chaim Ben-David for bringing this similarity to our attention. On the "Moabite" fortress and the road system in its vicinity, see Ben-David (2009).

13 The use of a path along the valley below the fortress (Wadi Nukheila, a southern tributary of Wadi al-Mujib) during the Iron Age as one of the alternatives to the King's Highway is supported by several major Iron Age sites found along the wadi, among them the site of Khirbet Medeinet 'Aliyā (e.g., Miller 1991) and Qasr ed-Daba'a (Parker 2006:74, Site 194), located further up the wadi basin. Although the road along the ascent from the wadi to the fortress has impressive constructions, we should consider the possibility that its main target was the fortress itself, without an additional segment toward the north or east. Alternatively, one might date the massive road constructions to the Roman period, as a secondary access to the limes line.

14 If indeed this limited evidence dates to the Iron Age IIB–C, it will be one of the very few secure contexts with smelting activities in the entire Faynan region and the only one in the Ras al-Miyah Archaeological Complex. This will indicate that the failure of copper exploitation in this area may have been due to lack of sufficient technological knowledge.

15 Excluding the scant Nabataean pottery collected in the area of Ras al-Miyah East and mentioned above. We are grateful to Neil Smith for help identifying the Iron Age ceramics presented here.

16 But Weisgerber (2006) continues: "Nevertheless, from a technical point of view the best twin shaft assemblage ever seen was documented there" (see Figure 5.84).

17 The excavations were supervised by Erez Ben-Yosef with the assistance of Kathleen Bennallack.

18 Intensity measurements were done by Jason Steindorf. This project was funded by NSF grant 0636051 to Lisa Tauxe and Thomas E. Levy. Interpretation of the results was done by L. Tauxe and Erez Ben-Yosef. The final publication of this project will appear in Ben-Yosef, Tauxe, et al. (in prep.).

19 In the placer mines of Madsus, which appear to represent similar mine type and mining technology, there are frequent ground stones (hammer stones and hand stones) and also more ore fragments. Hauptmann (personal communication, 2010) recalled finding such tools in the vicinity of Jabal al-Jariya. In both regions, he suggested to date the mines to the Early Bronze Age I, based on the presence of these tools, which are similar to some finds in the site of Wadi Fidan 4 (for Madsus, see Hauptmann 2007:131). This dating should be regarded as tentative only, as technology, especially of mining in open pits, cannot be a secure chronological marker.

20 It is intriguing to link evidence of young magmatic activities in the JAJ area recorded by our team (see below) and probably related to the copper mineralization with our supposition that the ore quality in this location was higher. This is, of course, a speculation that probably could not be approved, as the region is completely depleted of ore.

21 The volcanic plug and dike recorded by our team in the area of JAJ provide significant information related to the geological history of the region. It is probably dated to one of two documented magmatic events, of the Lower Cretaceous (regional magmatic activity) or the Cenozoic (relating to the development of the rift system); it may also provide data for better understanding the copper mineralization process, the connection between Faynan and Timna deposits, and the movements along the Dead Sea transform.

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22 The excavations were supervised by Erez Ben-Yosef. Participating in the excavations: Kathleen Bennallack (assistant supervisor), Conor Buitenhuys, Shannon Groves, Yusuf 'Azazmeh, and Mohammad 'Azazmeh.

23 We are grateful to Naomi Porat for her help in this project.

24 Our ELRAP stratigraphic observations in metallurgical deposits, including clear evidence of superposition, have been challenged (or, more accurately, dismissed) by Finkelstein et al. (e.g., Finkelstein and Piasetzky 2008; Finkelstein and Singer-Avitz 2009), with no real basis. Radiocarbon dates, archaeomagnetic data, and material culture (technological) typologies all correlate well with field observations and strongly confirm (fine) superposition in "slag mounds" (e.g., Ben-Yosef, Levy, et al. 2010; Ben-Yosef, Ron, et al. 2008; Ben-Yosef, Tauxe, et al. 2009; Higham et al. 2005; Levy, Najjar, van der Plicht, 2005; Levy, Najjar, and Higham et al. 2005). Thus, layers exposed in excavations of "slag mounds" can be interpreted as representing consecutive time intervals, with careful attention to difficulties stemming from the three-dimensional complexity of such deposits.

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13 The Material Culture of Iron Age Copper Production in Faynan[1]

Erez Ben-Yosef and Thomas E. Levy

The following chapter provides a typological framework for artifacts and ecofacts related to copper production in the Iron Age southern Levant. In addition, the chapter presents in detail the archaeometallurgical assemblages of Edom Lowlands Regional Archaeology Project's (ELRAP's) excavations, ordered by their place in the *chaîne opératoire* of the relevant technologies. To date, ELRAP's archaeometallurgical assemblages constitute the largest collection available for the Iron Age in the southern Levant. As such, they allow detailed reconstructions of technologies and installations in an unprecedented degree of accuracy. Moreover, the abundant high-resolution radiocarbon dates from stratified archaeometallurgical contexts of ELRAP's excavations allow for the first time the identification of technological developments *within* the Iron Age, including the major transformation in smelting technology at the last third of the tenth century BCE. ELRAP's finds are presented in light of previous research into LB and IA copper production in the 'Araba (especially the projects of B. Rothenberg and A. Hauptmann) and should be used as a reference for future research into the material culture aspect of primary copper production technologies.

Introduction

To model the dynamics of Iron Age copper technology and diachronic social change during this formative period in the ancient Near East, this chapter presents an in-depth analysis of the full range of archaeometallurgical material culture from the new excavations in Jordan's Faynan district and, where appropriate, from Timna in Israel. To obtain a comprehensive understanding of Iron Age copper production processes and adequate reconstructions of the ancient technologies and installations, multiple avenues of data are used here, including fieldwork, visual investigation, and documentation of artifacts, ethnoarchaeological studies, experimental archaeology, analytical investigations, and more. Early on in the archaeological research of the 'Araba, it was realized that the investigation of ancient material culture of ancient copper production required a different, multidisciplinary research approach (e.g., Glueck 1936). Intensive collaborative work in archaeometallurgy was pioneered (worldwide) by the research of the 'Araba Expedition, headed by Beno Rothenberg,

Opposite: Details of the front piece of a used "large tuyère"—the clay nozzle of bellow pipes typical of the advanced copper smelting technology of the late tenth- to ninth-century BCE Faynan.

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and focused on the metallurgical remains in the (south) western side of the ʻAraba Valley. Twenty-five years of interdisciplinary research (1959–1984) on the metallurgical remains of the Timna region has yielded a substantial amount of technological information based on fieldwork (e.g., Rothenberg 1999a, 1999b), studies of artifact collections (e.g., Rothenberg 1990), analytic investigations (e.g., Bamberger et al. 1986; Gale et al. 1990; Leese et al. 1986; Tite et al. 1990), and experimental archaeology (e.g., Bamberger and Wincierz 1990; Merkel 1990).

The archaeometallurgical remains of Faynan were studied intensively by the Deutsches Bergbau-Museum (DBM) Bochum team, also as a multidisciplinary project (1982–1992; Hauptmann 2000, 2007). The DBM research had already recognized the similarity between the Iron Age archaeometallurgical record of Faynan and the Late Bronze/Iron Age copper production remains at Timna (e.g., Weisgerber 2006). In the current research, using a larger archaeometallurgical database from Faynan (and especially Khirbat en-Nahas), we reconfirm this similarity and further refine the correlation between the two copper production districts *throughout* the Iron Age (see below and Ben-Yosef 2010). Moreover, the results of our new excavations in Timna Site 30 (Ben-Yosef 2010; Ben-Yosef, Tauxe, et al. 2010) challenge the accepted chronological framework of Timna, indicating that the general chronology of the main smelting sites is similar between the two subregions of the greater ʻAraba Valley system (see Ben-Yosef et al. 2012). This situation allows us to rely on previous conclusions, both of the ʻAraba Expedition in Timna and the DMB team in Faynan, in the interpretation of the archaeometallurgical record excavated as part of the Edom Lowlands Regional Archaeology Project (ELRAP) project. Our intensive excavations at Iron Age copper production sites in Faynan have resulted in a substantial (and unprecedented) inventory of copper production-related artifacts presented in depth here for the first time. These artifacts, together with tight control over their archaeological and chronological context, provide additional and more refined information concerning Iron Age smelting technology in the southern Levant.

Archaeometallurgical Inventories from the ʻAraba

Previous to the research of the University of California at San Diego (UCSD) in Faynan (of which the current work is a part), Iron Age and Late Bronze Age archaeometallurgical artifacts from the ʻAraba were recorded and collected primarily as part of archaeological surveys. Only a few excavations of archaeometallurgical sites took place (Ben-Yosef 2010:Tables 6.1 and 12.0), including Sites 2 and 30 in Timna (the latter was re-excavated as part of the current research; Ben-Yosef 2010:Section 6.2.1) and probes at Site 5, Khirbat en-Nahas and Barqa el-Hetiye in Faynan. The technological reconstructions of the ʻAraba Expedition were based primarily on the results of the excavations in Sites 2 and 30. In Faynan, technological reconstructions were based primarily on the archaeometallurgical finds from Site 5, where several furnace bases and other installations were uncovered (the DBM excavations at Barqa al-Hetiye and Khirbat en-Nahas focused on architectural features without a targeted archaeometallurgical investigation). In addition, the ʻAraba Expedition surveyed and probed the typical "Late Bronze Age" mines in the Timna Valley, and the DBM team conducted several shallow probes in "slag mounds" at Khirbat en-Nahas and Khirbat al-Jariya, as well as limited excavations of several mines in the area of Wadi Khalid/Wadi Dana.

Our research in Faynan has resulted in a new collection of archaeometallurgical artifacts from excavated and well-documented contexts. This collection, housed mostly at the UCSD Levantine Archaeology Laboratory, significantly substantiates the previous available inventories of Iron Age copper production technologies. Some of the artifacts uncovered in our research were previously sorted in the field, and the bulk of slag fragments was discarded at the site after documentation (see Ben-Yosef 2010:Section 5.2.2). As most of the archaeometallurgical artifacts are not considered "museum-quality finds" and were found in vast quantities, we were able to ship them from Jordan to UCSD on permanent loan.[2] If weight and space consideration dictated otherwise, the artifacts were stored in the facilities of the Department of Antiquities of Jordan (DOAJ) in Amman.

A large part of the archaeometallurgical assemblage investigated in the current research came from the deep probe into the "slag mound" at Khirbat en-Nahas, Area M (see Chapter 2, this volume). This mound is representative of the entire sequence of Iron Age copper production in Faynan as we currently understand it, from the late phase of the Late Bronze Age to the end of the ninth century BCE. The materials from this context, coupled with high resolution radiocarbon dates and archaeomagnetic data (see Chapter 12, this volume), provide an accurate diachronic reference for technological changes throughout the Iron Age.

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The Iron Age archaeometallurgical inventories from the 'Araba include a wide range of artifacts (and ecofacts) related to all aspects of ancient copper exploitation activities. In fact, most of the finds in the smelting and mining sites are related to different parts of the core actions constituting the *chaîne opératoire* of copper production (see Ben-Yosef 2010:Section 1.1.2 and Chapter 9, this volume; Levy et al. 2011), and the rest are related to supporting "gestures," mechanisms, and activities in the complex system of specialized, wide-scale production (e.g., artifacts related to food supply, status maintenance, spatial organization of production, transportation, and communication). As part of the *wider* definition of material culture, the principal artifacts and ecofacts of copper exploitation *technologies* consist of the following: (1) ore and flux, in the mining and smelting sites, together with related finds such as tailings (remains of the host rock [*gangue*] after ore dressing for beneficiation); (2) ground stones, of various types; (3) charcoal and wood; (4) furnaces and related installations (slag pits, working surfaces, etc.); (5) tuyères and bellows pipes; (6) slag; (7) raw metal and prills; (8) crucibles, molds, and other related technological ceramics; (9) various related installations (retaining walls, storage pits for ore and charcoal, etc.); (10) sediment deposits related to copper production (ash layers, "charcoal dust," fine-crushed slag, clayey sediments of decomposed materials or of sediment stocks prepared for the manufacturing of technological ceramics, etc.); (11) ingots and other final metal products (rare); (12) archaeozoological remains (draft animals [means of transportation], food supply, supporting economic practices); and (13) mortuary remains (health and physical conditions, identity, gender, and other attributes of the labor force). The artifacts from these categories are not equally available in the archaeological record; different depositional mechanisms and/or formation processes of the archaeological record (e.g., Schiffer 1987, 2010) exist and should be considered when analyzing excavated artifacts and attempting to reconstruct the production system as a whole. For example, ore found in smelting sites may represent the low-quality leftovers and not the original quality available in antiquity. Further considerations are emphasized in each relevant section below.

Faynan Iron Age Archaeometallurgy Assemblage: Statistics from Khirbat en-Nahas and Khirbat al-Jariya

Important statistical information concerning basic technological artifacts uncovered during each excavation season has been recovered at Khirbat en-Nahas (KEN) and Khirbat al-Jariya (KAJ) by using our digital archaeology methods (Levy et al. 2010; Levy and Smith 2007; Petrovic et al. 2011). Here we summarize the archaeometallurgical results of the 2002 and 2006 field seasons at KEN and KAJ. The 2009 excavations focused mostly on large-scale buildings at KEN (Area R "monumental building" and the Area W complex), and in this study, only some exceptional archaeometallurgical finds from those excavations are incorporated into the discussions below, together with some comments on the finds from Khirbat al-Ghuwayba and Timna Site 30.

The recording system for archaeometallurgical artifacts was somewhat different for the 2002 and the 2006 field seasons. The differences are mostly in categories of slag (more categories in 2006) and the attributes recorded for tuyères and bellows pipes (number of fragments and length in the 2006 season and number of fragments and weight in the 2002 season). Attributes recorded for furnace fragments were also slightly different between the two seasons (Table 13.1). The data in Table 13.1 are useful to characterize the excavated contexts (e.g., Layers M1, S2, and A2 of the 2002 season are the richest in archaeometallurgical debris, representing a peak in metallurgical activity in each respective area) and to evaluate the representative bulk volumes of metallurgical debris per typical context—and especially in a typical Iron Age "slag mound." In addition, the following parameters help to indicate *technological* differences between excavated contexts: (1) the proportion of slag sizes represents advancement in technology as the relative amount of slab slag (and/or large slag) increases; (2) the average fragment weight (AFW) of furnaces has three distinct groups of values, probably indicating technological differences (Figure 13.1); (3) a similar pattern is recognized in the average fragment length (AFL) of tuyères and the proportion between the number of tuyères and bellows pipes in each area (in Table 13.1, the tuyères of Area R represent the largest AFL, and this corresponds to other distinct technological patterns described below. Note that the 2006 Area M statistics include very little of Layer M1, as most of it was excavated during the 2002 field season.).

The data collected in the field are accompanied by detailed descriptions of the visual characteristics of each artifact (slag, furnace fragments, tuyères, and bellows pipes), organized in a Microsoft Access format. These data are intended to become available online in the near future as part of the general ELRAP database.

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Table 13.1 Quantitative summary of basic archaeometallurgical artifacts from ELRAP's 2002 and 2006 field seasons, presented by excavation areas.

	Slag Weight (kg)					Tuyères and Bellows Pipes				Furnace Fragments					
A/L.	Small	Large	Slabs	Sieved	Total*	NOF	Total Length (cm)	AFL (cm)	Weight (kg)	Total NOB	Weight (kg)	NOF	SF (cm)	LF (cm)	AFW (g)
Khirbat en-Nahas, 2006 excavations															
A	465	387	187	2	1,039	28	115	4.1		26	86	489	1	25	175.9
F**	637	584	207	26	1,428	82	376	4.6		48	94	1,077	1	25	87.3
T**	785	1,827	662	11	3,274	490	1,911	3.9		73	230	2,518	1	31	91.3
R	1,068	1,781	973	0	3,822	447	2,625	5.9		33	357	711	1	25	502.1
M***	3,501	2,321	981	55	6,803	1,070	4,329	4		130	575	3,536	1	30	162.6
Khirbat al-Jariya, 2006 excavations															
A	171	125	4	0	300	401	1,486	3.7		18	85	579	1	20	147
Khirbat en-Nahas, 2002 excavations															
A1					70.3	0			0		0.64	1			
A2a					507.6	179			7.6		8.2	178			
A2b					1722.2	535			58.8		81.22	492			
A3					172.1	64			6.4		11.4	51			
A4					23.9	5			0.25		0.71	9			
A total					2,496.1	783			73		102.18	731			
S1					3,871.1	325			14.5		18.80	297			
S2a					4,308.35	846			56.8		133.6	1,611			
S2b					1,077.7	280			18.2		70.5	726			
S3					156.4	54			1.7		5.8	94			
S4					3.7	0			0		0	0			
S total					9,417.4	1,505			91.2		228.8	2,728			
M1					6,625.4	6,026			219.3		373.5	6,869			
M2a					NA	NA			NA		NA	NA			
M2b					33.1	5			0.41		2.9	87			
M3					89.4	5			0.23		1.1	127			
M4					NA	NA			NA		NA	NA			
M total					6,747.9	6,036			220		377.5	7,083			

*Total does not include sieved.
**In these excavation areas, we found a large quantity of well-preserved ceramic bellows pipes (205 fragments in total length of 1,005 cm in Area F and 214 fragments in total length of 872 cm in Area T). This type of artifact is unique to the pyrotechnological workshop of Areas F and T; note also the relatively small AFW in these two areas in comparison to the rest of KEN.
***Note that Area M 2006 statistics includes very little of Layer M1 as most of it was excavated during the 2002 excavation season.
Abbreviations: A/L = area/locus; AFL = average fragment length; AFW = average fragment weight; LF = largest fragment; NA = not applicable (no data); NOB = number of baskets; NOF = number of fragments; SF = smallest fragment.
The average furnace fragment weight (AFW) and average tuyère fragment length (ATL) suggest that Area R provided the most well-preserved pyrotechnological artifacts.

The Iron Age Archaeometallurgical Collection of ELRAP at UCSD

Out of the thousands of archaeometallurgical artifacts collected during ELRAP's field seasons, 570 representative samples were selected for further investigation in the laboratory (excluding slag) (Figure 13.2). As we wanted the collection to represent both diachronic and synchronic technological differences, only a few contexts from the 2006 field season were studied: (1) the deep sounding at the "slag mound" in KEN-M (a high-resolution sequence of metallurgical debris spanning the thirteenth to ninth centuries BCE), (2) KAJ-A (a high-resolution sequence of metallurgical debris in a "slag mound" representing the Early Iron Age, twelfth to first half of the tenth century BCE), and (3) KEN-F (tenth [?] to ninth centuries BCE specialized workshop) (see Chapter 2, this volume, and Ben-Yosef, Levy, et al. 2010). All of the excavated archaeometallurgical artifacts from these areas were reinvestigated and sorted by us in the laboratory.[3] The collection was further

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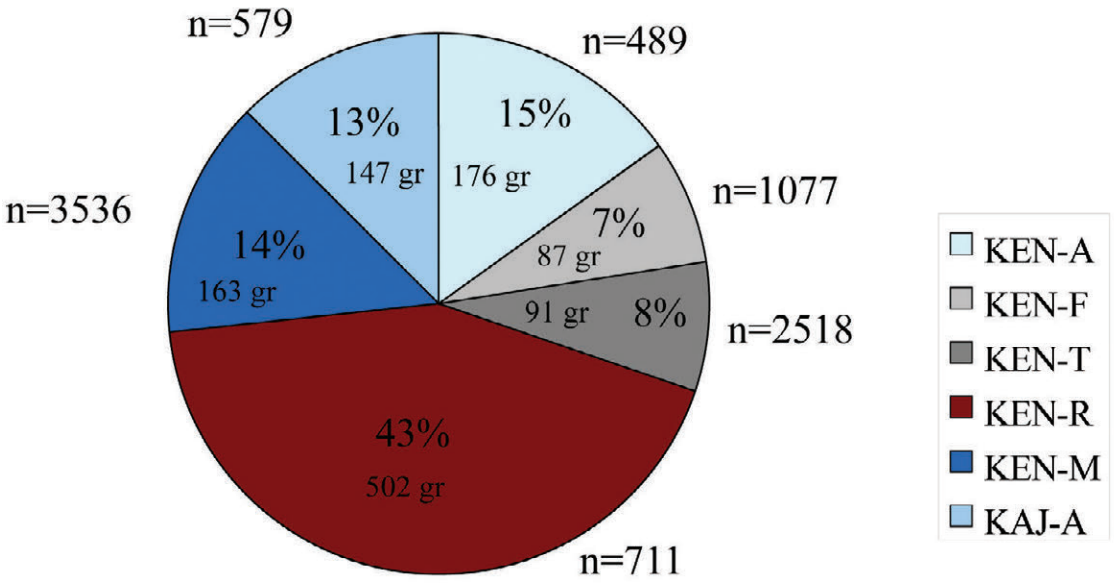

Figure 13.1 Average furnace fragment weight (AFL) by context, based on the recording system of the 2006 excavation season. Three distinct groups are visible (different shades of blue, gray, and red); these correspond to technological differences: KEN-T and KEN-F have evidence of refining/casting technologies, and KEN-A, KAJ-A, and KEN-M have evidence of smelting with smaller installations than those represented by KEN-R (note that KEN-M in this diagram contains little of the M1 assemblage, which was mainly excavated during the 2002 field season).

complemented (although not with a systematic sorting method) by some artifacts from other excavation areas, including Area R (2006 and 2009 field seasons), Area T (2006 field season), and Area A (2006 field season).

The selected archaeometallurgical study collection from ELRAP includes bellows pipes (n = 31), copper ore (n = 13), copper prills (n = 12), metal objects (n = 3), "metal chunks" (n = 92), tuyère fragments (n = 159), technological ceramics (n = 63), mold fragments (n = 39), furnace walls (n = 48), furnace stones (n = 11), furnace smelting/melting residues (n = 5), furnace rims (n = 9), furnace fragments (n = 77), and furnace bases (n = 5). Slag samples were sorted into a different collection and are discussed in Chapter 8 (except for a few representative pieces, n = 13, that are part of the general archaeometallurgical collection). All of these artifacts are now stored in special containers according to the above categories; one container was designated for a "representative metallurgical locus" and included all archaeometallurgical artifacts excavated from L629 at Area M. The attempt to put together all the components of a metallurgical system (smelting) from one well-defined context was done to facilitate comprehensive technological reconstruction.[4]

During the work on the archaeometallurgical collection, it became evident that some of the particular definitions of artifacts were confused in the field and needed to be corrected. Most notably, bellows pipes were often recorded as tuyères (and sometimes vice versa), and tuyère fragments were often recorded as furnace fragments; the "S"-shaped furnace fragments (see below) were often mistaken as large tuyères or other "technological ceramics"; many of the molds were recorded simply as "technological ceramic," and conversely, artifacts recorded as "technological ceramics" were often found to be furnace fragments. The separation into furnace walls, fragments, rims, and bottoms was not included in the field recording system as well as the important separation between "small" and "large" tuyères (see below), which is often difficult to determine, even in the laboratory, when only a small fragment of tuyère is available. In sum, the field-recorded database (Geographic Information System [GIS] based) regarding the archaeometallurgy remains should be treated with caution, especially when analyzing a small sample size. Analysis of contexts with a large sample size usually compensates for incorrect field recordings by rendering such mistakes negligible.

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Figure 13.2 Working on the archaeometallurgical collection at the UCSD Levantine Archaeology Laboratory. Out of thousands of artifacts (excluding slag), 570 were selected for careful investigation and special storage by category for future reference.

Artifacts and Ecofacts Related to Iron Age Copper Production in the Southern Levant

Ore and Flux

No special investigation of ore and flux[5] was conducted as part of the current research. However, a number of important observations can be made based on the fieldwork: (1) in the excavations of Timna Site 30, several installations designated for storage of ore, flux, and probably charcoal were found, both during the 'Araba Expedition's project and the new excavations at the site conducted as part of the current research (L905 in Area S; see Ben-Yosef 2010:Section 6.2.1.2). The recently excavated storage installation at Timna 30 was a circular stone-built feature containing fine-crushed copper ore (a grain size of a few millimeters each). This grain size probably represents the original size used for preparation of the smelting mixture and is not a result of post-depositional decomposing processes. One of the installations uncovered by the 'Araba Expedition in 1976 (Rothenberg 1980) contained manganese ore (pyrolusite) and was interpreted as a designated storage place for ore used as flux in smelting processes represented by Layer 1 (manganese-rich slag). This is an important observation, suggesting a *deliberate* fluxing in the latest phase of copper production at Timna 30. (2) At the Iron Age sites we excavated in Faynan, no similar storage installations for ore and flux were found. However, Hauptmann (2007:102) reports several storage pits, possibly for charcoal and ore, from Faynan Site 5. (3) Many "ore fragments" collected in Khirbat en-Nahas (and which are part of the ERLAP's archaeometallurgical collection) are possibly the result of decomposition of building stones of the Burj formation (Ben-Yosef 2010:Chapter 2), abundantly used at the site as a construction material. These stones often contain green nodules of copper minerals and probably do *not* represent the common type of mineral used for smelting, which came mostly from the shale unit (of the same formation that the building stones came from).

Ground Stones

No special investigation of ground stones was conducted as part of the current research. The various types of ground stones were an essential part of the copper extraction process, from ore dressing and crushing to the processing of slag material. Based on the general study of the ELRAP's inventory, the most common types of ground stones at Khirbat en-Nahas are summarized in Figures 13.3 to 13.5 and at Timna 30 (the new excavations; Ben-Yosef 2010:Chapter 6) in Figure 13.6. In both sites, a large assortment of ground stones exists, all made of the local rocks found in the nearby wadi beds. It is interesting to note that in both Faynan and Timna, many of the flint flakes (if not all) found during the excavations are actually defragmented ground stones made of rounded chert nodules and used for crushing. Only a few of these were found intact; however, it seems that they were quite commonly in use during the Iron Age.

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Figure 13.3 Common types of ground stone artifacts found at the smelting site of Khirbat en-Nahas: (*a*) grinding slab (Area T, L1523, EDM 40741_T), (*b*) dimpled hammer stone (Area R, L1803, EDM 30031_T), (*c*) multiple use/sharpening stone (Area R, L1826, EDM 30310_T), (*d*) saddle quern (Area T, L1504, EDM 40164_S), (*e*) mortar (Area T, L1511, EDM 40150_T), (*f*) "ballistic" stone (Area R, L1827, EDM 30479_T), (*g*) grooved hammer stone (Area T, L1541, EDM 40493_S), (*h*) anvil (Area A, L160, EDM 50126_T), (*i*) hand stone (Area M, L693, EDM 91503_T), (*j*) hammer stone (Area M, L732, EDM 91674_T), (*k*) polishing stone (Area M, L707, EDM 91577_T), and (*l*) pestle (Area M, L701, EDM 91523_T).

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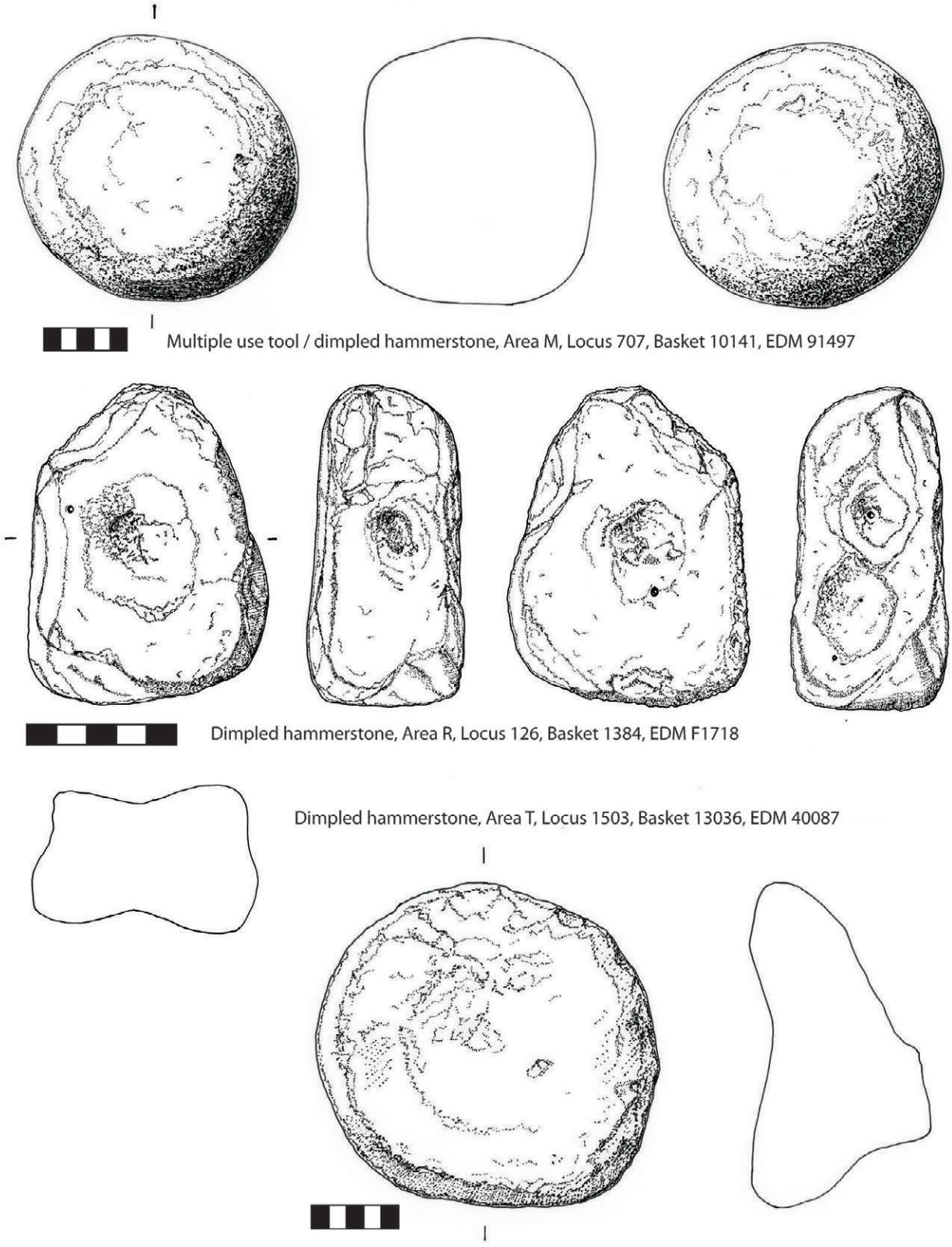

Figure 13.4 An illustration of some of the most common ground stones from Khirbat en-Nahas; many of the hammer stones have signs of use on more than one side (cf. dimpled hammer stone EDM F1718 above, with signs of use on all four sides).

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Figure 13.5 Dimpled hammer stones in situ (located in a defragmented stone basin) at Khirbat en-Nahas, Area T (EDM 40967).

Charcoal and Wood

As the basic fuel in ancient (s)melting processes, charcoal is usually abundant at smelting sites. However, charcoal in the archaeological record may also be simply the result of using wood as fuel for smelting. The assumption that deliberately made charcoal was used, and not wood, is based on ethnographic evidence (e.g., Bisson et al. 2000) and on the fact that charcoal is ideal fuel for smelting. However, recent experiments have shown that smelting in some ancient technologies could have been done using wood only (see discussion in Ben-Yosef 2010:Chapter 9.1.1).

Currently, there is very limited archaeological evidence of charcoal production and only from some late sites in Europe, in locations where locals preserve knowledge of older charcoal burning and archaeologists were able to identify special platforms or other designated areas used for the production of charcoal (e.g., Kenny and Dolan 2011; Timperley n.d.). The paucity of archaeological evidence of charcoal burning is not surprising as charcoal production technologies do not require any substantial installations and leave little remains. In addition, due to site formation processes, it would be difficult to distinguish on-site charcoal production from a variety of metallurgical related activities. To date, in Faynan and Timna, there is no evidence of charcoal production for any period, and the use of charcoal as fuel is inferred mostly from technological consideration based on efficiency of the smelting process. Nevertheless, charcoal is abundant at smelting sites in both Faynan and Timna, particularly in Late Bronze Age and later "slag mounds."

Regarding wood remains, it is important to point out the striking difference in the quality of preservation of organic materials between Faynan and Timna. While the former has almost no uncharred organic remains, the latter has abundant, as is well exemplified by the results of our excavations in Site Timna 30 (Ben-Yosef 2010:Section 6.2.1.2) (high preservation quality was reported also from other sites, including Timna 200; see, e.g., Rothenberg 1988). Consequently, we have found wood only in Timna 30, and quite frequently in relation to the small volume of excavated contexts. The wood pieces are uncharred and can be identified visually as acacia (Figure 13.7). They were found both in Area S and Area L (15 pieces in total, 15 cm the longest). Rothenberg (1980) also reports abundant pieces of acacia and palm wood, mostly associated with Layer 2.

The evidence of wood, especially the small chopped fragments, raises the possibility that uncharred wood was also used as fuel. Although recent experimental archaeology research has demonstrated that smelting with wood is also efficient and not substantially different from smelting with charcoal (Erica Hanning, personal communication, 2010), this question must remain open in the current stage of research.

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Figure 13.6 Various ground stones from the new excavations at Timna Site 30.

#	EDM #	Site	Area	Locus	Basket	Comments
1	160	T30	S	905	564	Two sides (*a* and *b*) of a rounded limestone pebble used as a hammer stone
2	271	T30	L	811	1511	Two sides (*a* and *b*) of a cylindrical brown limestone used as a hammer stone
3	34	T30	S	900	502	Two sides (*a* and *b*) of a flat, rectangular sandstone used as a hammer stone (one side with dimple) or an anvil

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Figure 13.7 Wood (acacia) remains found in the new excavations at Site Timna 30. The preservation of organic material in this site (and in Timna Valley in general) has no parallel in Faynan: (*a*) Area L, L808, B169 and (*b*) Area L, L801.



Figure 13.8 The common type of charcoal in Iron Age Faynan has thin, distinct branches.

Charcoal was collected in large quantities in all the excavations conducted as part of the current research. Besides sampling individual charcoal (or tight clusters) with precise recording for radiocarbon dates, we collected large amounts of samples in general baskets for future analyses and in particular for species identification to complete a thorough investigation of the fuel sources (see Ben-Yosef 2010:Section 5.2.2). Most of the samples from the Iron Age sites in Faynan are relatively thin branches and not thick parts of stems (Figure 13.8); this observation was not quantified in the current research.

All charcoal samples submitted for radiocarbon dating have had their species identified as part of ELRAP's routine dating methodology. The identifications were done by Mark Robinson of the Oxford University Museum of Natural History and are summarized in Figure 13.9.[6]

Although the sample size of the ELRAP charcoal species identifications is relatively small, it represents the same pattern reported by the DBM team based on thousands of samples from Khirbat en-Nahas, Khirbat al-Jariya, and Faynan 5 (Baierle et al. 1989; Engel 1992, 1993; Engel and Frey 1996; Steinhof 1994).[7] A total of 2,257 samples came from the upper part of one "slag mound" at Khirbat en-Nahas. The "slag mound" was partially excavated to a depth of 1.7 m, and samples from 12 different contexts were analyzed. The statistical results, coupled with three radiocarbon dates spanning the second half of the twelfth century to the first half of the ninth century BCE, brought Engel (1993:211) to conclude,

> In the period of copper ore smelting represented by the slag heap examined here [i.e., early Iron Age], the species composition of the fuel did not change. Thus, no evidence was found for immediate influence on the vegetation by the collection of wood as fuel for metal extraction during more or less consecutive phases of copper ore smelting over two to three centuries … Iron Age men seem to have kept the environment in a steady state by using mostly fast-growing shrub species. It can be concluded that even for one of the largest places of "industrial" Iron Age metal production the surrounding lowland vegetation of Khirbet en-Nahas was sufficient as fuel, and no transport of wood from further and higher localities was needed.

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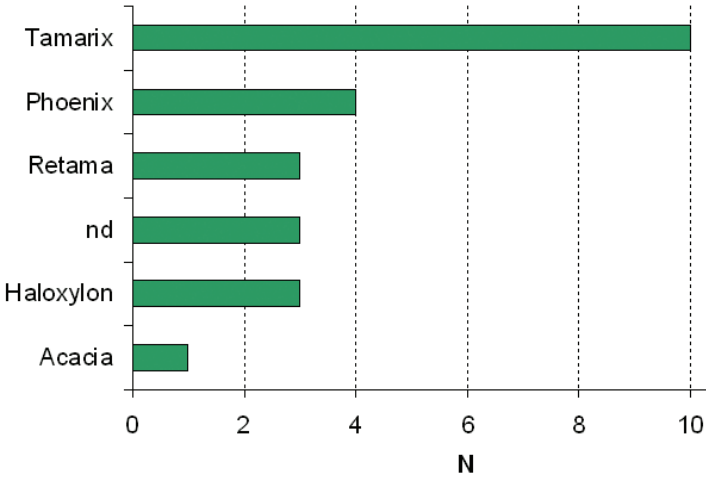

Figure 13.9 A histogram showing number (total *n* = 24) of identified charcoal samples per species (here technically represented by the genus; species are *Tamarix* species, *Phoenix dactylifera, Retama raetam, Haloxylon persicum,* and *Acacia* species) in ELRAP's investigations of Iron Age Faynan (note that these exclude seeds and other types of organic materials; nd = sent for identification but could not be identified; total *n* = 24; number of sample is too small to make any statistically meaningful analysis of precise contexts, i.e., species by stratum of each site); *Tamarix* = tamarisk, salt cedar; *Phoenix* = palm; *Retama* = broom; *Haloxylon* = saxaul; based on Levy et al. (2008:16463) and Ben-Yosef, Levy, et al. (2010:727, 733–734); other publications of radiocarbon from KEN (e.g., Higham, et al. 2005; Levy et al. 2004; Levy et al. 2005) do not include charcoal identifications.

The "steady state" of charcoal composition included all the species presented in Figure 13.9 in approximately the same percentage (*Retama* is second in frequency after *Tamarix* in most contexts in Engel's research). Additional species that were identified by Engel in relatively small quantities were *Chenopodiaceae*, *Ephedra* species, *Moringa peregrina, Olea europaea, Pistacia atlantica, Prosopis farcta, Rosaceae, Zilla spinosa,* and *Ziziphus* species; in the broad picture, these are negligible. The statistics for *all* Iron Age charcoal identifications of the DBM and the Free University of Berlin teams, including previously unpublished data, are provided in Hauptmann (2007:53) and are as follows: *Tamarix*, 52.7 weight percent; *Retama*, 20 weight percent; and *Phoenix*, 8.4 weight percent.

The most common plants used for fuel in the Iron Age are shrubs that grow in open wadis and alluvial fans (*Haloxylon* and *Retama*) and hydrophilic plants (*Tamarix* and *Phoenix*) that grow in oases and areas with a high water table. These plants, and *Tamarix* in particular, grow rather fast, and strategic pruning and pollarding probably kept the harvest yield constant. Robinson has found evidence of coppicing of *Tamarix* in the Iron Age samples from Khirbat en-Nahas (Levy et al. 2008).

In contrast to Faynan, most of the charcoal from Timna, including the Late Bronze and Iron Age sites, was identified as acacia (e.g., Rothenberg 1980) (there is no comprehensive discussion regarding fuel sources in any of the publications of the 'Araba Expedition). Although detailed botanical research like that in Faynan was never conducted in Timna, acacia was probably indeed the main source of fuel in the latter because of the major difference in the biogeography of the two regions (Ben-Yosef 2010:Section 2.3). In Timna, the shrubs discussed above and palm trees are much less abundant, and some (*Tamarix* and *Phoenix*) are rare in the immediate vicinity of the smelting sites.

Social Implications of the Iron Age Charcoal Record of Faynan

The most notable feature in the charcoal assemblage of Iron Age Faynan is the almost complete absence of acacia—a common tree in this Saharo-Arabian desert zone (Danin 1983). When compared to results of charcoal analyses from other periods in Faynan (Figure 13.10, after Baierle et al. 1989), this observation is even more striking as it is *unique* to the Iron Age smelting sites (with a possible exception at Khirbat al-Jariya; cf. Figures 12.9 and 12.10 and Ben-Yosef 2010:Table 5.12). In the Early Bronze Age, the most common source of fuel was the woodlands on the slopes of the Jordanian plateau (juniper trees; Figure 13.11c), and acacia was also exploited in the smelting process. In the next substantial phase of copper production, the Iron Age, shrubs were the primary source of fuel, with a strong dominance of *Tamarix* (again excluding Khirbat al-Jariya, whose report here is quite ambiguous, and the sample size is much smaller [out of the nine samples obtained from KAJ at this research, no charcoal was identified as acacia, cf. Ben-Yosef 2010:Table 5.12]). In the Roman period, the situation changes again, and this time acacia is used as a fuel source, together with the local shrubs. The Ayyubid/Mamluk period also has its unique pattern; the woodlands of the slopes are exploited again, but this time *Quercus* (oaks) are dominant and appear more frequently than junipers (this is an interesting pattern because oaks are more rare in this region and are found only in specific niches in the upper sandstones).

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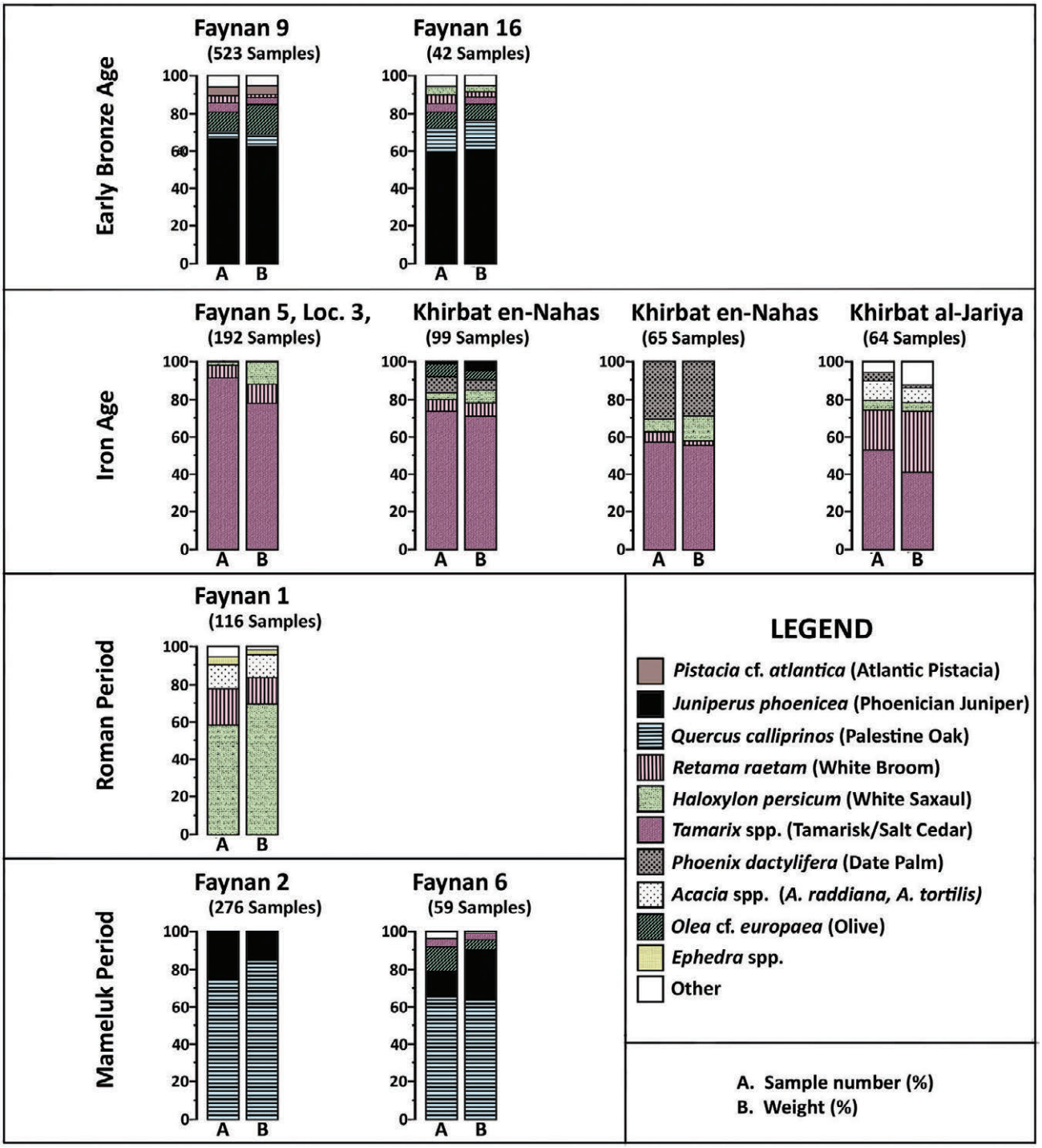

Figure 13.10 Frequency of charcoal species used for smelting in Faynan (from Baierle et al. 1989:219); 'Persian Period' Khirbat al-Jariya appears here as Iron Age according to the new dating of the site by ELRAP expedition (Chapter 12, this volume; out of the four Iron Age assemblages, Khirbat al-Jariya probably represents the earliest). Note the striking difference of fuel sources between the different periods (see text for details).

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Figure 13.11 Fuel sources in the Faynan area: (*a*) several oases in the lowlands contain lush fast-growing vegetation, including *Tamarix* (the low bushes in front of the reeds) and *Phoenix* (palm trees), two of the most common fuel sources in the Iron Age (in the picture: small oases in the sand dunes of Barqa al-Hetiye). (*b*) The acacia tree (appears also in *a*) characterizes the desert landscape and is one of the most impressive perennial plants in the 'Araba Valley and the lowlands of southern Jordan. (*c*) The wooded land on the slopes of the Jordanian plateau (looking south from Busayra region toward Wadi Dana and Faynan); the open forest consists mostly of juniper trees.

In several publications, the DBM team provides interpretations of the diachronic difference in fuel sources used for smelting in Faynan, particularly the absence of acacia in the Iron Age record. Their approach is simplistic and based on deterministic principles that exclude the human factor. For example, Engel (1993:211) suggests that

> this [the absence of acacia in the Iron Age record of KEN] could either be due to a supposed change of climate causing a withdrawal of the more suitable fuel tree species to higher elevations of the highland of Edom, or to the extinction of these species in the immediate vicinity of the copper ore smelting places, so that lowland and wadi shrub species came into use as fuel.

Or Hauptmann (2007:52–53):

> But it has to be assumed that the tree population of the 3rd millennium BCE [Early Bronze Age] was also to be found at much lower altitudes than today, when the trees are limited to the Jordanian plateau. This would certainly have been the result of much more humid weather conditions then, and it eliminates the arguments summarized under the recent slogan of 'charcoal to the ore' concerning a longer transportation route. … This [the absence of acacia in the Iron Age record] could be explained by the fact that the wadis still carried more water then.

The absence of acacia in the Iron Age archaeological record of Faynan cannot be satisfactorily explained by

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correlation to climate change or other deterministic interpretations for the following reasons: (1) the difference between the Iron Age and the current climate conditions (Ben-Yosef 2010:Section 2.3.1) is not substantial enough to significantly affect the distribution of acacia and juniper trees in the landscape of Faynan; (2) the absence of acacia cannot be explained by differences in spatial distribution of sites between the different periods, as the Iron Age site of Faynan 5 is located in the immediate vicinity of Early Bronze, Roman, and Mamluk sites, and its charcoal record presents the same pattern as the more isolated site of Khirbat en-Nahas; and (3) the argument that junipers were exploited in the Early Bronze Age because the climate was more humid and the trees grew further down the slopes and closer to Faynan cannot be simply derived from the archaeological record. This is because in the Roman and especially in the Mamluk periods, for which we have robust evidence that climate conditions were similar to the current ones, the archaeological record consists mostly of trees that grow on the slopes of the plateau. In short, one has to take into account the human factor and to apply considerations that derive from our understandings of societies and their interactions with the environment. These interactions are usually more complex than the common assumption in research originating from the natural sciences, with the best representative case being the study of paleoclimates and their impact on ancient societies (cf. Rosen 2007).

We suggest a different interpretation of the changing patterns of fuel sources through the *longue durée* of social change in Faynan, particularly the unique absence of acacia in the Iron Age (Ben-Yosef 2009). This interpretation is based on ethnographic studies of Bedouin tribes in the Sinai Peninsula (Levy 1980, 1983, 1987). These studies have demonstrated the unique place of the acacia tree in the folklore and tradition of pastoral nomads in arid zones, particularly in the southern Levant. The tree is one of the most prominent perennial plants in the floral landscape of the deserts of modern Israel, Jordan, and Egypt, and is a potential source of wood. It has a substantial stem (Figure 13.11a,b) and a higher calorific value than the common shrubs of this region, and thus it is most suitable as fuel for heating or as a strong building material. Nevertheless, among the tribal Bedouin societies of Sinai, the acacia tree is considered sacred, and a strict system of laws and customs protects it from being cut down, pruned, or damaged. Consequently, the main wood used by these desert societies originates in semi-shrubs and shrubs (e.g., *Ratama* and *Haloxylon*) and the rapidly regenerating hydrophytic vegetation (e.g., *Tamarix* and *Nerium*) when these are available (near high water table environments). Coupled with commonly accepted models for Iron Age societies in the southern Levant and in particular those for Edom, these ethnographic observations of the semi-nomadic Bedouin society are very insightful. Based mostly on archaeological evidence, historical and biblical sources, and some ethnographic studies, the common models for Iron Age Edomite societies suggest a "tribal confederation" or some other similar political structure that was founded and based on groups of semi-nomadic populations originating in the local desert area (e.g., Bienkowski and van der Steen 2001; LaBianca and Younker 1995; Levy 2008, 2009; see also Ben-Yosef 2010:Section I.IV and Chapter 10). Thus, the lack of acacia in the Iron Age record of Faynan may be interpreted as representing the practice of similar customs and values as those observed in modern Bedouin societies in the Sinai Peninsula; conversely, the same evidence strengthens the sociopolitical models for the Iron Age societies of Edom. These two ways of interpretation complement each other and emphasize different aspects of the correlation between models, archaeological data, and ethnographic evidence. Assuming that the sociopolitical models for Iron Age societies in Edom are correct (and they are based on multiple factors), and given that the desert environment is the same, the correlation with practices of modern societies with similar sociopolitical organization, or at least similar original structure (of nomadic tribes), has a strong basis. On the other hand, leaving aside the sociopolitical models of Iron Age societies in Edom and assuming that the practices observed among modern Bedouin societies represent a common means for semi-nomadic tribal societies to cope with desert environments, the lack of acacia in the Iron Age record of Faynan can be used as an additional strong argument concerning the social structure of the people in Faynan during this period and may have implications on the origin of these societies (semi-nomadic desert tribes). The latter is based on a model suggested to explain the origin of the special regard for acacia in modern Bedouin societies (e.g., Levy 1983). The model, which in itself is based on deterministic principles, basically argues that special care for the preservation of acacia trees is an essential economic strategy for pastoral nomadic societies in the desert environment,

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as the perennial and enduring tree is the only reliable source of food for the livestock (mostly goats) in times of drought. Being dependent on the survival of livestock in an extremely varied annual pattern of precipitation (Ben-Yosef 2010:Section 2.3), preserving the tree by embedding it into the society with a complex system of rules and values is in essence a long-run economic and subsistence strategy. If this mechanism is valid, the evidence from Faynan may directly indicate the presence of a pastoral nomadic society and the survival of their social values even when the main subsistence source changed to the production of copper. The lack of acacia can also stand as evidence that *tribalism* was the fundamental mechanism of social interaction in Iron Age Faynan, where collective decisions were made by a coalition of chiefs (or, to borrow an Arabic term from modern tribal societies, a confederation of *sheikhs*). In comparison to ethnographic studies of tribal organization, the leaders of such tribes were very much dependent on the support of the people. Thus, the fact that more than one leader was involved in decision making, and that all of the leaders were dependent on the support of all (male) members of the community, explains the preservation of social values that may have originated from a more pastoral-based society, even when high-calorific fuel was very much needed and the long-run subsistence of the society was not dependent on the acacia tree anymore.

From the *longue durée* perspective of charcoal use in Faynan, there is additional support for a model of *tribalism* during the Iron Age (Figure 13.10). The striking difference in fuel source patterns between the Iron Age and the preceding (Early Bronze Age) and following (Roman) periods represents well-studied differences in social structures. In both Early Bronze Age and Roman periods (and in the Mamluk), the political and social organizations were related to a wider social context than the local semi-nomadic societies; this is most notable for the Roman period, when the region was controlled by the political organization of a vast empire and its provinces. Given that the local governor and director of copper exploitation in Faynan was most probably part of the wider political system (see Friedman 2008), this person would have little regard for the preservation of acacia or the sociocultural values of the local population. Their approach to the tree environment would have been guided entirely by practical consideration and efficiency. Thus, in the charcoal record of the Roman period in Faynan, we see *all* of the fuel sources, in more or less the same proportions as their availability.

Our tentative interpretation should serve as a model for further inquiries regarding exploitation of natural resources in Faynan. Such inquiries should focus on the social components of human–nature interactions in which the physical conditions are a background for a complex system of social mechanisms. For the question of fuel patterns in Faynan, further ethnographic comparisons and more field data are required for establishing firm conclusions.

Furnaces

In Situ Furnace-Related Installations

Intact copper smelting furnaces are extremely rare in the archaeological record. In fact, only one complete Iron Age furnace is known thus far from the eastern Mediterranean, and even this furnace was reconstructed from over 60 individual fragments found at the site of Agia Varvara-Alymyras in Cyprus (Fasnacht et al. 2008; the furnace is dated to around 400 BCE). Furnaces had to be broken at the end of each smelting cycle to extract the metal chunks and copper-rich furnace slag for further processing. As a result, only the bases of furnaces and associated ground installations are usually found intact, and even these are not a common find. In the ʻAraba Valley, Rothenberg (1990) reports several Late Bronze–Iron Age intact furnace bases from Timna, and Hauptmann (2007:97–103) reports some similar remains from the Iron Age site of Faynan 5. As with the typology of tuyères (see below), there is a great similarity between furnace remains from Iron Age Faynan and Timna. In light of the new dates from Timna Site 30 (Ben-Yosef 2010:Section 6.2.1.3), we now know that there is also a significant chronological correlation and that the metallurgical remains at Timna do not necessarily represent a Late Bronze Age precedent to the Iron Age technology of Faynan but rather a contemporary operation. Thus, the finds from Timna and Faynan 5, as well as their interpretations, are fundamental to our analyses of furnace-related finds from the new excavations (here mostly from Khirbat en-Nahas).

In our ELRAP investigations, only a few excavated contexts were interpreted as intact furnace bases or related installations. All of these are at Khirbat en-Nahas, except from an accidental find at Timna Site 30 (see below). The probes at Khirbat al-Jaryia (KAJ), Khirbat al-Ghuwayba (KAG), Rujm Hamrat Ifdan (RHI), and

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Khirbat Hamra Ifdan (KHI) in Faynan did not yield any intact finds related to furnaces; therefore, most of our understanding of the shape, size, and construction methods of Iron Age furnaces is based on meticulous analyses of furnace fragments (FF) that were recorded and collected by the thousands. In contrast to the relatively standardized construction of tuyères (below), it appears that smelting furnaces had a variety of shapes and sizes, yet all conform to some basic principles and are made of the same basic materials.

In Area M at Khirbat en-Nahas, only one furnace base was found in situ (Figure 13.12). It was uncovered during the 2002 excavation season and dismantled during the 2006 excavations. The remains are of a semi-circular feature, located in "Horizon 6" in the upper part of the probe into the "slag mound" (see Ben-Yosef 2010:Figure 5.33 and Chapter 2, this volume); this is part of Layer M1 of the 2006 excavations, the latest phase of copper smelting at KEN. The feature was interpreted as a partially destroyed furnace, with its upper part completely missing. The interior diameter of the furnace was around 70 cm. The walls were relatively thick (ca. 15 cm) and preserved to a height of 20 to 30 cm. The bottom of the furnace was not preserved. Inside the area defined by the furnace walls was an extremely high concentration of furnace fragments with almost no sediment. Under these was ashy sediment with a very high concentration of charcoal. Large tap slags were found directly under the furnace.

Some features of the furnace base of KEN-M are similar to another furnace base documented by Ben-Yosef (2010) at the site of Timna 30. The latter was uncovered by accident as a result of unsupervised maintenance work during the 1990s and apparently had never been properly documented (Figure 13.13).[8] Like the furnace base at KEN-M, this base is also a semi-circular feature with around a 70-cm interior diameter and quite thick walls (ca. 20 cm). The material of the walls, rough clay with slag inclusions, is also similar to the KEN-M furnace. The preservation of only half of the original furnace base in both cases may be just coincidental, but this may indicate that deliberate breaking of such furnaces took place from one side only, probably the one in which the tapping process took place. Unfortunately, it is hard to determine the exact stratigraphic context of the furnace at Site 30. It is likely that it represents the same period (ninth century BCE) as the furnace at KEN-M (described above) and thus belongs to Layer 1 of Site 30.

In the metallurgical complex of KEN-R (Ben-Yosef 2010:Section 5.2.4.1), two areas were interpreted by us as remains of furnace bottoms (L123 and L106, 2009 excavations, Figure 13.14). These remains were found directly adjacent to roughly built walls (one row



Figure 13.12 Furnace base at KEN-M, L510. Semi-circular in shape, interior diameter of around 70 cm; walls 15 to 20 cm thick, preserved to a height of 20 to 30 cm. The furnace extended into the eastern balk of the probe; in order to try and define the rest of it, the probe was extended ½ meter east into square HHH27 (L517). The furnace extended only a few centimeters into HHH27. Inside the furnace was an extremely high concentration of furnace fragments with almost no sediment. Under these was an ashy sediment with a very high concentration of charcoal. Some wood was also found and collected (EDM 80337). The bottom of the furnace was not found probably because it was ripped out after the smelting to extract the copper. Large tap slags were found directly under the furnace. A tap slag fragment can be seen here in the center of the furnace.

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Figure 13.13 Furnace base accidentally uncovered during maintenance work at Timna Site 30 and first documented in the current research. *Photo: R. Shaar.*



Figure 13.14 Remains of furnace bottoms (?) in the metallurgical complex of Khirbat en-Nahas, Area R.

of stones in width, several courses in height), which are part of a larger structural complex (Figure 13.14). Initially, the walls and the enclosed spaces were interpreted as remains of buildings that preceded the metallurgical activity; however, in the current research, we show that these walls were in fact *part* of the metallurgical activities and had an important function for maintaining spatial divisions and organization of the intense labor at the smelting area (see Ben-Yosef 2010:Sections 5.2.4.1 and Section 13.3.9). One area, L123, is a large concentration of furnace slag and furnace fragments (2 x 0.8 m), constituting a rather thick accumulation (0.4 m) attached to wall L106. The other, L124, is a similar cluster of badly preserved furnace fragments and furnace slag measuring 1.5 x 1 m and 0.5 m thick, attached to wall L094. Based on the distinct layout of the furnace fragments (including base fragments), we interpret the cemented conglomerates of furnace slag,

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Figure 13.15 Khirbat en-Nahas, Area R, the metallurgical complex. The unexcavated patch in the front of the photograph and attached to wall L104 is one of the best-preserved furnace-related installations at the site.



Figure 13.16 A dome-shaped furnace-related installation at KEN-R (L145); also visible is the stone and slag installation L151 between the dome-shaped installation and wall L104 (Figure 13.20). The dome-shaped installation is probably a slag pit of the most advanced, ninth-century BCE smelting technology (see text for details).

charcoal, and clay fragments (some of the latter had finger imprints and may be intact) as the remains of furnace bottoms from the last phase of activity at this area. It is quite different from the regular dumps of metallurgical waste commonly found at KEN.

Near the "furnace bottom" remains of Area R, L123, one of the most well-preserved tuyères (31 cm long, 15 cm wide) was found on top of a bed of charcoal (L071). The tuyère is adjacent to wall L106 and was presumably found in situ, or at least very close to its original position relative to the furnace. Oriented samples were taken from the slag adhering to the mouth of this tuyère in order to test whether it is indeed in situ, although no other intact furnace remains were observed.

In the same metallurgical complex of Area R, one of the best-preserved furnace-related installations was uncovered (L142, 2009 excavations). This furnace was already identified as a unique feature during the 2006

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Figure 13.17 A close-up of the dome-shaped furnace-related installation at KEN-R (L145).

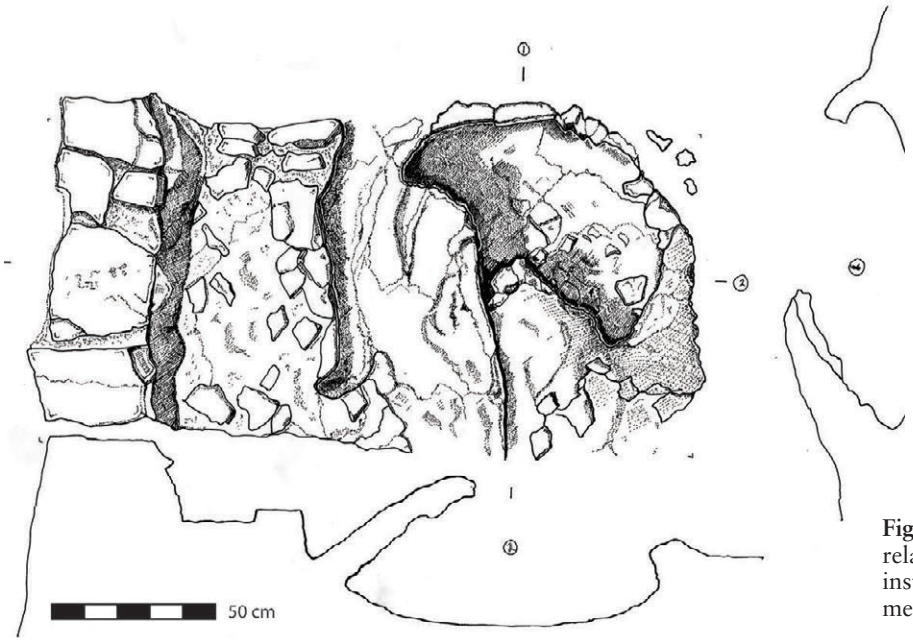

Figure 13.18 Drawing of the furnace-related installation L145, stone and slag installation L151, and wall L104 at the metallurgical complex of KEN-R.

excavations and was left untouched due to time constraints (Figure 13.15). More details can be found in Chapter 1 (this volume) concerning the excavations in Area R at KEN.

The furnace-related installation is a saucer-like structure with a basin measuring 1.01 x 0.80 m across (Figures 13.16–13.19). The hard clay walls are 5 cm thick. It survives to 0.31 m high at the spot where it appears to begin to curve upward to allow an opening in the center of the dome. The base of the furnace is free of slag, although slag was found adhering to curved pieces of the installation, believed to be the neck of it near the opening.

The remaining top parts of the furnace-related installation's dome are adjacent to a rectangular installation composed of small stones and chunks of slag

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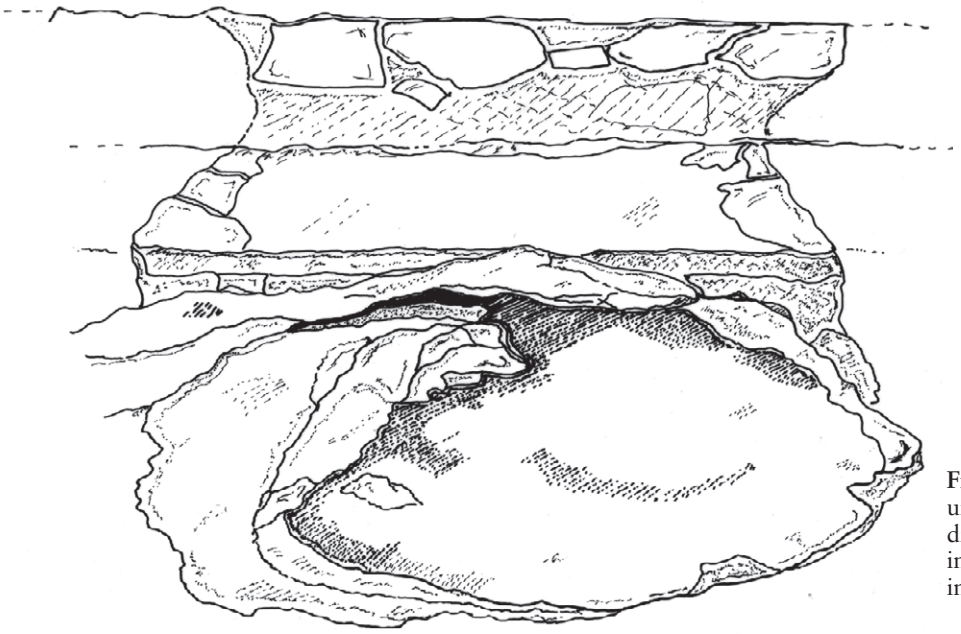

Figure 13.19 Another view of the unique installation at KEN-R: drawing of the furnace-related installation L145, stone and slag installation L151, and wall L104.



Figure 13.20 The stone and slag installation L151, KEN-R.

(R09L151, Figure 13.20). Two dimpled hammer stones were reused in the construction of this installation. This installation bridges a gap between wall R09L104 and the furnace-related installation itself. The purpose of the installation remains unknown, but we suggest it served either to support the furnace-related installations or as a foundation for metallurgical/smelting activities. The installations in this area were all covered by a thick layer of ash, slag, and baked clay furnace material (R09L135).

The furnace-related installation at KEN-R is similar to two previously excavated installations. One is L10, Layer 1 at Timna Site 30 (Rothenberg 1980:198–203; 1990:46–48) (Figure 13.21), and the other is L2 in Site 5 at Faynan (Hauptmann 2007:101–103) (Figure 13.22). The installation at Timna is also a dome-shaped

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structure with an inner diameter of around 90 cm (cf. 80 x 101 cm of the installation at KEN-R), interpreted as a "pyrotechnological installation" (Rothenberg 1990:47). Rothenberg (1990:47–48) is careful about calling this installation a furnace:

> The large diameter of the underground structure makes it difficult to see this installation as a smelting furnace, although it is quite possible that originally Locus 10 had been a smelting furnace of smaller dimensions which became deformed and damaged beyond repair by continuous use and was subsequently in secondary use for storage. When found, Locus 10 contained a 10 cm thick deposit of tiny slag fragments (0.3–0.5 cm), and may well have been a store of tempering material. […] In any event, Locus 10 serves as good evidence for the construction methods of Iron Age II furnaces in Timna.

The dome-shaped structure at Timna 30 was also constructed a short distance from a wall, and also here a stone "pavement" was found in between the installation and the wall (see Rothenberg 1990:Figure 70). At Faynan 5, one of the best-preserved smelting-related installations was found in L2, and it also has a dome-shaped part that is very similar to KEN-R (similar, not well-preserved features, also have been found in L1 and L4). Hauptmann (2007:101–103) briefly describes the installation and suggests interpretation of the dome-shaped feature:

> The construction has a flat, circular depression in the middle, which is covered by a dome. A comparison with the Iron Age tap slags indicates that *the depression is the slag-tapping pit of a furnace*. The entire construction is made from slag-tempered clay and is only weakly fired. The inner diameter of the

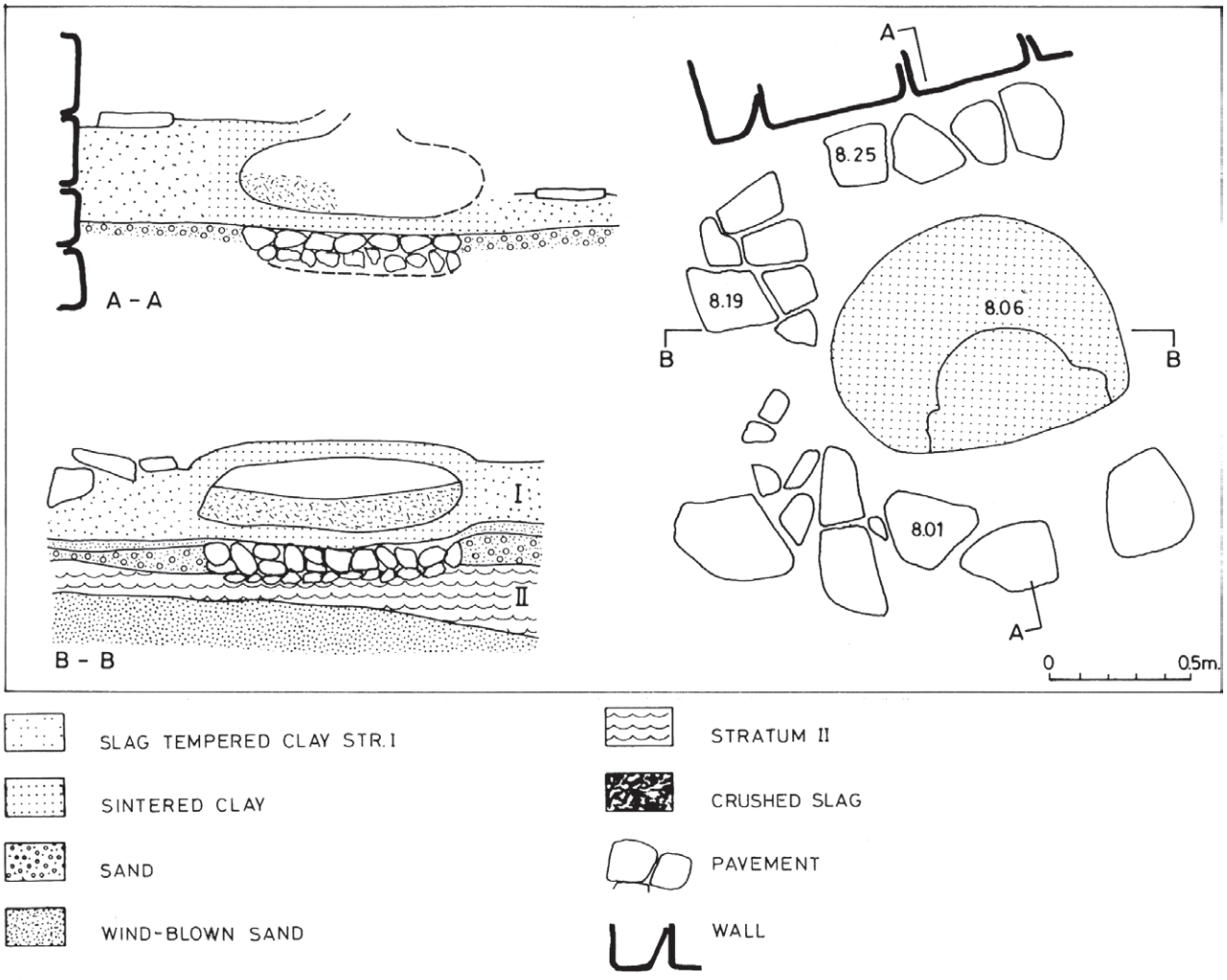

Figure 13.21 Site 30, Layer 1, L10 (Rothenberg 1990:47); the dome-shaped installation is similar to L145 at KEN-R; note that also the context is similar—near a stone "pavement" separating the installation from a wall.

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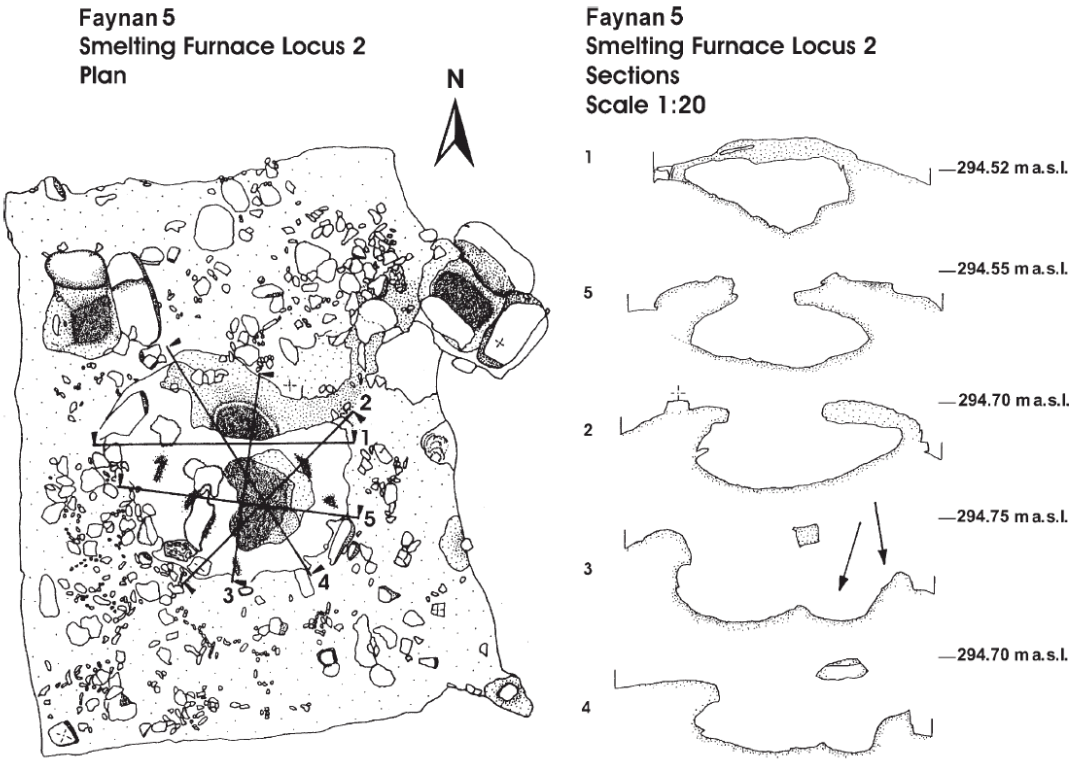

Figure 13.22 Faynan 5, L2 (Hauptmann 2007:102); a dome-shaped installation similar to L145 from KEN-R. The installation was interpreted as a slag pit, located in front of a furnace (which is represented by a heavily sintered base, indicated with arrows in the section on the right).

> lentil-shaped pit is at most 1 m, the height in the middle up to 40 cm. The dome has in the middle an opening towards the top, where the impressions of vertically set slag or stone plates are very clearly recognizable. … A second hole opens at the slope. The dome-covered tapping pit leads, via a small threshold, into a smaller hollow, which is almost completely vitrified and slagged due to intense heating … this hollow might possibly represent the last remains of the furnace combustion chamber, while the furnace upper walling is completely destroyed.

The interpretation of the domed installation as a slag pit located in front of a furnace is appealing, as it may explain a few of the field observations, particularly the size and shape of the depression and the lack of tuyère holes. However, it is not clear for what purpose the slag pit should have been so carefully constructed and why it should have had a dome with a central opening.[9]

The new excavations at Timna 30 and the high-precision radiocarbon dates obtained as part of the current research (Ben-Yosef et al. 2012) indicate a ninth-century date for Layer 1. A similar date, also based on radiocarbon analyses, was obtained for the site of Faynan 5 (with one date associated with L2, 889–789 BCE, 68.2 percent probability; see Table 5.2). These dates support the interpretation suggested in the current research that the archaeometallurgical complex at Area R represents the latest stage of copper metallurgy at Khirbat en-Nahas and dates to the ninth century BCE. This date has been supported (or at least not contradicted) recently by new radiocarbon measurements from this area (see Chapter 2, this volume). The dome-shaped installations and the semi-circular features described above (from KEN-M and Timna 30) represent the intact finds of the ninth-century BCE copper production technology. From the earlier phases of Iron Age copper production, only some "working surfaces" and stone-built installations that are probably related to smelting activities were found in situ. Such features are most notable in the deep sounding into the "slag mound" of KEN-M (Figure 13.23).

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Figure 13.23 Stone installations at KEN-M. These are probably related to smelting installations of the twelfth to tenth century BCE (supporting furnace bases and/or walls; see text for details). (1) EDM 91242, L678; (2) EDM 90351, L629; and (3) EDM 91249.

Furnaces—Upper Structure

The evidence for the upper furnace structure is based entirely on fragments. Even in the (relatively) well-preserved smelting installations of the ninth century BCE, it is only the dome-shaped dome-shaped pit (slag pit?) that was found intact, while the furnace itself is reconstructed according to the (supposed) nearby base. In Timna Sites 30, 185, and 2, several furnace bases have been excavated and interpreted as Egyptian New Kingdom (Late Bronze Age) installations (Rothenberg 1990). According to the reports of the 'Araba Expedition, there is high variability in furnace shapes in the main phase of copper production in Timna. However, to carefully assess their conclusions, we must acknowledge the difficulties in Timna's chronological framework discussed previously (Ben-Yosef, Tauxe, et al. 2010; see especially Ben-Yosef 2010:Chapters 4 and 6). First, the finds from the "New Kingdom phase" in Timna Site 30 (Layers 2 and 3) (Rothenberg 1990:8–12) should now be regarded as Early Iron Age (late twelfth to tenth centuries BCE), and probably the same revision should be applied to the furnace at Timna Site 185 and at least to some of the furnaces at Site F2 (Ben-Yosef, Tauxe, et al. 2010). Second, some of the furnaces at Timna Site 2 may represent much later (early Islamic) installations. This is very likely especially for furnaces "Z" and "I" that yielded late radiocarbon dates (Rothenberg 1990:71; all dates are mentioned and briefly discussed only in the endnotes) (FuZ: BM2242, 1400 ± 100 [543–767 cal. CE, 68.2 percent probability, OxCal 4.1, IntCal09, ©C. B. Ramsey 2010]; FuI: Grn 4381, 1350 ± 50 [640–766 cal. CE, 68.2 percent probability, OxCal 4.1, IntCal09, ©C. B. Ramsey 2010]). Only Furnace IV in Site 2 yielded an Early Iron Age date (H3625-2782, 2940 ± 50 [1257–1056 cal. BCE, 68.2 percent probability, OxCal 4.1,

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IntCal09, ©C. B. Ramsey 2010]), but also the connection between the sample and this furnace installation is questionable. Regarding the complex evidence from Site 2, the present author agrees with the conclusion of Avner and Magness (1998:n7) that the *ring slag* (but not all "cake slag") represents only Nabataean or later smelting technology.[10] This is supported, in addition to the late radiocarbon dates, by our observation that Timna 2 is the *only* archaeological context out of the entire "Late Bronze/Iron Age" smelting record in which such ring slag has been found (for definition of ring slag, see under 'Slag,' this chapter).

Although the furnace fragment collection from ELRAP is probably as comprehensive as the nature of the archaeological record allows (excluding possible future accidental discoveries), and although it provides important new data on furnace structures, it is still relevant to reiterate what Bachman and Rothenberg (1980), and later Hauptmann (2007:103), have stated:

> It has to be emphasized that neither in the Iron Age smelting sites of Faynan nor at those in Timna have there ever been any finds or contexts which would have allowed a realistic reconstruction of the smelting furnaces. … It is therefore quite probable, also following comparisons with other smelting sites, that the smelting furnaces have systematically been destroyed after each smelting process.

Nevertheless, the large sample size we currently have from Iron Age smelting contexts allows us to reconstruct at least some basic components of such furnaces. Evidence from Timna (Rothenberg 1990), smelting experiments (in particular Merkel 1990), and analytical investigations (in particular Al-Shorman 2009; Tite et al. 1990) also supports basic models of furnace reconstruction for this time period (Late Bronze–Iron Age).

Smelting furnaces *throughout* the Iron Age are primarily made of clay. Small stones, often found in "slag mounds," may have been used in the construction of furnaces, as part of the foundations or for propping up the (usually heavy) clay upper structure (at KEN-M, we have recorded several dozen "furnace stones"). They may have also been used for delineating slag pits (as was recorded in a few of the furnaces at Timna Site 2). Such stones usually show heat impact such as cracks, spalls, and blackened faces; they are roughly trimmed, usually rectangular and flat, on the scale of 15–30 x 20–40 cm. Most of these stones were not found in situ; however, in some contexts (e.g., Figure 13.23:2), they probably represent their original layout as supporting a bottom of a furnace. The use of stones for supporting a furnace is evident in Timna, where stones were used to support the base (located beneath the furnace; cf. Rothenberg 1990:Figure 2) and/or as a support for the clay walls at the nontapping sides of the furnaces (e.g., Furnaces I, II, IV, VII, VIII; cf. Rothenberg 1990:Figures 32, 40, 42, and 52).

According to our preliminary investigation of hundreds of well-preserved furnace fragments, the same type of furnace clay was used *throughout* the Iron Age. This local clay is very coarse, reddish pink, and contains a large quantity (up to 30 volume percent) of crushed slag, up to 5 mm in diameter (Figures 13.24, 13.26–13.31). However, both at Timna Sites 30, 2, and 185, and in Faynan Site 4, remains of clayey materials that do not contain crushed slag and that are tempered with quartz grains were reported as furnace fragments (or furnace linings) from the earlier stages of Iron Age copper production (or Late Bronze Age, according to the commonly accepted date for Sites 2 and 185). Rothenberg (1990) describes this material as "clay-like mortar" that was used as lining in bowl-shaped furnaces dug in the ground (Timna 30 and 185) or stone-built furnaces (Timna 2), and Tite et al. (1990:173) describe this clay in further detail (furnace walls containing 0.1 to 1 mm in diameter quartz grains, but deliberate tempering is questionable). Al-Shorman (2009:208–212) analyzed one fragment of furnace lining from Faynan 4 and reported it to be made of high calcium clay with quartz inclusions (and probably mixed with straw). This fragment also had no slag inclusions, and according to Al-Shorman, it represents a continuation of the "Early Bronze tradition" in the area.

Technological remains from the latest phase (ninth century BCE) of copper production at Khirbat en-Nahas contain the best-preserved and most abundant furnace fragments. These fragments constitute a large portion of the collection because of the intensive excavations at the metallurgical complex of Area R, which represents the ninth-century BCE technology. As a consequence, our reconstructions are mostly based on the Area R remains, and extrapolations of earlier Iron Age technologies may be biased. However, even in the earlier contexts, we found furnace fragments that contain large amounts of crushed slag (e.g., in KEN-M, L636 and L660; Khirbat al-Ghuwayba [KAG], Area E,

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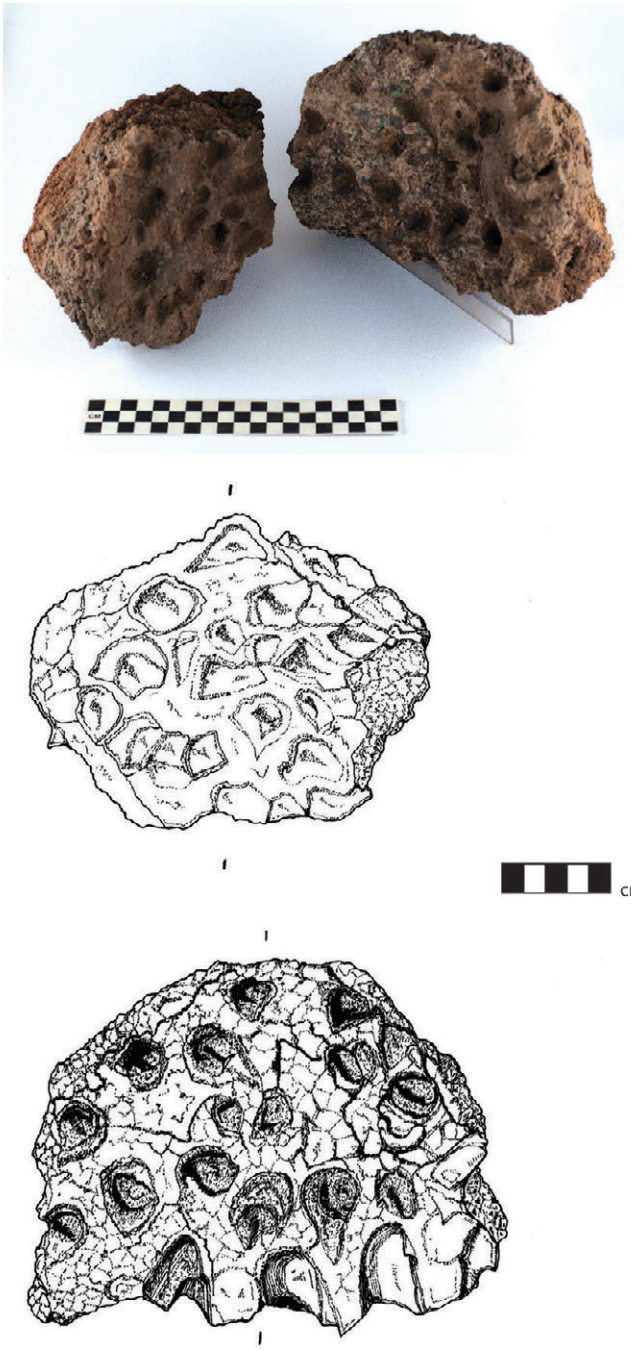

Figure 13.24 (*a*) Well-preserved furnace fragments; inner lining with fettling marks (finger imprints) on the clay. Heat impact is visible, including blackish residues (KEN-R, late tenth- to ninth-century copper production, EDM r09f0978, L079, B0861) (cf. Figure 13.24b). (*b*) Furnace fragments with finger imprints on the inner linings; note the distinct two layers of clay used in furnace construction (EDM 0978, L079, B0861); see photo in Figure 13.24a.

L008; Figure 13.31). In the current stage of research, we could not pinpoint a distinct technological transition based on furnace fragments alone; the major technological change, evident in the record of tuyères, has to be correlated with a change in furnace structure, but for now this change has been assessed only qualitatively (below).

Based on petrographic and chemical analyses of two fragments of typical furnace lining from Khirbat en-Nahas, A. H. Al-Shorman (2009:208–212) has found that the coarse slag fragments constitute approximately 15 to 30 volume percent of the clay. The clay itself (illite and montmorillonite) is low or noncalcareous, with CaO content ranging between 4.8 and 7.7 weight percent, silica 55.3 to 60.8 weight percent, and alumina 10.8 to 11.6 weight percent. Noncalcareous clays were used as furnace linings also in Timna Site 30 (both in Layers 1 and 2) (Tite et al. 1990). Given that

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the temperature range for smelting copper is 1,100 to 1,200°C (cf. 600–1,050°C for ceramics; Maniatis and Tite 1981), furnaces should be designed to survive temperatures of 1,150 to 1,200°C without total collapse or large-scale bloating. The typical furnace clay (with slag inclusions) is *not* a refractory material; in fact, only the material constituting the front part of the tuyères was suitable for such temperatures (however, this material is less stable and needs special treatment; see below). The crushed slag probably did help with heat resistance to some degree; it was deliberately used as temper mostly to reduce shrinkage and distortion, as well as to allow the escape of volatiles that evolved from the clay (Freestone 1989).[11] They also help to achieve the rigidity needed for the furnace walls to retain their shape prior to firing (Tite et al. 1990). By examining the slag inclusions from furnace clay from Timna 30, Layer 1, Tite et al. (1990:170) argue that the crushed slag was reheated before being used as temper (based on petrographic evidence—no angular boundaries, oxidation zone at their outer boundaries, etc.).[12]

Instead of using refractory clay for furnace walls and lining, we believe that the solution to the heating and distortion problem was building relatively thick furnace walls consisting of multiple layers (Figure 13.24; these are the first to decompose by breaking apart along the seams between the clay layers, and thus multilayered furnace walls are rarely found intact). The clay has low thermal conductivity, which would have resulted in only the thin surface layer of the ceramic reaching high temperatures: a temperature of 1,100°C is typically reached at a depth of 5 mm after the surface of the ceramic has been exposed to 1,150°C for about two hours (Tite et al. 1990). The furnace linings that were exposed to heat are sintered and in some cases slagged; they tend to flake off and are often found as thin, relatively flat fragments in "slag mounds." The main body of the furnace was cylindrical, averaging 30 to 50 cm in diameter. Some rare evidence for the use of cloth in the construction process was found on several furnace fragments (Tite et al. 1990:Figure 27:5). The cloth was probably used to stabilize the unfired furnace structure and was laid between different clay layers of the furnace wall. A more common find are furnace fragments with finger imprints, remains of hand fettling with the furnace clay (Figures 13.24 and 13.25). The same pattern was found in Timna (Rothenberg 1990 and also the new excavations Ben-Yosef 2010:Figure 13.25.4).

An indicative type of furnace fragment is the "double-curve" or the "S"-shaped furnace wall (see in particular Figures 13.28 and 13.29). This represents the middle portion of a pear-shaped shaft furnace (Figure 13.32). In Timna, this furnace shape has been considered as representing only the later, ninth-century technology (Timna 30, Layer 1) (Rothenberg 1990:46, and in particular Figures 67 and 68). However, in Faynan, it seems that this shape had precedents in the earlier Iron Age (e.g., Figures 13.28:1, 4, both are from deeper contexts of Layer M3; and more). The dimensions given by Rothenberg (1990) are similar to ours: an upper shaft of approximately 20 cm in diameter and lower shaft of approximately 40 cm, with *rounded* corners at the bottom. The proposed location of the tuyères, right at the curve (Figure 13.32), is supported by the evidence from KEN. There is a distinct "slag line" representing the level of the molten mixture and the active smelting area that had been located just in front of the tuyères (Figure 13.28:2–3). We found one fragment with a rim (Figure 13.29); this seems to be a unique find so far from the 'Araba Valley. This fragment shows that the upper shaft was rather short, about 15 to 18 cm from the beginning of the curve. Another unique find is probably an "imprint" of a furnace base (Figure 13.30). This fragment is a detached furnace bottom composed of heavily sintered clay and some copper droplets. The fragment shows that the bottom of the furnace had rounded corners and that the lowest most part of the furnace was approximately 15 to 20 cm in diameter (while the diameter of the lower shaft is about 40 cm).

In the current stage of research, it is still difficult to suggest a satisfactory reconstruction of furnaces from the early part of the Iron Age (twelfth to tenth centuries BCE), and our understanding of furnace construction in later phases (late tenth to ninth centuries BCE) is only somewhat better. The state of preservation of furnace fragments at KAJ, KAG, and Layers 2 to 4 in the new excavations at Timna 30 is poor, as are fragments found in the deeper layers of "slag mound" of KEN-M. The substantial difference in the state of preservation between the two technological phases is shown in the average fragment weight (AFW) values in Table 13.1 (see also Figure 13.1). While the recording methods applied during the ELRAP's 2006 field season at KEN were the same in all excavation areas, the metallurgical complex at Area R has an AFW three times more than the AFW of the sounding at the Area M "slag mound" (502 vs. 162 kg, respectively). This is not accidental:

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Figure 13.25 Representative furnace fragments with finger imprints of the artisan who constructed the walls and linings.

#	EDM #	Site	Area	Locus	Basket	Comments
1	91285	KEN	M	682	9983	Reddish clay with slag inclusions and fingers imprints
2	90121	KEN	M	612	9048	Pinkish clay, finger imprints, a layer of lining without slag attached to slag-rich furnace wall
3	90788	KEN	M	647	9590	Finger imprints on a furnace fragment
4	NA	T30	S	900	NA	(From the section's collapse at the "slag mound"), finger imprints on a lining layer of a furnace fragment (cf.2)

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Figure 13.26 Examples of furnace walls from KEN.

#	EDM #	Site	Area	Locus	Basket	Comments
1	90432	KEN	M	629	9280	Furnace wall, section, clay with slag inclusions
2	12043	KEN	M	629	9181	Furnace wall, smooth inner lining
3	90360	KEN	M	629	9213	Furnace wall, multiple layers of linings
4	R09f0979	KEN	R	073	0962	Furnace wall, heat impact

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Figure 13.27 Various furnace fragments from ELRAP excavations.

#	EDM #	Site	Area	Locus	Basket	Comments
1	12047	KEN	M	629	9205	Rim fragment (?), typical reddish clay with slag inclusions
2	12130	KAJ	A	105	3196	Furnace fragment with marks of fettling fingers
3	90814	KEN	M	647	9610	Curved furnace fragment
4	90581	KEN	M	636	9417	Curved furnace fragment with a thinning edge
5	12060	KEN	M	660	9758	Furnace fragment with cloth marks on one face
6a	12176	KEN	M	732	10429	Furnace fragment; (*a*) back side, reddish clay, marks of fettling fingers (?), (*b*) front (inner) side, slag coating, bloating, heat impact
7a	10034	KEN	M	629	9270	Three views (*a, b, c*) of a furnace fragment; note the curve, the clay layers, and the heat-impacted face

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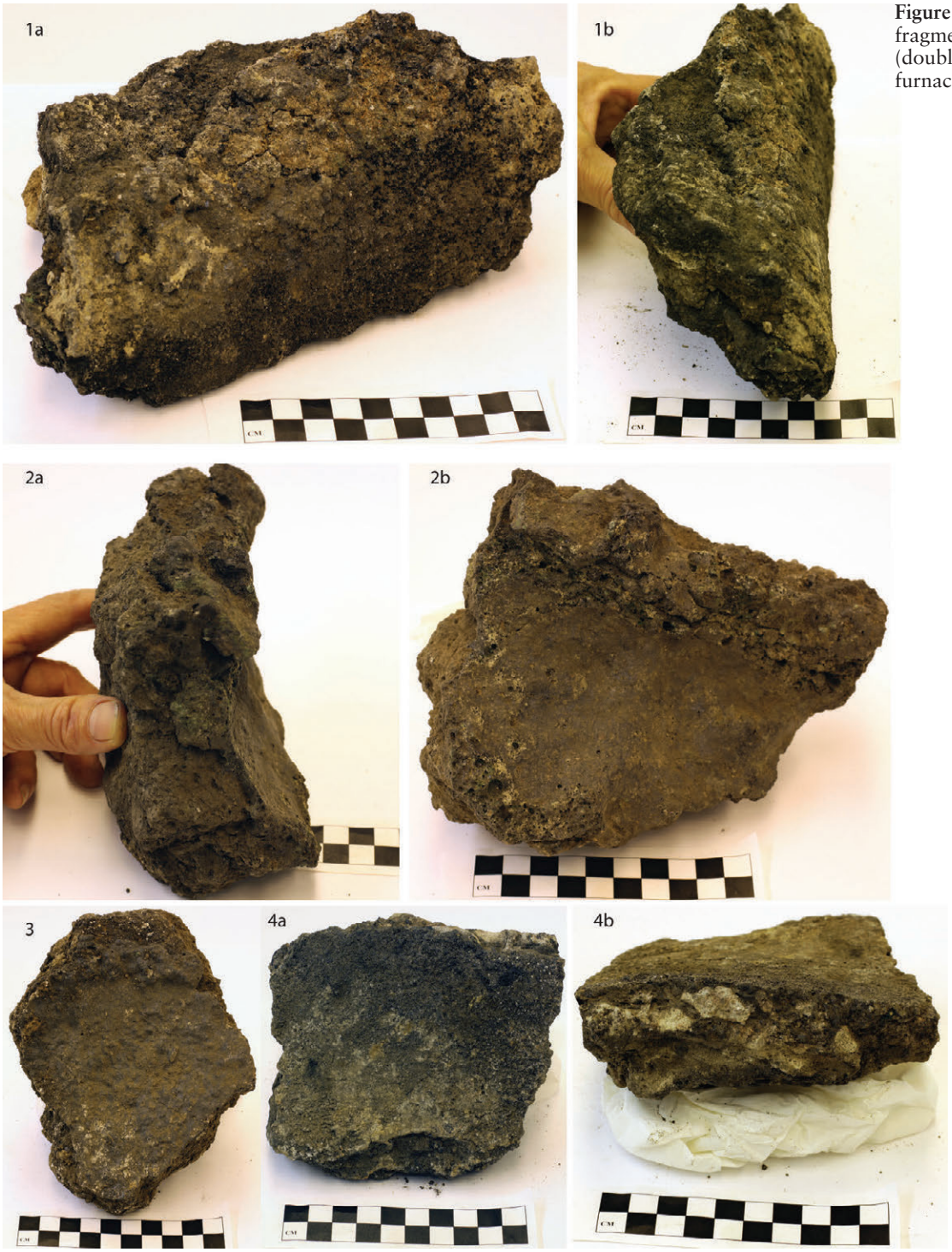

Figure 13.28 Various fragments of the S-shaped (double-curved) part of furnaces from KEN-M.

#	EDM #	Site	Area	Locus	Basket	Comments
1	90657	KEN	M	636	9479	Two views (*a* and *b*) of the upper part of the "S" section in a furnace wall
2	90313	KEN	M	629	9197	Bottom part of the "S" section in a furnace wall; side (*a*) and front (b) views; note the distinct "slag line" indicating the level of the molten mixture in the furnace
3	91492	KEN	M	767	10136	Bottom part of the "S" section in a furnace wall; note the distinct "slag line" indicating the level of the molten mixture in the furnace
4	91015	KEN	M	665	9778	A front view and a section of furnace wall

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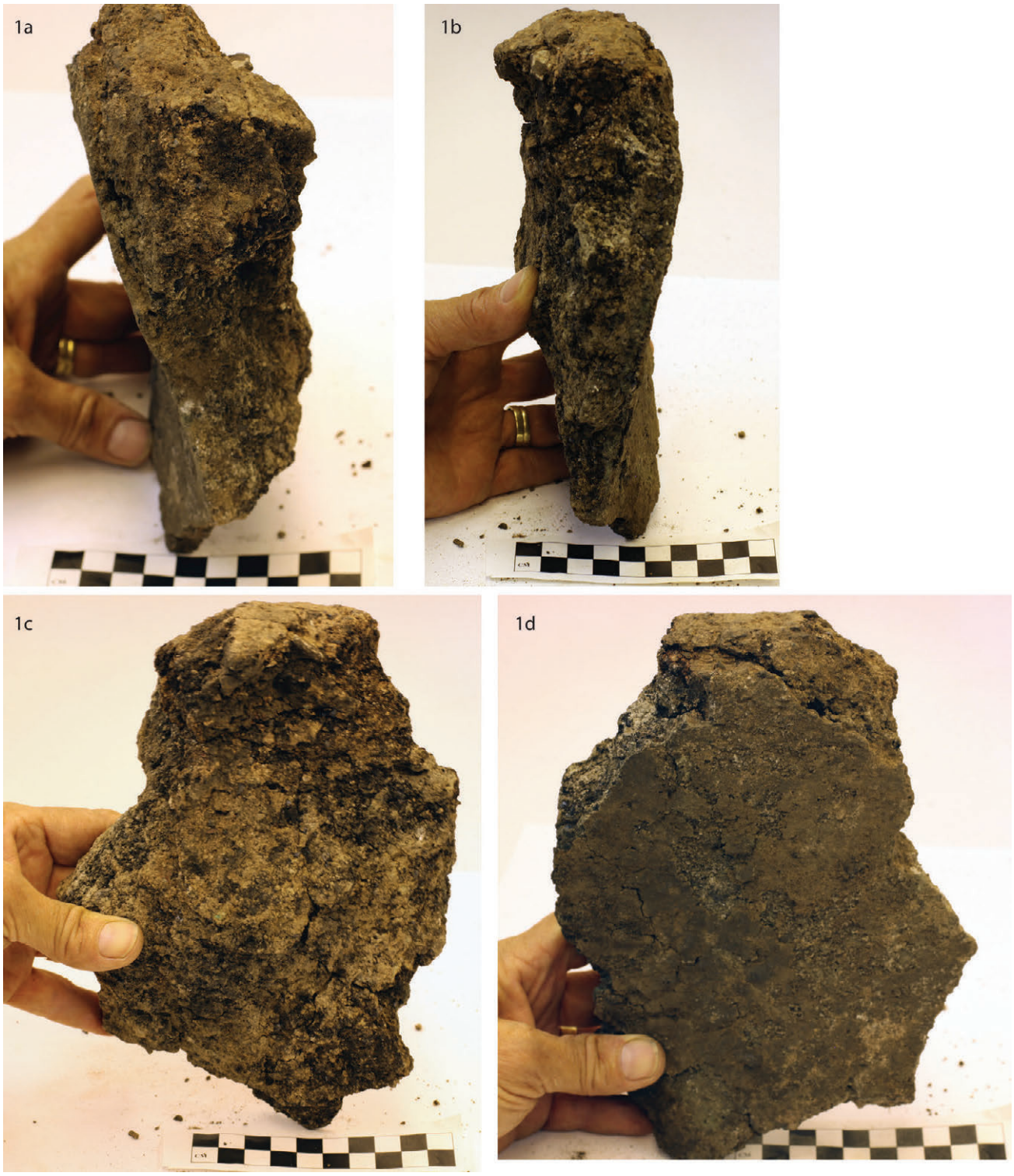

Figure 13.29 Well-preserved furnace fragment, including furnace rim, KEN-M.

#	EDM #	Site	Area	Locus	Basket	Comments
1	91795	KEN	M	745	10541	Four different views of a furnace fragment with a rim

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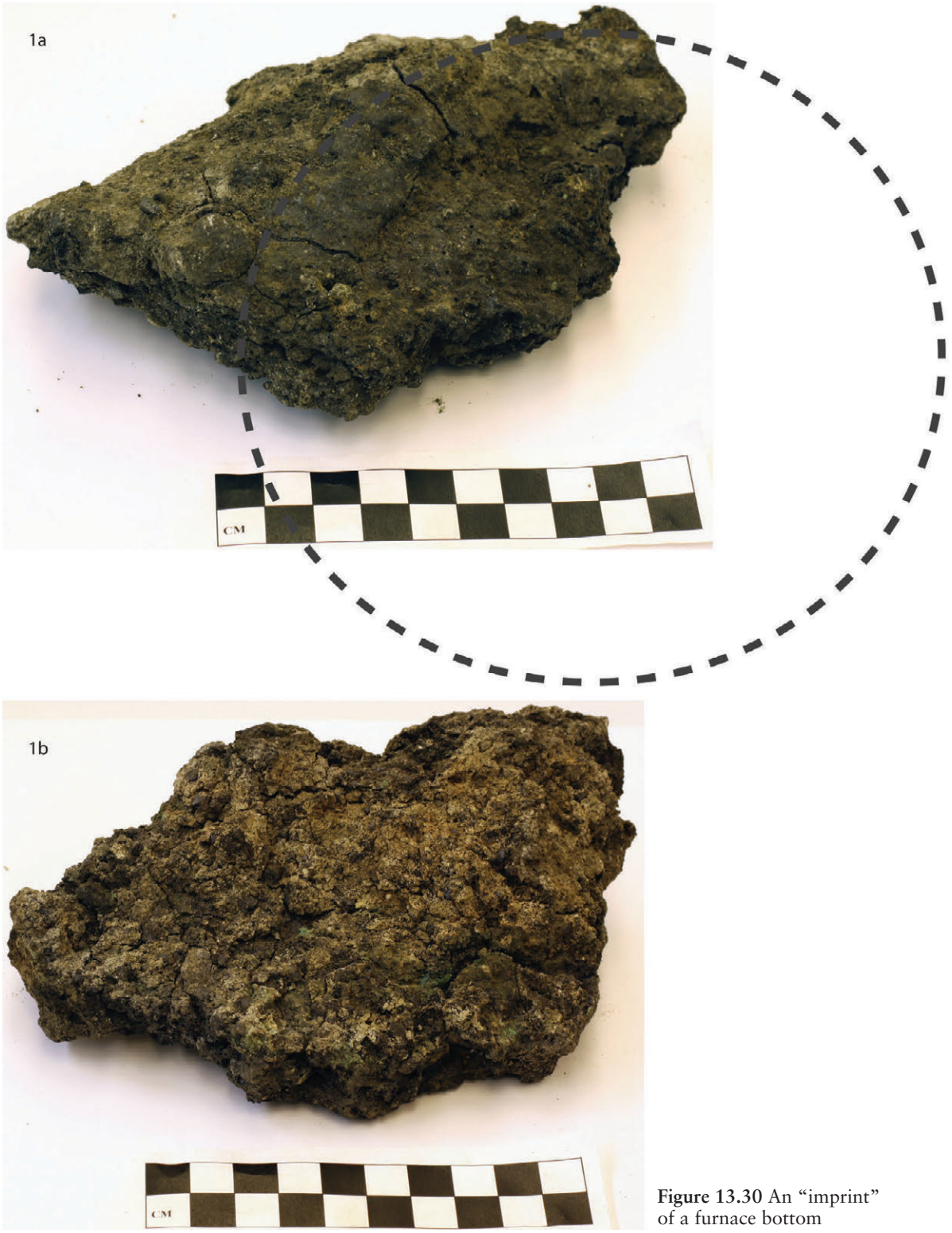

Figure 13.30 An "imprint" of a furnace bottom

#	EDM #	Site	Area	Locus	Basket	Comments
1	90649	KEN	M	641	9471	Layer M2b, the sounding into the "slag mound," an "imprint" of a base of a furnace (*a*: upside down, *b*: upside up); heavily sintered clay that flaked off the furnace bottom

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Figure 13.31 Furnace fragments from Khirbat al-Ghuwayba, Area E; the clay contains large amount of slag inclusions (EDM 0113, L008, B99).

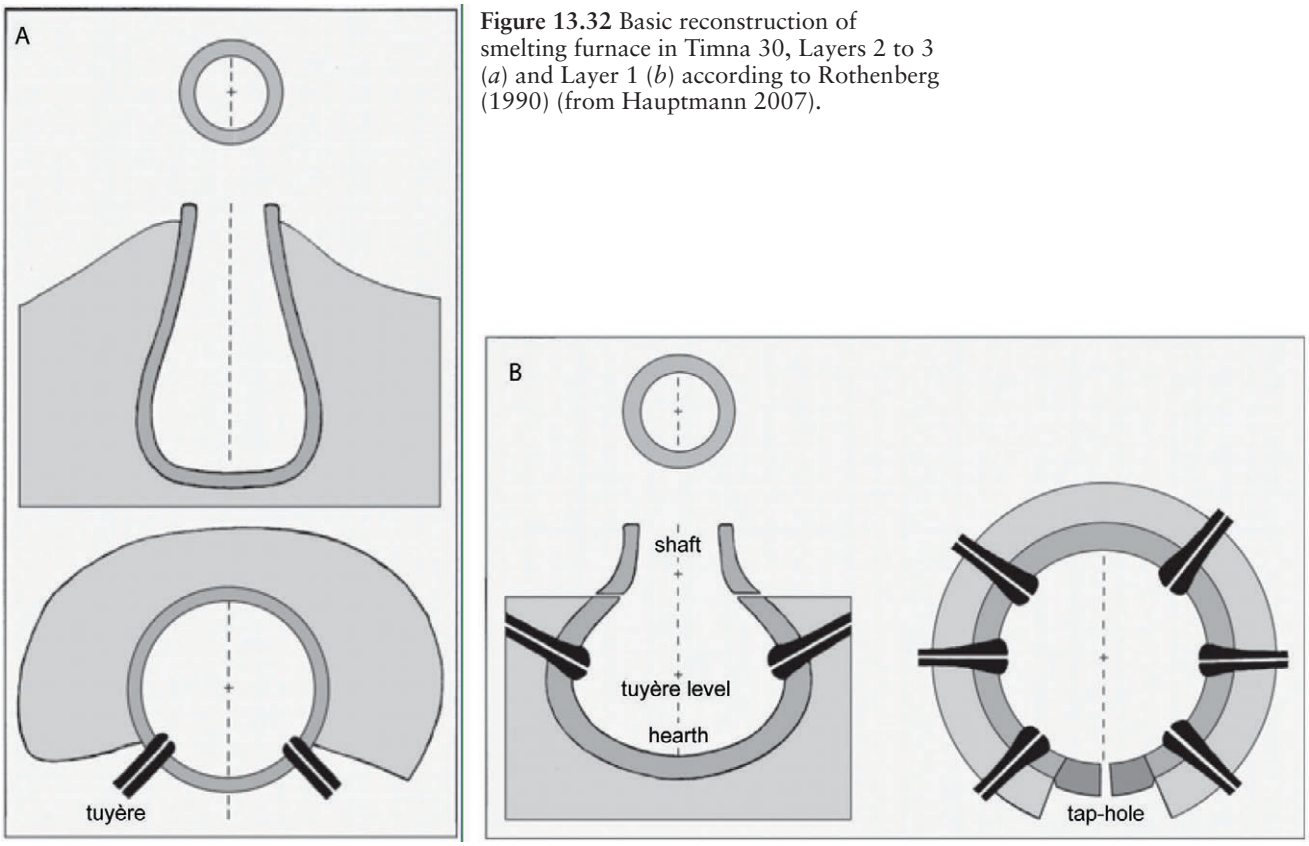

Figure 13.32 Basic reconstruction of smelting furnace in Timna 30, Layers 2 to 3 (*a*) and Layer 1 (*b*) according to Rothenberg (1990) (from Hauptmann 2007).

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the excavated contexts at Area R contain remains of the most advanced, ninth-century BCE technology, while most of the 2006 sounding in Area M was done in earlier contexts (the ninth-century BCE metallurgical debris was excavated during the 2002 field season). This difference stands as evidence of substantial change in furnace construction techniques and probably also furnace operation procedures between the two major technological phases evident in the Iron Age archaeometallurgical record of the 'Araba Valley (and defined in the current research; see Ben-Yosef 2010:Chapter 8 and below). Most of the S-shaped fragments discussed above and other parts of the pear-shaped furnaces came from late contexts; however, as mentioned above, some are from earlier contexts and suggest *continuity* in the basic shape with a possible change only in dimensions. Based on the typical slag and tuyères of each of the two main technological phases of the Iron Age, it is also evident that the furnaces of the later phase were much larger. Finally, it is also noted that there was more variety in smelting installation shapes in the early phase of the Iron Age technologies (twelfth to tenth centuries BCE), including, as mentioned above, the use of stones. While furnace fragments from the later contexts were easily typified in the ELRAP metallurgical collection (three to five forms), the fragments from the earlier contexts presented a high variability of shapes and materials (more than eight different forms and shapes). The large sample number in the selected collection at UCSD (several hundreds of fragments) makes this qualitative observation reliable. Further research is needed to pinpoint specific technological differences.

Miscellaneous Technological Ceramics

Many fragments of ceramics (including slag-less clay vessels) that seem to be related to pyrotechnical technologies but did not have the typical qualities of furnace fragments, molds, or crucibles (and obviously domestic pottery) were labeled by us generally as "technological ceramics" (Figure 13.33). Such clay fragments may be related to installations associated with the (s)melting furnaces, such as "slag pits," the bellows system (of which we know very little), refining and melting installations, and so on. As most of these have also not been fired, the record is usually too fragmentary to say much about their function in this stage of research. Many of the finds in Area F at Khirbat en-Nahas were labeled as "technological ceramics"; together with the relative large quantities of copper metal chunks, mold fragments, bellows pipes, large stone basins, and other architectural installations, as described earlier, Area F has been interpreted by us as a specialized workshop for refining, melting, and casting of copper metal (e.g., Figure 13.33:2, 4). Some similarities between the archaeometallurgical assemblages of Areas F and T suggest that the latter has also functioned as a specialized metallurgical workshop, although the metallurgical area there was only excavated to a limited degree and the archaeometallurgical assemblage has not been thoroughly studied yet (cf. Table 13.1 [see also notes to the table]).

A typical and ubiquitous find in all of the Iron Age smelting sites of Faynan are thin and flat clay fragments, smooth on one side and covered with a layer of crushed slag on their opposite side (Figure 13.33:1). At the field recording stage, we could not provide a satisfactory explanation for these fragments, and all were labeled as "technological ceramics"; however, after working on the archaeometallurgical collection, it appears that these are fragments of sintered furnace linings that flaked off the slag-rich furnace clay walls probably when the furnaces were broken. A layer of crushed slag from the furnace walls adhered only to the back side of the lining and resulted in this characteristics appearance (nicknamed "cookies" by us).

A unique find (Figure 13.33:3) possibly represents the location/position of a (large) tuyère within the furnace wall. The artifact was found in a context of smelting debris and is composed of furnace clay material. A reconstruction of the fragment based on its original shape suggests that it is a hole in a furnace wall; this hole has an inclination of about 10° from the horizon, supposedly pointing toward the bottom of a furnace. The dimensions of the hole can fit a tuyère. However, the smooth face of the hole and other features challenge such interpretation, and this artifact may be related to other technological activities. Many other unique fragments are still without proper interpretation and await future research.

Furnaces, Pottery, and "Technological Style"

In addition to inclusions in furnace clay, crushed slag was commonly used as a temper in domestic pottery vessels at KEN and KAJ, and probably also in other Iron Age copper production sites (Smith 2009; Smith and Levy 2008; Chapters 3 and 4, this volume).[13] Crushed slag was found in almost all the local vessel types, although in some cases, especially among very

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Figure 13.33 A few artifacts labeled as "technological ceramic" and a bellows pipe from Area F.

#	EDM #	Site	Area	Locus	Basket	Comments
1	40897	KEN	T	1563	13591	A common artifact labeled as "technological ceramic" in Iron Age smelting sites excavated as part of the current project. They are now interpreted as the back (*a*) and front (*b*) of a sintered furnace lining.
2	?	KEN	F	?	?	A fragment of a "technological ceramic" with unknown function; found in Area F and may be related to refining or casting procedures
3	91551	KEN	M	707	10184	A fragment of "technological ceramic"; may represent a tuyère hole in a furnace wall (see text)
4	12009	KEN	F	858	1173	A fragment of bellows pipe with a coating of oxidized copper in its inner tube

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fine pottery, it was found on the microscopic level only (suggesting that pottery was produced on site and slag became part of the clay unintentionally). In cooking pots, pithoi, handmade ware, and some kraters, it is evident that the slag was intentionally added; many inclusions of slag are present, mostly 1 mm in diameter, and it is unlikely that such amount of fine-crushed slag was part of the original clay deposits. Slag as a temper may have had practical benefits in domestic ceramics, such as making the vessels more resistant to higher temperatures and breakage and facilitating "sweating" of vessels by rendering them more porous (this is sometime desirable, e.g., when cooling water in storage jars, etc.). It was also a material that was abundant at the copper production sites. However, it is very likely that this phenomenon represents a specific *technological choice* and, more precisely, a *technological style* of the society responsible for the copper production in Faynan throughout the Iron Age I to II (twelfth to ninth centuries BCE) (cf. Lechtman 1988; Lechtman and Merrill 1977). *Technological style* is expressed by a common attitude toward different materials, not unlike stylistic choice studies in other realms of material culture by anthropologists (Conkey and Hastorf 1990; Dietler and Herbich 1998). The choice of using slag inclusions in most of the pottery vessel types, even if in some cases this was a substitute for other commonly used nonplastic tempers such as calcite ($CaCO_3$) in cooking pots (Rice 1987:229; Rye 1976:116–117), is clearly a conscious choice, a technological practice that originated not only from functional reasoning. A number of ceramic studies (e.g., Rice 1987:119, and references therein) have shown that potters added different inclusions into their pottery that served no functional purpose but rather is related to customs, religion, or superstition (e.g., if we do not put this in the clay, then the pottery will break or something worse will happen). Given the central place slag material must have had in many different aspects of the copper production system (including being a source of "hidden" metal, a flux, and a proxy for the success of the smelting cycle) and its origin directly from s(melting) processes (often considered a magical phenomenon in traditional societies; see Introduction, this volume), it is highly likely that slag material had an extra value, a symbolic quality, and a social function that we are unable to completely decipher today. The use of slag in manufacturing domestic pottery at the Iron Age smelting site may indeed represent embedded social meanings. This distinct feature in a very common material (that is often considered as representing ethnicity, but see Ben-Yosef 2010:Chapter 10 for further discussion) may have also been used as an identifier of the social group working at the smelting sites.

Tuyères and Bellows Pipes

In previous research, three main groups of ceramic objects related to the bellows system have been recognized in the Iron Age (and Late Bronze Age) archaeometallurgical record of the 'Araba (cf. Hauptmann 2007; Rothenberg 1990). These include "small tuyères," "large tuyères," and bellows pipes (or "tubes"). The results of the current research provide additional information on the nature of these objects and their manufacturing process. In addition, based on several thousand fragments from various sites, these objects have, for the first time, been precisely correlated with specific spatial and temporal contexts. In turn, as these objects are distinct and relatively easy to recognize (cf., e.g., furnace fragments above), they are excellent temporal and functional markers, as demonstrated below.

Two of these object groups are tuyères, distinguished from each other by their size and hence classified as "small tuyères" and "large tuyères" (following both Hauptmann 2007; Rothenberg 1990). It has been recognized that the difference between these groups represents a technological development corresponding to time (e.g., Hauptmann 2007; there the small tuyères are suggested as representative of a Late Bronze Age smelting technology, and cf. Hauptmann's discussion on the tuyères at KAJ described above). However, only now we can precisely pinpoint the timeframe of this technological change and suggest a correlation with culture-historical events in this region. The third group of objects consists of bellows pipes (or "tubes") and, according to our research, *does not* represent primary smelting activities. These objects have been found in specific contexts associated with secondary metallurgical activities, in particular refining, melting, and casting of copper metal. In Faynan, bellows pipes were found only at the excavated site of Faynan 5 (Hauptmann 2007:Figure 5.10.3) and at Khirbat en-Nahas (mostly Areas F and T). These are the only sites in Faynan that also include remains of the more advanced copper smelting technology (associated with the "large tuyères" and other technological

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features), dating to the late tenth to ninth centuries BCE. This may imply that bellows tubes were used only in association with the more advanced smelting technology. However, the sample size from the earlier Iron Age contexts at Khirbat en-Nahas and other sites (mostly KAJ and KAG) is possibly too small for decisively excluding the practice of a similar technology in special workshops also in the earlier phase of the Iron Age. As reconstructed here, the use of bellows pipes for refining processes in the *later* phase of Iron Age smelting activities is in accordance with the abundance of iron-contaminated copper chunks in smelting contexts associated with advanced smelting technologies. In Timna, the situation regarding evidence of bellows pipes is more complex. From Timna Site 30, Layer 1, the only context where evidence of advanced Iron Age copper smelting technology in the southern ʻAraba has been identified, no bellows pipes are reported in the publications of the ʻAraba Expedition, and none were found in our recent excavations at the site. This may be attributed to the relatively small size of excavated material representing this technological phase at the site (and, as mentioned above, bellows pipes are less abundant and found in very different contexts than are tuyères). In Timna Site 2, a few "tubular tuyères" were reported only in situ in several furnaces (Furnaces II, IV, and Z; see Rothenberg 1990:35–36) and have been reconstructed as having a tapering nozzle (although they were attached to the furnace walls and apparently never separated). The tapering nozzle and the dimensions of these tuyères (10–12 cm in diameter of air holes, clay wall of ca. 1 cm thick, ca. 20 cm long) render this type of object distinct from any of the other bellows-related object groups documented by us for the Iron Age. Either this group of "tubular tuyères" represents an earlier, Late Bronze Age technological phase (not documented anywhere else), or, most likely, this distinct object type is additional evidence for the *late* date of these furnaces (Early Islamic; see discussion about slag typology and radiocarbon dates for this site under 'Slag' below, and a general overview of the site in Ben-Yosef 2010:Table 6.1).

A great difficulty in the interpretation of furnace remains in the ʻAraba Valley concerns the reconstruction of the location and number of tuyères that were used in relation to each furnace type. Concerning the position of the tuyères, Rothenberg (1990:35) suggests using the distinct borderline between the slag-coated portion of the tuyère and the bare portion to reconstruct the angle of the tuyère in the furnace wall (see, e.g., Figure 13.40:2c,d). In addition, the solidified drops of slag material on the tuyère bottom (that look like a "beard") are a good indication of the original angle of the tuyère in the furnace (e.g., Figure 13.42:2c). In general, based on the KEN assemblage, we agree with the main conclusions of Rothenberg regarding the position of both the small tuyère (1990:37) and large tuyère (cf. Hauptmann 2007:99, 1990). The small tuyères were located in two different positions in the furnace: (a) inclined at 25 to 30° to the horizontal and located in a straight, upright segment of a furnace wall (indicated by a straight, diagonal borderline) and (b) inclined up to 40 to 50° in a curved segment of the furnace wall (see above and the description of the double-curved furnaces) (indicated by a curved borderline and the steep angle of the pendant slag drops). The large tuyères were also found to be located in two different positions in the furnace: (a) inclined at 20 to 25° to the horizontal (cf. Figure 13.42:2c) and (b) inclined at around 60° (cf. 40–60° for large tuyères from Faynan 5; Hauptmann 2007). Most of the large tuyères came from a curved segment of the furnace and very few from a straight segment. Their location was determined to be in the convex base of the upper shaft. We have found this conclusion to be supported by ample finds of S-shaped furnace fragments, as there was a distinct slag line in the inner part of the furnace, right at the curve, separating the slag-coated lower part of the interior and the bare clay lining on the upper part (cf. Figure 13.28:2–3). Regarding the number of tuyères per furnace, there is still not enough archaeological evidence to provide a decisive reconstruction. The general reconstruction of the furnaces, coupled with experimental archaeology (Merkel 1990), suggests that there could not have been more than three tuyères per furnace (and probably there was more than one tuyère; this applies to both types of tuyères discussed here).

Small Tuyères

Both the small and large tuyères of the Iron Age ʻAraba are composite ceramic objects intended to protect those portions of a bellows system that were most exposed to heat during the smelting process (Figures

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13.34–13.42).[14] These objects protruded into the furnace walls and contained the tip of an air pipe that was connected to the bellows and was probably made of animal skin. Skin-made artifacts and other organic materials related to the bellows system (such as ropes) are rarely preserved in the archaeological record. It is possible that the skin fragments, ropes, and textile excavated by us in the organic-rich layers of Timna 30 represent some parts of the bellows system (Ben-Yosef 2010:Section 6.2.1.2). The bellows were probably composed of organic materials and not ceramic or stone. The commonly suggested reconstruction of a pot-bellows for the Late Bronze Age/Iron Age smelting sites in the 'Araba (e.g., Bachmann and Rothenberg 1980:230) is based on Egyptian tomb drawings and not on archaeological evidence. The excavations of the 'Araba Expedition in the southern 'Araba Valley and our recent research in Faynan yielded not a single artifact that can be interpreted as related to a pot-bellows system. The very few examples of identified pot bellows from the ancient Near East (Davey 1979) came only from workshops for secondary metallurgical processes within settlements (e.g., Tell Beit Mirsim, Meggido, Ras Shamra, Enkomi, and more) (cf. Yahalom-Mack 2010, for the use of bellows in Iron Age metallurgical workshops in settlements). Alternative reconstructions of bellows operation are discussed in Ben-Yosef (2010:Chapter 9).

The small tuyères are made of two separate parts that fit into each other and together protected and facilitated the operation of the bellows system. The front part (referred to also as "nozzle" or "cap"; Figure 13.34) is made of the most refractory material in the smelting system, in accordance with its exposure to the highest temperatures achieved during smelting operations. Smelting experiments have shown that while average temperatures in smelting furnaces are about 1,000°C, a wide range of temperatures correspond to the distance from the tuyère. Temperatures near the tuyère itself may get up to 1,300°C (Tylecote and Boydell 1978) or even 1,500°C (Juleff 1996), and consequently, the most active slag-forming and copper extraction zone is also located around the tuyères. The material making up the front part of the small tuyères could have resisted distortion at temperatures over 1,200°C (Tite et al. 1990 and cf. clay of furnaces and the rear parts of tuyères with distortion occurring at about 1,150°C). The back part (referred to also as the "rear part" or the "main body") of the small tuyères is made of reddish clay with slag tempers, similar to that used for furnace walls (Figure 13.35). As mentioned in the discussion on furnaces above, this is not a true refractory material, and it was probably easily replaceable.

The tuyère fragments from KAJ-A belong only to the small tuyère group (most probably similar to all other archaeological contexts from KAJ; see discussion about Area A "slag mound" and dating in Chapter 2, this volume), and thus their measurements may stand for the entire group. The average diameter of the small tuyère air holes is 3 ± 0.7 cm (n = 23; five fragments = 3 cm, three fragments = 2 cm, six fragments = 2.5 cm, seven fragments = 3.5, and two fragments = 4 cm). There is a relatively large variation in the dimensions of the air hole of these tuyères (in comparison to the "large tuyères") and, in some cases, also in the quality of materials used. The nozzles are made of white sandy clay and the rear part (main body) made of unfired reddish clay tempered with slag inclusions; in ELRAP's excavations and in the new excavations at Timna 30, there were few fragments found of the rear parts, as might be expected from a nonfired and much more fragile material. Another more indicative measurement of tuyère dimensions is its thickness. As the common find is the tapered front part, we measured the thickness from the edge of the hole in the center of the back part of the socket to the external edge of the tuyère (assuming the socket is located in more or less the same position in relation to the tapering tuyère). There were fewer fragments from Khirbat al-Jariya that allowed such measurement since the front part of the tuyère was often found disintegrated. The results indicate an average thickness of 3.5 cm (n = 7; one fragment = 2.5 cm, two fragments = 3 cm, two fragments = 3.5 cm, and two fragments = 4 cm). Fragments EDM 20200 and EDM 20181 had the longest slagged portions, representing the minimum length of the portion of the tuyères that was inside the furnace. Both are approximately 9 cm in length.

Cloth marks are observable on the back parts of the tuyères, on the side that connects to the nozzle (front parts) (Figure 13.34:3a). Only a few of the nozzle sockets have observable cloth marks on them (Figure 13.34:4), but this is probably due to the difference in materials, as the sandy clay is less plastic

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and thus is less likely to preserve cloth marks. The external parts of the nozzles (front part) are usually covered with slag, but where there is no slag, usually the areas that were inside the furnace wall, cloth marks are often visible (the part of the nozzle that protruded into the furnace is easily recognized by slag cover, molten parts, and other heat impacts. In some cases, a distinct slag line represents the boundary between the protruding portion of the tuyère and the one that was embedded in the furnace's wall.). The rear part of the small tuyère is often found with typical reed marks (Figure 13.35).[15] The cloth and reed marks provide clues about the manufacturing process of the small tuyères. Based on our detailed observations, we have amended Rothenberg's (1990:41) and Werker's (1990) suggestions regarding the manufacturing technique of such tuyères. Our tentative suggestion seems to be the most parsimonious reconstruction, based on the currently available archaeological evidence; however, slightly different alternatives are also relevant (including the use of designated molds, different firing stages of clays, etc.). According to our suggestion here, a shallow hole was dug into the earth and was lined with cloth before the sandy white clay was placed into it. A layer of cloth was then also placed upon the lump of clay before the socket was pressed into it by some hard, round object (smooth rock or fired ceramic). A reed or piece of wood matching the average 3-cm diameter was used to create the air hole. This piece, representing the front, refractory part of the tuyère, was then fired in a kiln before the tuyère body (rear part) was fit into it (a kiln probably used for this purpose has been uncovered in Timna 30, Layer 2; see Rothenberg 1990:Figure 21). The clay of the tuyère body, red clay tempered with slag, was then placed into the socket of the nozzle, and a reed or wooden rod was inserted through the centers of both pieces. The cloth imprints from the socket of the nozzle would transfer onto the soft clay of the tuyère body. Then a small pliable reed mat (or "net") was used to form the outer body of the tuyère into the tubular shape that was fitted into the furnace wall.[16] Often it included more than one layer of clay (usually two layers: clay, pliable reed mat, and clay, and sometime three layers; the external layer was clay, and the typical fragments with reed imprints such as those in Figure 13.34 are broken in a way that the reed imprints are exposed). The two parts of the tuyère were easily separated after they were used in the furnace; the rear part was replaced, and when possible, the refractory front part was reused for a new tuyère. Reuse of the front nozzles is supported by observations reported by Al-Shorman (2009:114).

The small tuyères of the southern 'Araba Valley and Sinai vary in size with outer diameters from 5 to 8 cm (measured on the rear parts), lengths of 4 to 9.2 cm, and air hole diameters of about 2 cm (Rothenberg 1990:35–36). Overall, they represent the same technology as the one in contemporary Faynan. At Timna, the manufacturing technique of those tuyères was reconstructed by the 'Araba Expedition as fitting clay around a wooden rod of around 2 cm. The clay was then wrapped in a net of reeds, and then with another layer of clay and sometimes another net of reeds, forming a tuyère body in a clay-reed-clay-reed pattern. Based on a single random find of an "unused" tuyère fragment found at Timna Site 13, it has been assumed that the whole tuyère was fired in a kiln (Rothenberg 1990:36–37). In some fragments, charred reed remains have been found. These reeds have been identified as *Phragmites australis*, a common plant in the springs and marshes of the desert areas of the southern Levant (Werker 1990).

Large Tuyères

The best representative context of large tuyères from the recent excavations in Faynan is the metallurgical complex at KEN-R (Figures 13.36–13.42). In the metallurgical deposits excavated so far in this area, all of the tuyères belong to this group. This type of tuyère, like the small tuyères described above, is composed of two primary components, a front part (a "nozzle" or a "cap") made of refractory clay and a rear (or "back" or "main body") part made of reddish clay rich in crushed slag inclusions. The most distinct difference between the two groups of tuyères is the circumference of the front part (the sandy white clay) and the depth of the socket made into it. The same features recorded for the small tuyères were recorded also for the large tuyères from Area R. The average air hole diameter was around 2.5 ± 0.4 cm (n = 15; six fragments = 2 cm, four fragments = 2.5 cm, and five fragments = 3 cm), demonstrating less variability than the small tuyères. The average thickness (measured from the edge of the hole in the socket side to the external edge of the tuyère) was around 6 ± 0.9 cm (n = 12; three fragments = 5 cm, one fragment = 5.5 cm, three fragments = 6 cm, one fragment = 6.5 cm, three fragments = 7 cm, and one fragment = 7.5 cm), demonstrating more

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variability than the small tuyères. The large tuyères do not have cloth marks. Instead and in the same locations, there are marks of organic material (grass, or weeds, with no defined pattern to the markings, Figure 13.40:3b; on the nozzles, beneath the slag, e.g., L1853, EDM 30675, B16530; on the sockets of the nozzles, e.g., L071, B0886 EDM F1007; on the tip of the inner parts, e.g., L1833, B16384, EDM 30506). In addition, the rear parts do not have the typical reed marks described above for the small tuyères. Large fragments and intact tuyères (Figure 13.41:3–4) preserved additional socket(s) related to the composite construction of the rear part (main body).

In the excavations at Area R, a few large tuyères have been found *intact* (Figures 13.36–13.38), the first such artifacts from the smelting sites of the southern Levant. The dimensions of the complete tuyères are approximately 32 cm long, 15 cm wide, and 13 cm high (from the supposed original stance; the tuyère is thus not entirely rounded). The length of the complete tuyère is surprisingly large, suggesting a very thick furnace wall; it appears that, similar to the poor preservation of the main bodies of the tuyères (rear parts), most of the furnace wall material was entirely decomposed, and the preserved parts represent only the inner layers that were hardened by heat. There are no intact furnace fragments in the entire collection that correspond to 30 cm+ wall thickness, and we believe this is a consequence of poor preservation of the unfired clay material that the furnace walls were made of.

Large tuyères in the southern 'Araba have been reported only from Timna Site 30, Layer 1. They have nozzle diameters measuring from 13.0 to 16.5 cm and air hole diameters ranging from 2.0 to 2.3 cm. No completely intact tuyère was found, and the greatest length measured was 12.3 cm. The tuyères were made from clay that was highly tempered with crushed slag, just like the material of the furnace walls (Rothenberg 1990:48). As for the construction of the "large" tuyères, Rothenberg (1990:49) writes of superimposed layers of clay being used to construct the tapered body, then a quartz clay was applied to form the outer refractory casing (front part) of the tuyère. Similar to the small tuyères, Rothenberg argues that the whole tuyère was prefired in a kiln before it was inserted into the furnace. As indicated here, the new evidence supports that only the front part of the tuyères (small and large) was prefired and the body itself was not fired (and thus has easily decomposed; a few fragments of body parts showed that one side of the body was flattened as the still soft clay had been set to rest on one of the stone walls that served as a support for the tuyère and as a side of the furnace).

On the basis of our observations, we suggest the following reconstruction for the manufacturing technique of the large tuyères (both in Faynan and in Timna). Like the construction technique used with the small tuyères, a shallow hole was dug into the earth and then lined with organic material such as straw, grass, or reeds to allow for the easy removal of the part after it dried. After placing a lump of the white sandy clay in the hole, another layer of organic material would be laid on top, a socket was then pressed into it, and a hole was made before this piece was fired. After being fired, a mass of red clay would be placed into the nozzle socket. This red clay would then be pressed with a round object to create the second socket. Other layers may have been made on top of this in the same manner, resulting in a tuyère constructed in layers. In contrast to the small tuyères, the bodies of the large tuyères do not show evidence of the net reed markings. It seems that the large and heavy bodies of the large tuyères could not be constructed using a net of reeds and that the "multilayer" (and multisocket) construction technique was necessary for creating a stable tuyère.

Tuyère Materials

Tuyères from Faynan 5 were investigated by Hauptmann (2007:99). At the site, two different types of tuyères were found and were believed to represent different dates (following Rothenberg's publications, Late Bronze Age and Iron Age for the small and large tuyères, respectively). The site itself (Chapter 12, Table 12.1, this volume) is considered by its excavator to be the second largest Iron Age smelting site in Faynan (after KEN), containing about 30,000 tons of slag. Hauptmann's analytic results of the large tuyère indicate that the front part contains 70 to 80 weight percent SiO_2 and 10 to 20 weight percent Al_2O_3, a composition that is heat resistant up to over 1,100°C and thus a highly refractive material. Hauptmann (2007:99) suggests that the clay of this ceramic is made of kaolinite or from a siliceous rock. The back part, made of reddish clay tempered with crushed slag, contains nearly 65 weight percent SiO_2, has 7 to 9 weight percent of iron oxides, and is thus much less fire/heat resistant.

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Al-Shorman (2009) also provides analytical data on tuyère fragments from the Deutsches Bergbau-Museum (DBM) work at Faynan 5, Khirbat en-Nahas, and Sinai. The back parts contain "moderate" amounts of nonplastic inclusions, 15 to 30 volume percent quartz with two grain size population (*hiatal* texture), and the same amount of angular, very coarse crushed slag. It is made of calcareous clay.[17] The front parts can be considered, "from a modern point of view … as fireclay refractories" (Al-Shorman 2009:223) and represent *the first time that true refractory vessels appear in the southern Levant* (in Faynan, Timna, and southern Sinai simultaneously). They contain a mixture of clay and quartz; fine to medium subangular grains, exceeding 50 volume percent; and small amounts of feldspar. Mullite and cristobalite, high aluminum-silicate and silicate minerals, were present in the front parts, formed as a result of the heat. The main clay was noncalcareous (kaolinite/illite for KEN) (value ranges, CaO = 2.1–0.44 weight percent; Si = 79.9–81.9 weight percent). The quartz amount in the front part is ideal, as more than 60 volume percent would be too crumbly, and less would be less refractory. Tylecote (1982) further emphasized the qualities of quartz-rich materials as refractories. The quartz grains remained inert and did not react extensively with the matrix (throughout the "short duration" of the smelting process). The formation of a network of mullite crystals formed a bonding phase that enhanced its refractoriness. Mullite has a low thermal expansion, high thermal shock resistance, high creep resistance, strength at high temperatures, and an outstanding stability in aggressive chemical environments—a solution for the strength of composite materials. The initial vitrification of the front part of the tuyère occurs at 900°C; at 1,200°C and even up to 1,250°C, it still retains its shape without any signs of terminal distortion. Micro-textures of these nozzles indicate that the original firing temperature was greater than 1,200°C, confirmed by the formation of mullite and cristobalite (mullite forms in noncalcareous illite and kaolinite clays between 1,000 and 1200°C, cristobalite at 1200°C, but the existence of both indicates greater than 1,200°C). Al-Shorman (2009) also points to 1,230°C as the temperature in the reaction area, around 80°C more than the estimation of Title et al. (1990), but still lower than the finds of experimental archaeology (around 1,300–1,500°C; see above).

Dating Technological Change

The difference between the two primary types of tuyères represents a major technological change in the Iron Age archaeometallurgical record of the southern Levant. The front parts of the tuyères are usually well preserved in the archaeological record. Because they have unique and easily recognized characteristics corresponding to the tuyère type (as described above), these artifacts constitute an excellent chronological marker that is much better defined than any of the other archaeometallurgical materials and, in most cases, even better than ceramic typology. Following the publications of the 'Araba Expedition, it was accepted that the small tuyères represented a Late Bronze Age smelting activity, and the large tuyère represented Iron Age production. The new excavations, particularly Area S in Timna 30 and Area M at Khirbat en-Nahas, provide a much better dating resolution, with significant revision of the previous accepted chronological–technological framework.

The small tuyères have been recorded at all New Kingdom–related sites in the southern 'Araba and Sinai (Rothenberg 1990:29). It is likely that even when considering the new chronological framework suggested here for some of the principal smelting sites in the Timna Valley (Ben-Yosef 2010:Chapter 6), this type of tuyère indeed represents a technological tradition that first appeared in the southern Levant during the thirteenth century BCE or even earlier (for the possible origin of this technological tradition, see Ben-Yosef 2010:Chapters 9 and 10). This is based on radiocarbon dates from KEN and Khirbat Faynan (which include the Late Bronze Age, Chapter 12, Table 12.2, this volume), on the accepted date of the site of Bir Nasib in Sinai, and on a few radiocarbon dates from Timna Site 2 (Ben-Yosef 2010:Table 6.2). The appearance of the new (larger) type of tuyère occurred *within* the Iron Age, and its date now can be pinpointed in the section of Area S in Timna 30 and in the deep sounding in Area M at Khirbat en-Nahas. In Timna 30, only the upper most deposits, found in a very limited portion of the site, contain the large tuyères (Layer 1). The transition between this layer and the deposits below occurred, according to the new radiocarbon dates and Bayesian analysis, between 912 and 836 (1σ modeled, calibrated age, BCE) or 970 and 808 (2σ modeled, calibrated age, BCE) (Ben-Yosef 2010:Table 6.5, Figure 6.17). The stratigraphic layout at the site shows that a break in

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occupation of the site occurred just before the new technology arrived. This break, however, was probably rather short (cf. Ben-Yosef 2010: radiocarbon dates in Table 6.5).

The deep sounding in the "slag mound" of Area M provides excellent chronological control over the contexts of archaeometallurgical debris. Working with the entire metallurgical assemblage, we were able to characterize each metallurgical locus by the type of its tuyères (small or large). Using the Harris matrix, the sections' drawings (Appendix 2.M.8), and the associated radiocarbon dates (Chapter 2, this volume and Appendix 2.2), we could precisely pinpoint the technological transition that occurred at KEN. The loci containing small tuyères are as follows: 629 (representative "model" locus with many tuyères in the collection), 657, 666, 707, 660, 612, 606, 653, 652, 631, 642, 659, 647, 659, 641, 624, and 627. The loci containing large tuyères are 602, 608, 616, 620, 648, 663, and 701. L701 contained large tuyères but did include a piece of tuyère body that was reed marked (EDM 91545, an outlier?). The stratigraphic context and the radiocarbon dates indicate the same time range for the technological change as the one from Timna 30. It is evident that this change occurred simultaneously in Timna and Faynan and that it happened in the late tenth to early ninth centuries BCE, probably after a short break. The correlation of this date with historical events and the sociocultural implications of it are discussed in Ben-Yosef (2010:Chapters 9 and 10).

Bellows Pipes

Bellows pipes (Figures 13.43–13.45) are made of reddish clay, not tempered with slag or large quartz inclusions. They are much less abundant than tuyères and are found in more specific archaeological contexts. According to our interpretation of the archaeological record, these vessels are not related to primary smelting but are a part of secondary, refining, melting, and casting activities that took place in specialized, designated workshops. Such a workshop was discovered at KEN-F. From this area, *only* bellows pipes and not a single tuyère were unearthed (at least from the occupation contexts of the workshop, Layer F2). On the other hand, in the Area R smelting complex at KEN, *only* tuyères (large) were found and not a single bellows pipe. Interestingly, bellows pipes were not found at any of the other sites probed in the current research. This may be the result of the small sample size (because, as mentioned above, bellows pipes are more rare and located only in specific contexts) or the result of time/technology differences, if bellows pipes are correlated only with the later, more advanced smelting technology (which is not evident in any other sites excavated in the current research except Timna 30). The latter possibility is supported by the abundance of metal chunks of a copper–iron mixture found mostly in context of the later and more advanced smelting (e.g., Area R). These metal chunks possibly represent the raw smelting product that *needed* to go through a specialized refining process before ingots could have been produced. This is also supported by the distribution of bellows pipes at KEN-M. In this area, all of the bellows pipes came from upper (younger) contexts that (mostly) correlate with the advanced, later technology. Tentatively, we correlate the bellows pipes and the Area F workshop only with the advanced technology (Ben-Yosef 2010:Chapter 9).

The results of our work on the archaeometallurgical collection of ELRAP include the following:

(1) Bellows pipes from Area M were found only in L619 (EDM 90213, 90131), L689 (EDM 91349), L619 (EDM 90134), L701 (EDM 91418), L628 (EDM 90261), L607 (EDM 90062), L699 (EDM 91939), L604 (EDM 90044), L613 (EDM 90116), and L707 (EDM 91527).

(2) Fragments with well-preserved edges (fronts) include L902 (EDM 20714) and L888 (EDM 20643) at Area F and at L607 (EDM 90062) and L619 (EDM 90134) at Area M.

(3) The longest fragment of bellows pipe in the entire collection is 11 cm long (Area M, EDM 90134, L619) and has a diameter of ~6 cm and an air hole diameter of ~2 cm (it has a front slagged complete edge). A length of 11 cm should be considered the *minimum* length of bellows pipes.

(4) Average diameters of 5.5 to 6.5 cm and an average air hole diameter of 2 cm (n = 14; see possible exception in Figure 13.44:2).

(5) Several unique finds provide additional technological information: L855 (EDM 20498) and L900 (EDM 20701) have a flat side, indicating its position on the melting/refining installation; L858 (EDM 20213) (Figure 13.45:2) is a large fragment of a bellows pipe found probably in situ in the metallurgical workshop of Area F.

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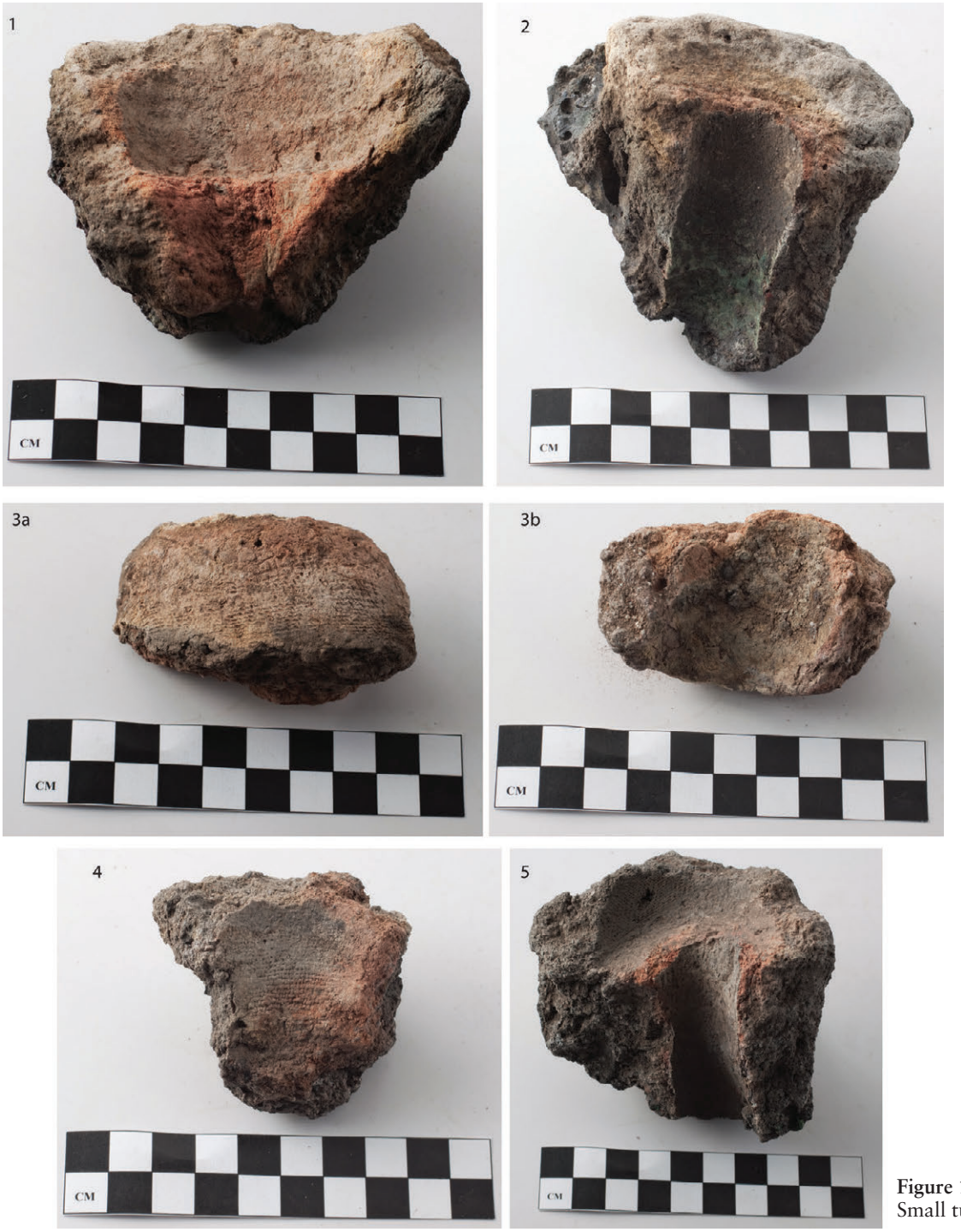

Figure 13.34
Small tuyères.

#	EDM #	Site	Area	Locus	Basket	Comments
1	20200	KAJ	A	106	3188	Small tuyère—front part
2	20181	KAJ	A	106	3169	Small tuyère—front part, refractory clay, slag coat, heat impact, copper remains
3	20210	KAJ	A	105	3196	Small tuyère—exterior (*a*) and interior (*b*) views of a rear part, textile marks on the exterior
4	90595	KEN	M	641	4430	Small tuyère—front part, textile (cloth) marks on the interior socket; tuyère is deformed as a result of heat impact
5	90808	KEN	M	642	9604	Small tuyère—front part view of section; note the textile (cloth) marks on the socket

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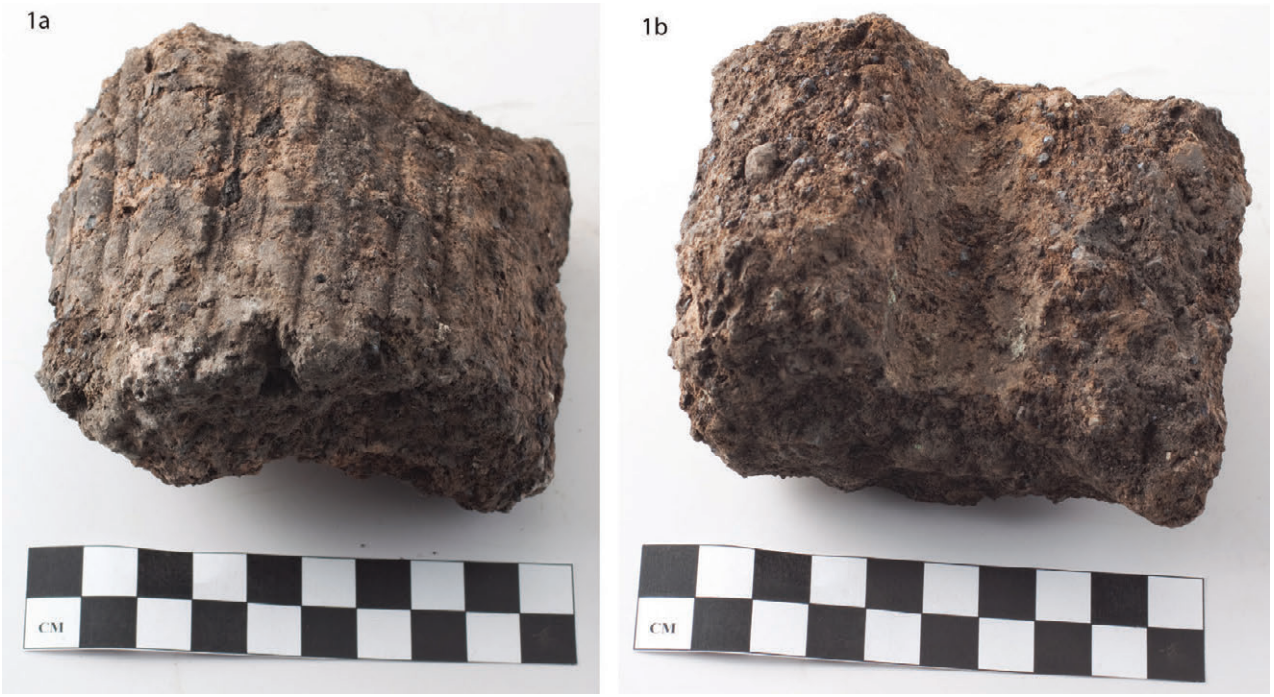

Figure 13.35 Small tuyère, rear part—cylinder with typical reed marks.

#	EDM #	Site	Area	Locus	Basket	Comments
1	20227	KAJ	A	118	3705	Cylindrical rear part of small tuyère, reed marks on the exterior (*a*) and its air tube (*b*); rough reddish clay with inclusions of crushed slag



Figure 13.36 Intact large ninth-century BCE tuyère found in KEN-R (EDM R09f1007). Its location near a probable furnace base suggests that it was found close to its original location.

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Figure 13.37 Detail of intact large tuyère from KEN-R.

#	EDM #	Site	Area	Locus	Basket	Comments
1	R09f1007	KEN	R	071	0886	Large tuyère with rear part still attached to the front (the rear part has been entirely decomposed in shipment); front view (*a*), back view (*b*), and side view (*c*).

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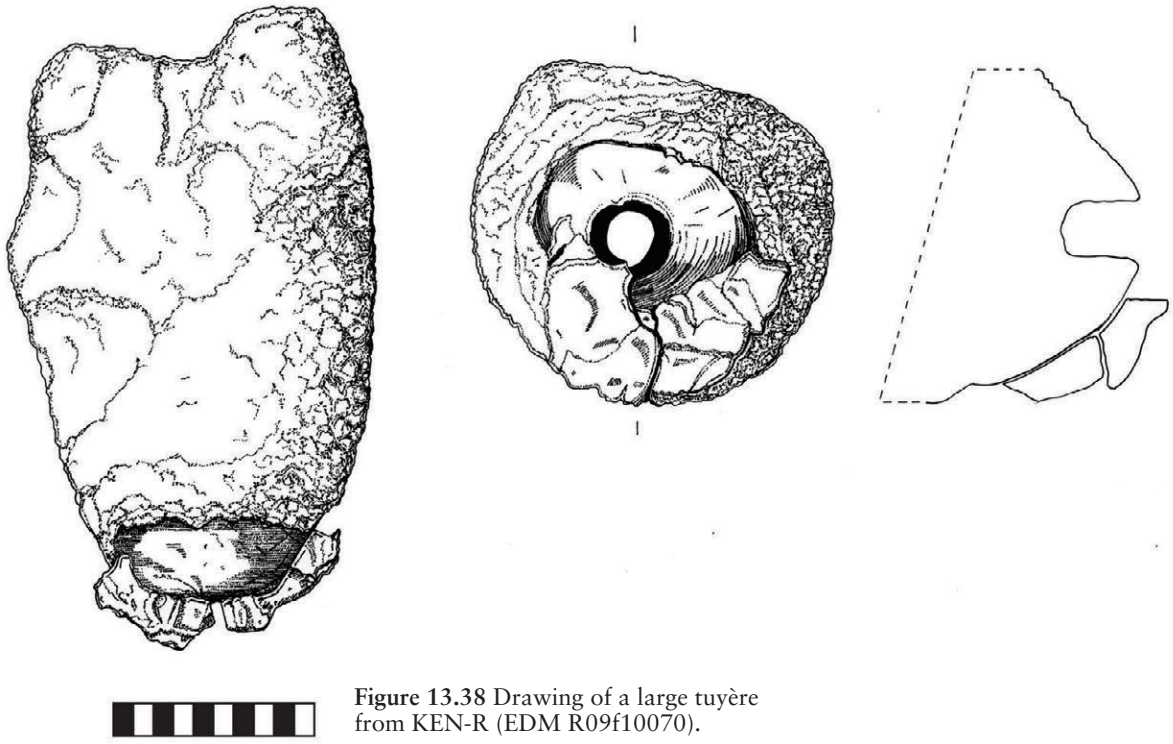

Figure 13.38 Drawing of a large tuyère from KEN-R (EDM R09f10070).

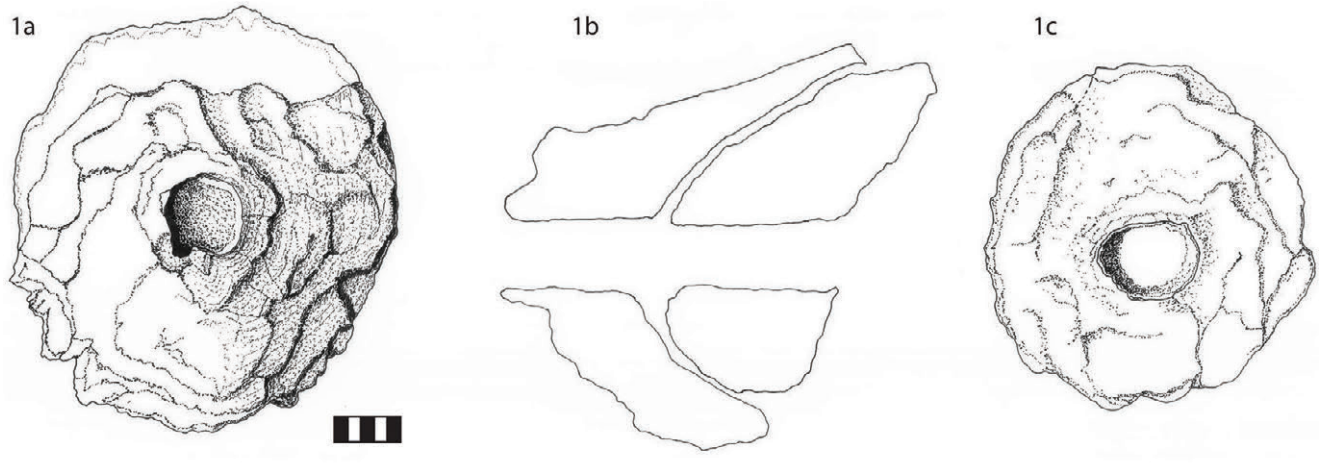



Figure 13.39 Two matching parts of a large tuyère, Area M; illustration (*a–c*) and photographs (*d*, *e*) (EDM 91494, L707, B10138).

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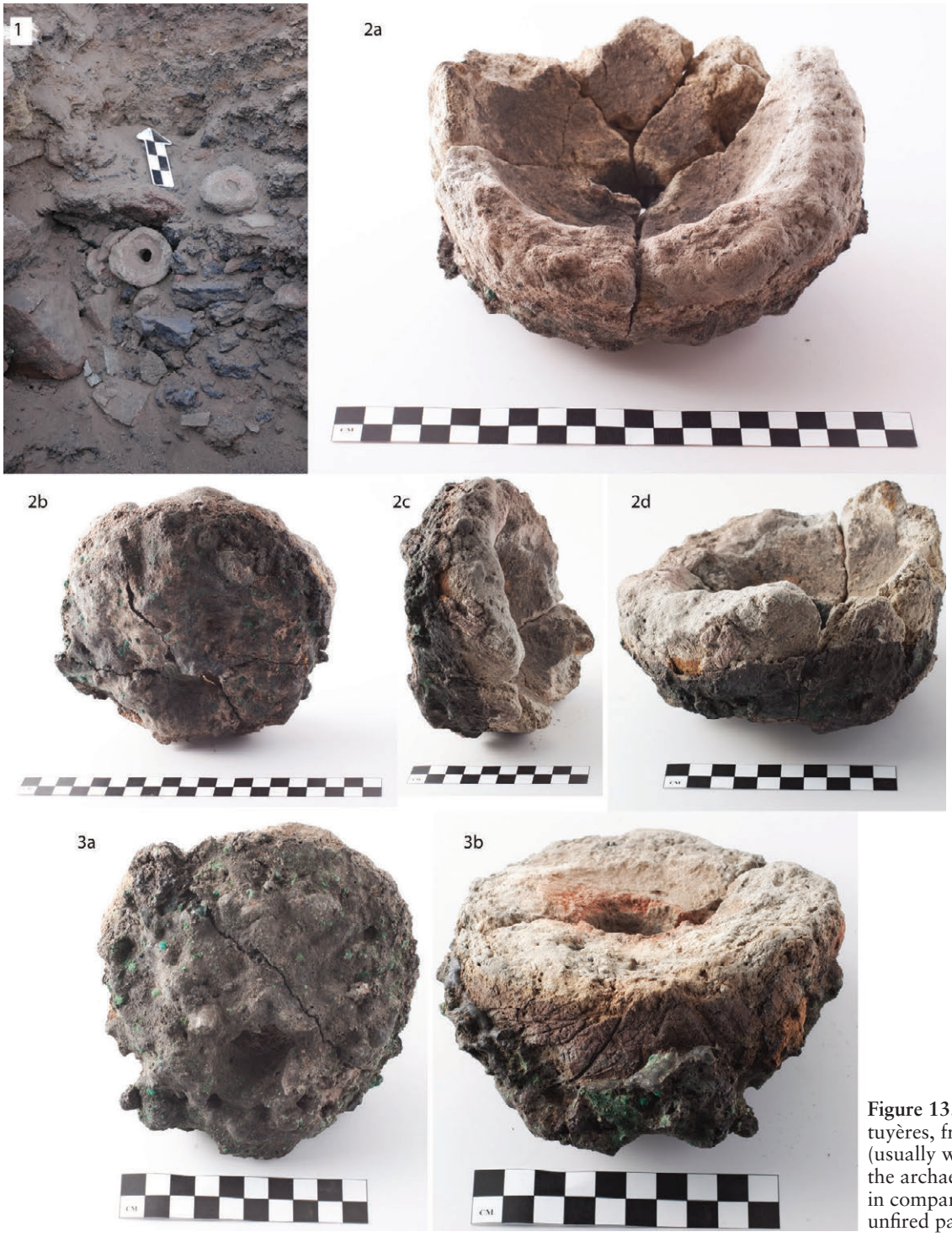

Figure 13.40 Large tuyères, front pieces (usually well preserved in the archaeological record, in comparison to the back, unfired parts).

#	EDM #	Site	Area	Locus	Basket	Comments
1	NA	KEN	R	NA	NA	Front pieces of large tuyères in situ as found in the metallurgical disposal designated zone in Area R
2a	30433	KEN	R	1833	16317	Large tuyère, front part, back (*a*), front (*b*), and side (*c*, *d*) views; note the distinct socket, the copper prills on the tuyère front, and the sharp line of slag coating representing the original position of the tuyère in the furnace
3a	30603	KEN	R	1847	16464	Large tuyère—front part, covered with slag and copper prills (*a*), and reed/weed marks below (*b*)

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Figure 13.41 Several views of typical large tuyère fragments from Iron Age KEN.

#	EDM #	Site	Area	Locus	Basket	Comments
1	91527	KEN	M	707	10169	Large tuyère—close-up on the refractory front part (quartz-rich clay)
2	R09f1466	KEN	R	R09l093	R09b1186	Large tuyère—rear part, front (*a*) and back (*b*) views; this part fitted into the socket of the front piece, reddish clay with crushed slag tempers
3	90215	KEN	M	612	9122	Large tuyère—rear part, front (*a*) and back (*b*) views; manufacturing method, using several layers of clay, is evident by the way the artifact is defragmented
4	30506	KEN	R	1833	16384	Large tuyère—rear part, additional socket in the back side of the rear part (usually not preserved)

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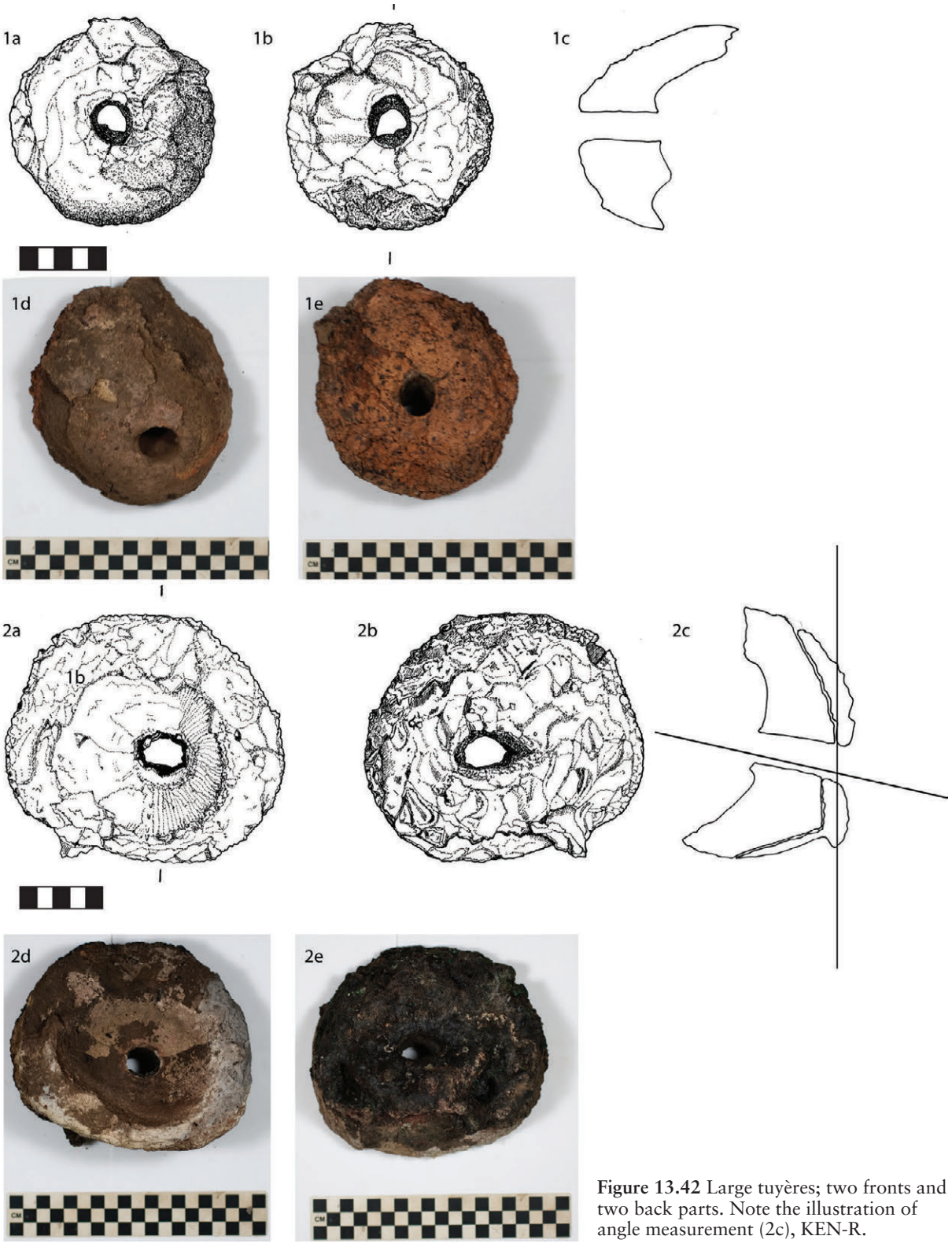

Figure 13.42 Large tuyères; two fronts and two back parts. Note the illustration of angle measurement (2c), KEN-R.

#	EDM #	Site	Area	Locus	Basket	Comments
1	R09f1466	KEN	R	093	R09b1186	Front (*a*, *d*), back (*b*, *e*), and side (*c*) views of a back part of a large tuyère (probably related to 2).
2	R09f1467	KEN	R	093	R09b1187	Back (*a*, *d*), front (*b*, *e*), and side (*c*) views of a front part of a large tuyère

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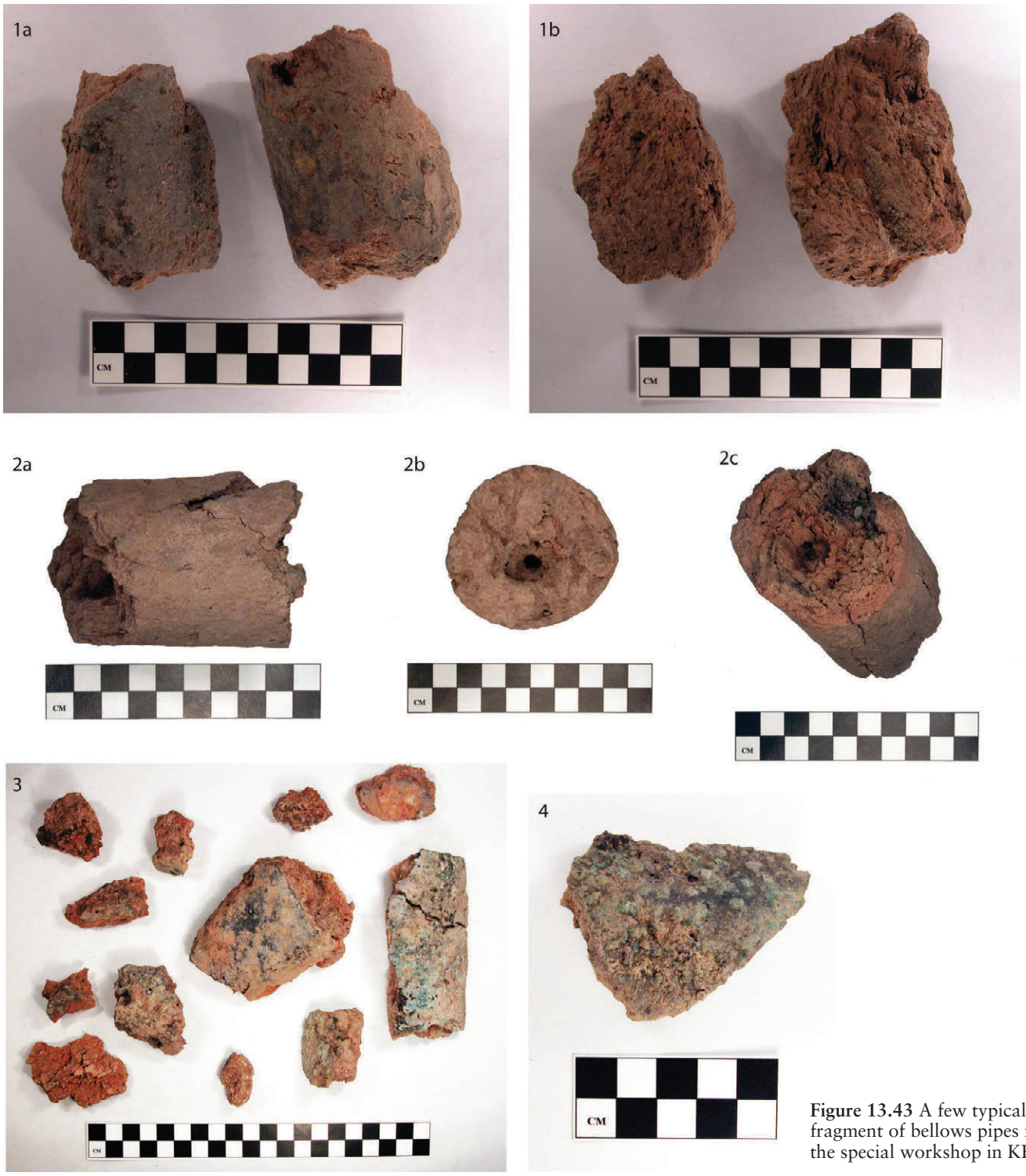

Figure 13.43 A few typical fragment of bellows pipes from the special workshop in KEN-F.

#	EDM #	Site	Area	Locus	Basket	Comments
1	12011	KEN	F	819	1190	Two fragments of bellows pipe; vitrified exterior parts (*a*), interior reddish clay (*b*)
2	20394	KEN	F	819	1218	Bellows pipe—side view (*a*), top view, narrow air hole (*b*), and diagonal view (internal heat impact)
3	20298	KEN	F	833	1162	Vitrified fragments of bellows pipes
4	20215	KEN	F	836	1111	Vitrified exterior of bellows pipe; copper prills

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Figure 13.44 Some representative fragments of bellows pipes, KEN-F.

#	EDM #	Site	Area	Locus	Basket	Comments
1	20643	KEN	F	888	1394	Bellows pipe—fragments; (*a*) exterior, vitrified area and copper prill indicate heat impact zone (furnace side) and (*b*) top view
2	20703	KEN	F	860	20703	Bellows pipe—fragments; (*a*) exterior, vitrified, (*b*) interior, flakey red clay and possibly a wider air hole

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Figure 13.45 Bellows pipes, with in situ fragments in one of the installations of Area F, a refining/casting workshop at Khirbat en-Nahas.

#	EDM #	Site	Area	Locus	Basket	Comments
1	20701	KEN	F	900	1447	Bellows pipe—fragments, vitrified and bloated area indicates heat impact; side (*a*) and top (*b*) views
2	20312	KEN	F	858	NA	Bellows pipe in situ, excavated in the metallurgical workshop of Area F

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The exact function of the bellows pipe in the melting/refining system is still not clear. The general layout of the Area F workshop is described in Chapter 2 (this volume), and some other related installations and artifacts in the following sections. The identification of the workshop at Area F and the distinct use of the bellows pipes, which is clearly different from the contemporaneous tuyères, are one of the main contributions of the current research to our understanding of Iron Age copper smelting technologies in the southern Levant.

Slag

Slag is a mixture formed during smelting, originating from the molten gangue and fluxes. It mainly consists of silicates and metal oxides (FeO, MnO, CaO, etc.) and has a relative low density, enabling it to solidify as a separate layer on top of the molten metal. Because of the fast cooling rate, slag is usually composed of a high proportion of glassy, noncrystalline mass. In contrast to the modern definition of the material, slag in antiquity was usually not an immediate waste (Hauptmann 2007b:18). Due to limited control over smelting conditions, in many cases slag contained metal and metallic phases (e.g., copper sulfide, delafossite) that can be further extracted by re(s)melting or by mechanic exploitation of copper prills. As we show in the current research, slag material was used as a flux in the Iron Age copper smelting process (Ben-Yosef 2010:Chapter 8).

As slag is present in (almost) all metal extraction sites, it is key for studying the smelting technology (e.g., Bachmann 1982; Hauptmann 2007). Its texture, shape, size, mineralogy, and chemical composition help to determine the smelting method (e.g., tapping vs. nontapping), conditions in the furnace (e.g., control over temperature, maximum temperatures achieved, redox conditions), and physical characteristics of the smelting installations (size of "slag pit," orientation of tuyères in the furnace, etc.). Furthermore, assessment of *scale, intensity,* and *efficiency* of production are commonly derived from slag studies. The amount of metal in slag is a proxy of smelting efficiency, and estimations of slag quantities can in some cases (cautiously) be used to calculate amounts of metal produced in the investigated contexts (site, layer, etc.). For copper production slag in Faynan and Timna, the calculation of quantities of copper is based on the assumption that we know the quality of the original copper ore (copper weight percent). This is somewhat speculative, as the ore found today probably represents "leftovers," and the degree of ore beneficiation is not easy to estimate; the numbers used for ore quality in Faynan and Timna (10–15 percent) should be taken as *minimum* values for any calculation based on this feature (see also Ben-Yosef 2010:Section 2.2.2 for description of the ore deposits in the 'Araba and the basis for ore quality estimations).

The Iron Age slag deposits of the 'Araba Valley were reassessed as part of the current research. Based on field observations alone, these deposits can be divided into two main types, corresponding to their physical appearance. We had already defined two main types of slag, "A" and "B," in the early stages of the new research at Timna 30 (Shaar et al. 2010). These types are associated with the technological development evident in the tuyère record and have distinct physical appearance. Type A slag is found only in Khirbat en-Nahas, Khirbat Faynan (represented by slag deposits of Faynan 5, excavated as part of the Deutsches Bergbau-Museum project), and Timna 30 (possibly also in Timna 2, but this is not clear; see discussion below). The slag of this type is mostly represented by large slabs of solid black tap slag, up to 1 m in diameter (Figures 13.46 and 13.47:1, 2, 11). These slabs are often found intact, and the broken pieces are not a result of deliberate crushing but rather a consequence of post-depositional weathering. The massive slabs were formed in a well-designed, clay-built "slag pit," probably represented by the intact installations found at Faynan 5, KEN-R, and Timna 30 (Figure 13.46). They do have matching furnace slags that consolidated in the furnace itself; the furnace slags are also quite solid (less porous than the Type B slag). It is not entirely clear if the furnace slags of Type A were further processed by deliberately crushing or simply discarded together with the debris from the broken furnaces. The results of the laboratory analyses presented in Ben-Yosef (2011:Chapter 8) indicate that the smelting process associated with this type of slag was extremely efficient (about 0.4 weight percent of copper on average in a wide range of slag samples from Type A contexts), and thus further processing of slag for extracting copper prills was probably not necessary. However, in Timna Site 30, there is some evidence that these slags were crushed, at least to serve as a flux in the smelting process and to be used as tempers in furnace and tuyère clays. In Timna 30, Type A slag is different from Type B slag also in the main chemical and mineralogical composition, and thus X-ray fluorescence and microscopic analyses can be used for

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distinguishing between the two types also in very small fragments. Tite et al. (1990) show that the slag used as temper in furnace and tuyère clays found in the Type A archaeological contexts has the same chemical and mineralogical compositions of Type A slag (manganese rich in general, tephroite as the main mineralogical phase), a clear indication that Type A slag was further processed and crushed to millimeter-size grains.[18] In Faynan, as both Type A and Type B slag have the same bulk chemical and mineralogical compositions, such distinction was not practical.

Type A slag also corresponds to stratigraphic context (i.e., to diachronic technological development). This type is found only in late tenth- to ninth-century BCE contexts (Khirbat en-Nahas Layer M1, and general Stratum I, Timna 30 Layer I) and represents the latest and most advanced phase of *successful* Iron Age copper smelting in the 'Araba (see discussion of Late Iron Age [probably failed] attempts of copper exploitation in Ben-Yosef 2010:Chapters 5, 9, and 10). Both in Khirbat en-Nahas and Timna 30, there is evidence of use of the large slabs of tap slags as a *building material*. The most prominent evidence comes from KEN-R, where such slabs were used as part of the retaining walls in the archaeometallurgical complex, and in Timna 30, where such slabs were used for building the wall of installation L809 (Ben-Yosef 2010:Section 6.2.1.2 and Figure 6.14). Using slag slabs as a building material in walls probably started only with the advancement in technology such as that seen in the 'Araba region, which entailed production of huge, relatively flat, black stones useful for building. Such use of slag for construction of massive walls is known from various places, including the field mosque from the Early Islamic period of Beer Ora (e.g., Sharon et al. 1996) (Figure 13.48a,b) and the Roman smelting site of Skoriotisa in Cyprus (Figure 13.48c). Previous to the appearance of the large slag slabs of the late tenth to ninth centuries, slag, particularly crushed slag, was used for construction only as a foundation material (see below).

The distinct physical appearance of Type A slag, especially compared to the immediately predecessor Type B slag, has caused some confusion in the research of the Timna region. In their review of the Islamic activities in the southern 'Araba, Avner and Magness (1998:n7) argue that *all* of the large tap slag from the 'Araba represents only Nabataean or later smelting processes, including Timna 30 Layer 1 and the upper layers of Timna 2. The new excavations at Faynan and in particular our new excavations and high-precision radiocarbon results from Timna 30 have clearly demonstrated that the solid slabs of tap slag first appeared in the Iron Age (IIA/B). Nevertheless, we agree with Avner and Magness (ibid.) that all the *ring slag* (large slabs of tap slag with a distinct hole in the middle; Figure 13.48:16) indeed appeared not earlier than the Nabataean period. Such slag is present in Timna 2, and there it is associated with early Islamic radiocarbon dates and other chronological problems (Ben-Yosef 2010:Chapter 6, Table 6.1).

Type B slag includes all the slag fragments formed earlier than the technological transition of the late tenth to early ninth centuries BCE discussed above (Figure 13.48:10,12–15). In fact, it is impossible to *visually* distinguish between slags of the Late Bronze Age, Iron Age I, and those of most of the tenth century BCE (but see Ben-Yosef 2010:Chapter 8 for analytic methods and fine changes found *within* this period). These slags are also a result of *tapping technology* (in the 'Araba region, from the Early Bronze Age, smelting technologies can be considered to be *tapping* to some degree; the technology of the Late Bronze Age is based on advanced tapping procedures). However, it appears that all slags were further processed to some degree and that there was no *standard* "slag pit" (and final slag shapes). Also here there is a difference between tap and furnace slag; furnace slag often contains embedded charcoals (Figure 13.48:15), copper prills, and sometimes incompletely smelted ore fragments or gangue (Ben-Yosef 2010:Chapter 8, Figure 8.36:D). The furnace slags are very heterogeneous, both in distribution of mineralogical phases per sample and distribution of grain sizes per sample. Often these slags are found in "slag mounds," discarded with mixed furnace materials (Figure 13.48:10). Tap slags of Type B have less inclusions (of charcoals, prills, etc.) and are found broken to roughly 5 to 20 cm (in diameter, although the shapes are irregular). It is reasonable to assume that both furnace and tap slags of Type B slag was further processed by crushing (maybe with a preference to furnace slag, which probably contained more copper). Storage places with crushed slag have been reported from sites in Timna (e.g., Rothenberg 1990:47–48) and Faynan (Hauptmann 2007:102–103), and the extensive thick layers of crushed slag distributed all over the slopes surrounding Khirbat en-Nahas are the result of well-organized crushing activities and piling up of such material for further use (see detailed description of

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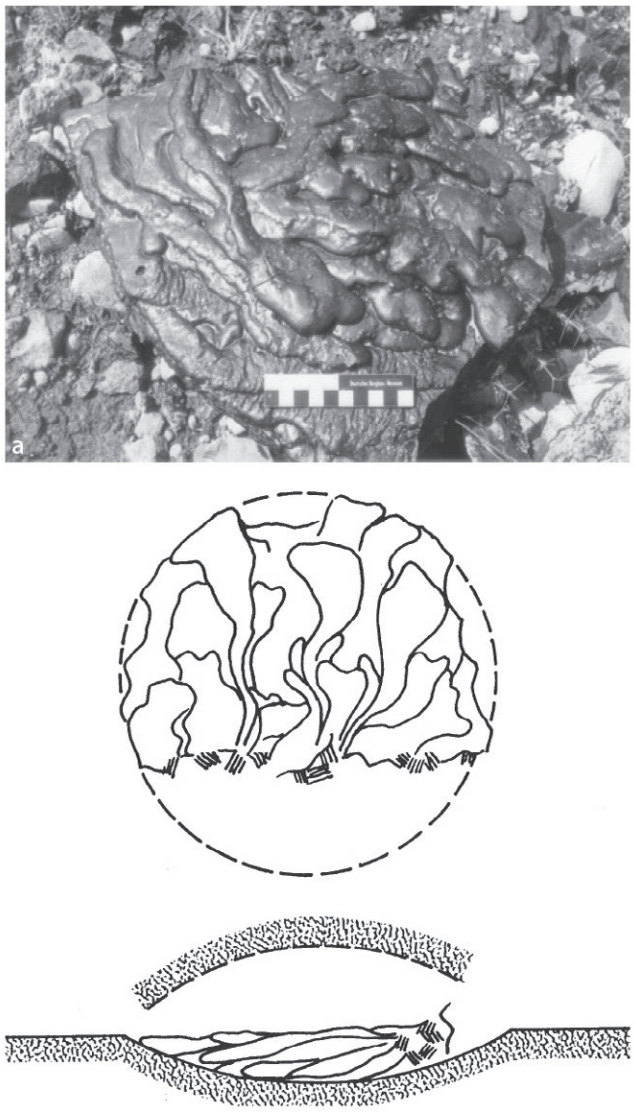

Figure 13.46 Type A slag. A complete slag slab (or "cake") from Faynan 5 and a reconstruction of the "slag pit" (from Hauptmann 2007:98); note the flow texture, the multilayer layout, and the transition between tap slag and furnace slag in the edge closest to the furnace (cf. Rothenberg 1990:Figure 80).

these layers in Chapter 2, this volume). The extensive crushed slag layers at KEN are unique and not well dated. It is important to try and achieve a reliable date for these deposits in the future to accurately correlate them with the technological phases at KEN. The results of the current research substantiate previous observations and indicate that crushed slag was used for the following: (1) preparing "technological clays" for furnace walls, rear parts of tuyères, and other pyrotechnological installations; (2) preparing clays for certain domestic ceramic vessels; (3) facilitating the smelting process by adding crushed slag to the smelting mixture as a flux (Ben-Yosef 2010:Section 8.5.2); and (4) construction of buildings by using layers of crushed slag as foundation material. This has been observed in many of the probes beneath the architectural features at Khirbat en-Nahas (Areas R, Rooms 1 and 5, and Areas T, A, and M; see Chapter 1, this volume). In all of those areas, the first material encountered just below the foundations was a distinct layer of fine-crushed slag). In summary, further processing of slag was an essential part of the Iron Age copper exploitation process, and slag material was definitely not considered purely waste by the Iron Age smelters.

Type B slag characterizes the present-day surface of several Iron Age smelting sites, including Khirbat al-Jariya and Khirbat al-Ghuwayba in Faynan. This is in agreement with the chronological time frame of these sites, established as part of the current research, which shows that copper production there ceased during the second half of the tenth century BCE. The same correlation between slag type and chronology may be used as a tool for initial dating of Iron Age "slag mounds." For example, the excavations of the "slag mound" at Khirbat Hamra Ifdan (Ben-Yosef 2010:Section 5.2.8) showed two distinct layers composed of different types of slag; the upper (younger) layer has slag that is similar to Type A, and the lower (older) has slag that is similar to Type B. The mound was dated roughly to the Iron Age by archaeomagnetic techniques and one loosely associated radiocarbon date (Ben-Yosef 2010:Section 5.2.8.2). The slag typology may indicate that the upper layer is ninth century BCE and the lower layer is tenth century or older.

Raw Metal and Prills

Copper prills are an important raw product of the smelting process (Figure 13.49). These are rounded metallic droplets extracted from the molten phase during the smelting but usually remaining trapped within the slag material. In excavations, they are found embedded in slag as individual artifacts (probably a result of weathering of slag material) or on the slag coating the tuyères (Figure 13.40:3a; this is a common occurrence as the tuyère was located in the most active smelting zone in the furnace). Their size ranges from microscopic dimensions (e.g., Ben-Yosef 2010:Figures 8.39–8.40) up to a centimeter

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Figure 13.47 Examples of slag fragments for the 'Araba Valley. (1–2) A *large* tap slag slab representing the technology of the late tenth to ninth centuries BCE at KEN-M; top (1) with clear layered flow texture and bottom (2) with typical rugged appearance. (3) Intact tap slag from the Iron Age "slag mound" at Khirbat Hamra Ifdan. (4–8) Glassy fragments and "droplets" of slag from Khirbat en-Nahas. (9) A unique pattern of holes on a tap slag—bubbles in slag, or deliberately made with a stick (KEN-F, EDM 20209, L837, B1107). (10) A mix of furnace slag and tuyère fragments, remains of a broken furnace. (11) A large slab of tap slag of the later technology (KEN-W, L20). (12) Broken furnace slag with oxidized copper/ore residues and embedded charcoals (KEN-M, EDM 90493, L629, B9333). (13) Typical broken tap slag of the main technological phase at Khirbat en-Nahas (Area W, L111). (14) Broken tap slag with "slag droplets" (cf. 6–7) (KAJ, surface find). (15) Furnace slag with embedded charcoals. (16) Typical *ring slag* from the Early Islamic site of Beer Ora in the southern 'Araba. Similar ring slags from Timna 2 probably belong to the same period and *not* to the Late Bronze/Iron Age (see text).

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Figure 13.48 Examples of buildings made of slabs of tap slag. (*a*, *b*) "Open mosque" in Beer Ora, southern 'Araba (Early Islamic), Israel. (*c*) Terraces at the Roman site of Skoriotisa, Cyprus. The first constructions with tap slag in the southern Levant have been observed in the Iron Age, with tap slag of the later technology at the metallurgical complex at KEN-R and installations at Timna 30 (late tenth to ninth centuries BCE).

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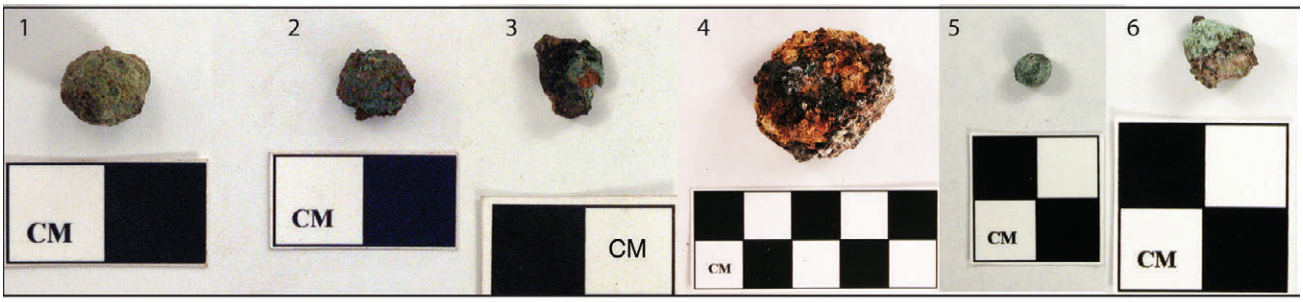

Figure 13.49 Copper prill samples; note that some (3, 4, 2?) have an indication of iron contamination.

#	EDM #	Site	Area	Locus	Basket	Comments
1	91280	KEN	M	680	9978	Copper prill
2	90868	KEN	M	618	9651	Copper prill
3	90871	KEN	M	649	9654	Copper (-iron?) prill
4	90176	KEN	M	621	9085	Copper-iron prill
5	20146	KEN	F	819	1078	Copper prill
6	50046	KEN	A	0	4019	Copper prill

or two, but usually they are in the range of several millimeters. Copper prills must have been collected for further processing that included remelting and casting. It is possible that prills, like metal chunks (below), contained a large amount of iron that had to be removed in a refining process. Prills were not chemically analyzed in the current research, but some have observable residues of iron (Figure 13.49:3–4). We have collected several hundreds of prills during the different ELRAP excavations.

It has long been recognized that the model predicting a nicely rounded ("bun-shaped") pure copper ingot in the bottom of the furnace at the end of each smelting cycle (e.g., Rothenberg 1972:236) is too idealistic (e.g., Merkel 1990). Instead, the results of our excavations suggest that the raw smelting process produced "metal chunks," small (2–12 cm in diameter, irregular shapes; Figure 13.50) metallic concentrations that accumulated in the furnace bottom and should have been separated from the attached furnace slag above. Generally speaking, these can be considered large-scale prills that were heavy enough to sink to the bottom of the furnace. These "metallic chunks" must have been further processed, or at least melted and cast into "commercial" ingots.

Preliminary analyses of such metal chunks indicate that they are present in all smelting contexts and are much more abundant in contexts of the late, tenth- to ninth-century BCE technologies. In addition, most of these chunks appear to be contaminated with iron, a pattern that is much more prominent in metallic chunks of the later technology (represented mostly by the metallurgical complex at KEN-R). A few X-ray fluorescence analyses on such chunks indicate a high concentration of iron (Ben-Yosef 2010:Figure 8.34). Whether the excavated metal chunks are the remains of "failed" smelting attempts or of representative raw products is discussed in Ben-Yosef (2010:Section 8.5.1). We believe that these represent the raw product and that further processing must have taken place in specialized workshops. Moreover, we see the iron contamination mostly as a problem of the advanced smelting process, in which iron was reduced to metal much more easily. As discussed earlier, a specialized workshop for refining metal chunks was discovered at KEN-F (Ben-Yosef 2010:Section 5.2.4.1). The archaeometallurgical assemblage from this excavation area is unique (with some similarities to Area T only; see above), both in pyrotechnological installations and metallurgical-related artifacts. In the workshop of Area F, iron-contaminated copper chunks similar to those found in the smelting complex of Area R were recorded. However, in addition to recording this chunk type, relatively abundant pure copper metal "droplets" and chunks have been found (Figure 13.51; cf. almost none at Area R and only a few in Area M). These finds support our interpretation of Area F as a refining and casting workshop, transforming the raw smelting products into commercially valid commodities.

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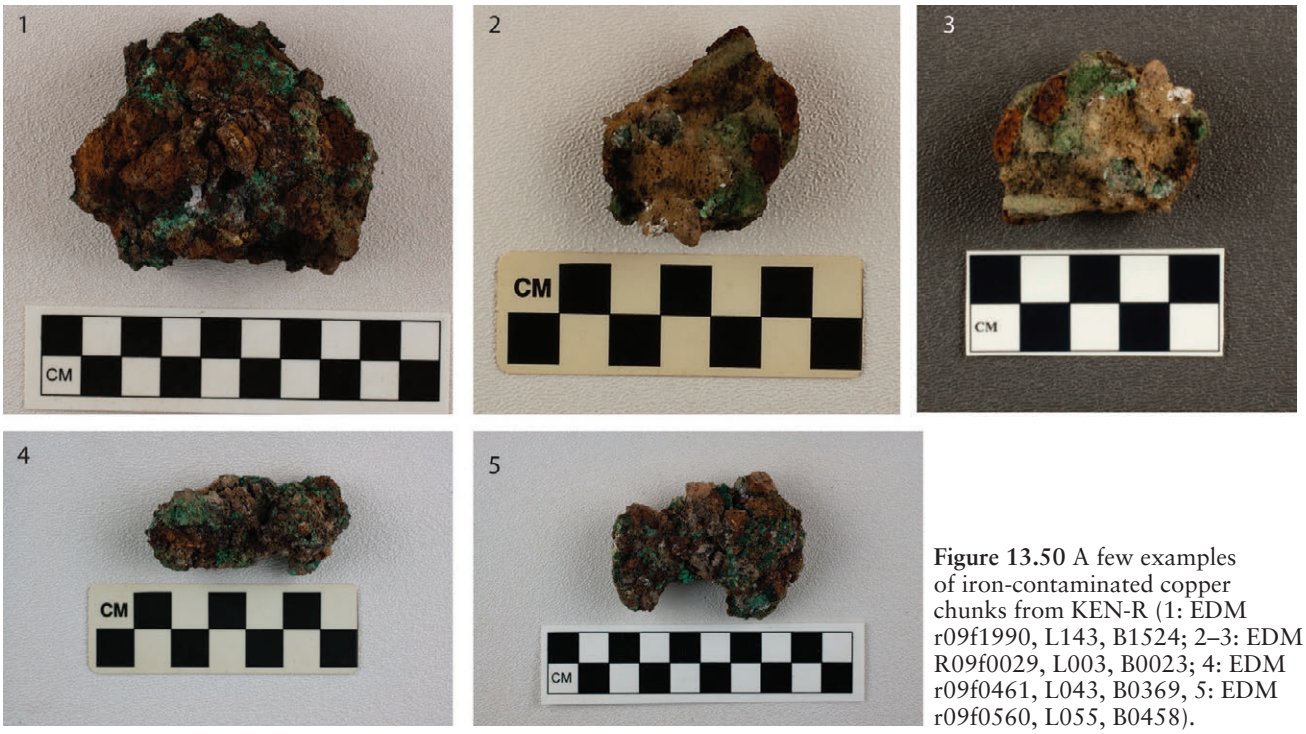

Figure 13.50 A few examples of iron-contaminated copper chunks from KEN-R (1: EDM r09f1990, L143, B1524; 2–3: EDM R09f0029, L003, B0023; 4: EDM r09f0461, L043, B0369, 5: EDM r09f0560, L055, B0458).

Further analyses are needed to achieve a conclusive answer regarding the quality of raw copper smelting products and the procedures of further refining in the Iron Age smelting sites of the 'Araba (e.g., careful examination of the residues on molds [and crucibles] from Area F, to track iron remains from the secondary processing stage). This should be done in consideration of the two distinct technological traditions discussed in the current research.

Molds, Crucibles, and Ingots

Clay molds are extremely rare in the archaeological record, and very few are reported from Iron Age contexts in the southern Levant. This is because such molds were not fired, were deliberately broken to extract the copper products, and are often difficult to recognize in the archaeological record. For example, it took some years for the 'Araba Expedition to identify ceramic fragments from Timna 30 as molds (Rothenberg 1990:54). Being aware of this situation, we paid careful attention to such material and tried to identify molds and other pyrotechnological clay vessels (like crucibles) in the field. However, most of the clay molds from the ELRAP expeditions were identified only later, during the meticulous work on the metallurgical collection at UCSD. In the field, most of these artifacts were labeled as "furnace fragments" and some as "technological ceramic." In the sample collection of selected artifacts described above, about 30 fragments were identified as molds. They are mostly from Area F (Figure 13.52). It is possible that some of these objects are very shallow or fragmentary crucibles, but in the current stage of research, we could not confidently identify *any* crucible in the archaeological record. The issue of the use of crucibles should be investigated in the future, together with other technological aspects of the specialized workshop at Area F. The refining/melting and casting process is far from being clear, and given the novelty of this recent discovery, considerable (analytic and other) effort should be focused on this intriguing feature of copper exploitation at the Iron Age 'Araba Valley.

Mold fragments have been found also in Area M (Figure 13.53), mostly from upper (younger) loci. This is in accordance with finds of bellows pipes at these contexts. These finds probably indicate the existence of a specialized workshop similar to the one uncovered in Area F somewhere nearby (with its debris disposed of in Area M).

Only a handful of copper ingots were found in the 'Araba Valley (Rothenberg 1990:63–66), some of which were associated with the Late Bronze Age copper production in Timna, including small "ingots" from the workshop at Site 2 (although those pieces are probably the result of primary smelting, as other "copper

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Figure 13.51 Metal chunks from KEN-F.

#	EDM #	Site	Area	Locus	Basket	Comments
1	12171	KEN	F	861	1181	Iron-rich metal chunk
2	20595	KEN	F	888	1357	Iron + copper metal chunk
3	20083	KEN	F	804	1043	Iron-rich copper prills
4	20285	KEN	F	819	1155	Copper metal droplets (amorphous pure copper metallic fragment, probably a spill from refining/casting activities; note the not oxidized pure copper in several places)
5	20327	KEN	F	803	1178	Oxidized copper metal chunks
6	20359	KEN	F	819	1199	Oxidized copper metal droplet
7	20362	KEN	F	815	1201	Oxidized copper metal droplet

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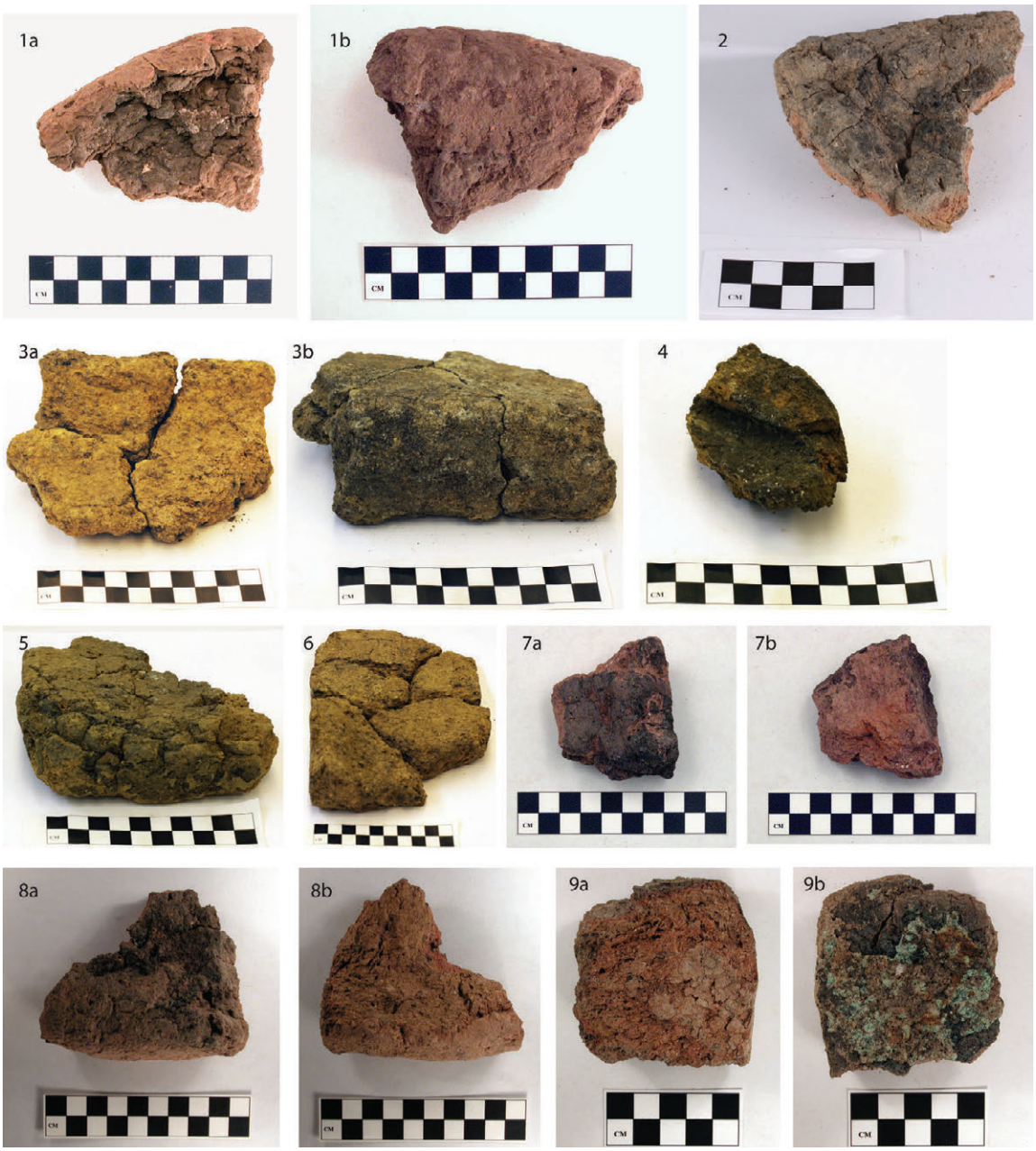

Figure 13.52 Example of mold fragments from KEN-F, a specialized metallurgical workshop for refining and casting (see text).

#	EDM #	Site	Area	Locus	Basket	Comments
1	12107	KEN	F	910	1515	Mold fragment, edge, (*a*) sintered black top side, (*b*) bottom side
2	20420	KEN	F	819	1240	Mold fragment, edge, sintered black upper side
3	12123	KEN	F	860	1412	Mold fragment, edge, clay with slag inclusions (similar to furnace walls' material); top (*a*) and bottom (*b*) sides
4	20733	KEN	F	902	1475	Mold fragment, edge, sintered, black upper side
5	20641	KEN	F	860	1392	Mold fragment, heavily sintered black upper part
6	20641	KEN	F	860	1392	Five restorable fragments of a mold; although same recording details as (5), the fragments probably belong to a different mold
7	12122	KEN	F	900	1503	Mold fragment, (*a*) top sintered black part, (*b*) bottom side, reddish clay
8	20420	KEN	F	819	1240	Mold fragment, (*a*) top sintered black part, (*b*) bottom side
9	20597	KEN	F	895	1359	Mold fragment, (*a*) bottom side, reddish clay, (*b*) top side, sintered blackish copper residues

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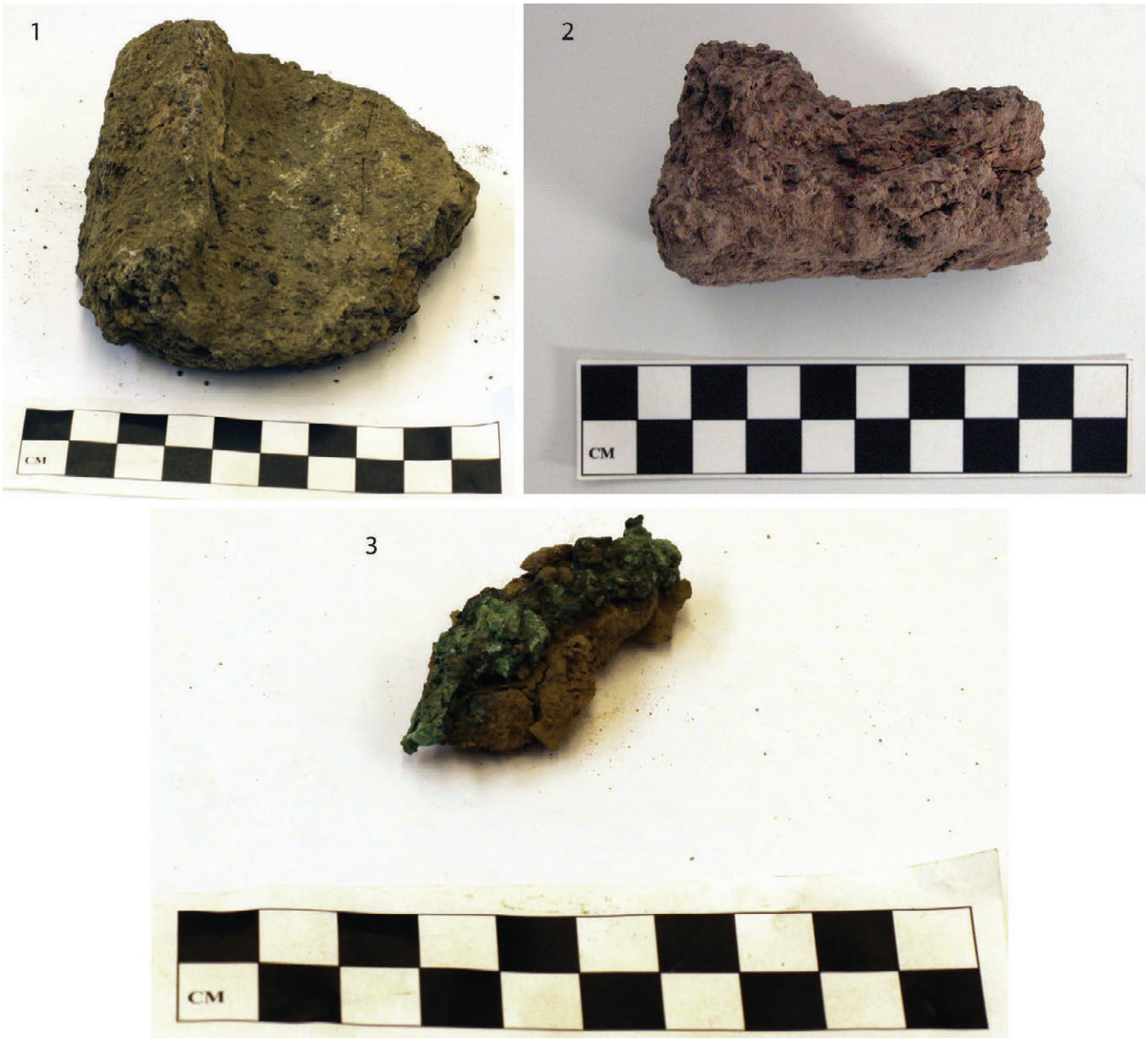

Figure 13.53 Clay mold fragments from KEN-M, two probably for ingots (1, 2) and one for a final product (copper pin, 3).

#	EDM #	Site	Area	Locus	Basket	Comments
1	90190	KEN	M	619	9098	Mold fragment, upper side, edge, clay with slag fragments
2	91283	KEN	M	681	9981	Mold fragment (section), edge, clay with slag fragments
3	90079	KEN	M	607	9025	Small mold with copper pin intact; evidence of final product casting at KEN

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Figure 13.54 The metallurgical complex at KEN-R; walls constructed for organizing working and disposal spaces.



Figure 13.55 A large stone basin at KEN-F (scale = 20 cm).

lumps" [in this work, those are called "chunks"] and amorphous "ingots" from Site 3). Three plano-convex pieces of copper, two from Bir Nasib in Sinai and one from Ain Yahav in the northern 'Araba, may represent Late Bronze Age–Iron Age ingots, although they also were found to be very impure and the result of primary smelting (Rothenberg 1990:65–66). The "ingots" from Bir Nasib are around 10 cm in diameter, are 3 cm thick, and weigh around 680 g. The dimensions of the "ingot" from Ain Yahav, considered to originate from Faynan, are 19 x 14.5 cm and 5 cm thick. In sum, the best evidence we have thus far for the shape of the traded copper ingots are the fragments of clay molds found in the smelting sites of the 'Araba.

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Very limited evidence from Khirbat en-Nahas indicates the casting of final products (not commercially valuable ingots) at the site. This includes a copper pin found intact inside a small clay mold at Area M (Figure 12.53:3) and a casting mold for a female figurine (see Levy 2008). Rothenberg (e.g., 1990:65) describes the casting workshop (copper smithy) identified in Timna (e.g., Timna 2, Area K) also as the production center of jewelry and many other final products.

Other Installations

The Iron Age archaeometallurgical record in the 'Araba contains other various installations related to the copper exploitation process, such as architectural features, rock basins, and more, including many that we do not recognize as related to the production system or that we do not understand. For example, in the mining areas in Faynan, carved holes for a winch have been reported in a few shafts (but many of the shafts do not have any; see Chapter 12, this volume). We have reported for the first time the feature of holes carved into a rock face in both Ras al-Miyah West and East, which was probably also related to the mining system (Ben-Yosef et al. 2009 and Chapter 6, this volume). Small stone-built installations, like the ones exposed in the deepest parts of the sounding at KEN-M and a "standing stone" in KEN-F, might be related to the copper production system, maybe to the religious/cultic aspects of it, but these are usually not associated with further indicative finds (e.g., Ben-Yosef 2010:Figure 5.50).

We interpret the wall complex at KEN-R as a deliberate construction of designated disposal spaces and retaining facilities, done as part of careful organization of the *smelting* working area (Ben-Yosef 2010:Section 5.2.4.1). The well-organized dumping is illustrated in Figure 13.54. The walls themselves are loosely built of local stones and tap slags; they include some features that we could not explain (such as deliberate "windows" or holes). Retaining walls and designated dumps have also been recorded at Timna Site 30 (Rothenberg 1990). It seems that this carful organization and tight arrangement of working and disposal spaces (including digging subterranean installations) mostly characterizes the advanced phase of copper production (late ninth to tenth centuries BCE). This is probably part of deliberate efforts to increase efficiency in production, a trend that is evident in many other aspects of the production system (Ben-Yosef 2010:Chapter 9). It is possibly also related to the fact that the later technological phase was practiced on previous deposits and in areas with dense remains and constructions, which required better control over space for keeping a smoothly working production system.

Another set of installations is associated with the specialized metallurgical workshop at KEN-F and includes large rock basins (Figure 13.55) and various architectural features. These have to do with the refining/melting and casting operation at the site, but their exact function is still not clear.

Copper-Production Related Sediments and the Composition of a "Slag Mound"

The bulk of the sediment in copper production sites is directly related to technological waste. Detailed description of various sediments and their quality is provided as part of the discussion on the deep sounding at KEN-M (Ben-Yosef 2010:Section 5.2.4.2). The main conclusion of our observations is that less than 40 volume percent of the deposits of a "slag mound" are actually slag material (at KEN-M, it has been found to be around 38 volume percent; at KAJ-A, it was found to be much less [no precise value available]; see Ben-Yosef 2010:Section 5.2.4.2). The rest of the sediment in a typical "slag mound" includes large amounts of clayey deposits, ash, charcoal, organic materials (in the case of Timna 30), and domestic waste (a large component of the "slag mound" at KAJ-A). The clayey sediments are derived from furnace walls and tuyères, probably in considerable quantities as the unfired clay component of these vessels and installations has been found in the current research to be substantial (see discussion on "large tuyère" above). They may also simply represent deposition of clay brought to the site as part of the manufacturing process of relevant installations and vessels (e.g., red clay deposits at Timna 30, Area L). Charcoal, "charcoal dust," and ash are also a prominent composition of deposits in a "slag mound." Those are mostly the refuse of furnaces (and other pyrotechnical installations) but probably include charcoal being prepared for use in smelting and remains of charcoal processing before their use in the furnace. Before the final use of charcoal as fuel, it was important to get rid of all the fine charcoal fragments, as those would choke the fire. Thus, in many ethnographic examples, charcoal was sieved as part of its final preparation. The fine fragments were disposed, and those are probably part of the "slag mound" debris (cf. Layer 62 in the Corto Lago section at Rio Tinto; Rothenberg and Blanco

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1981:105). If wood was used as fuel, ash would have accumulated in large quantities (which is the case in many contexts, but this is typically related to domestic activities [oven] or kilns).

The relatively low amount of slag in a typical "slag mound" found in the current research is corroborated by the results of recent excavations of "slag mounds" associated with iron production in England (Gill Juleff, personal communication, 2008, and see the Exmore Iron Project website: http://www.ndas.org.uk/exiron.htm). The quantities of slag material in "slag mounds" have important implications on estimating quantities of metal produced at a site. The quantities of metal are derived from the estimated quantities of slag, which are based on surface observation and estimation of volumes of "slag mounds." Therefore it appears that previous investigations overestimated quantities of metal produced in ancient sites (see Ben-Yosef 2010:Chapter 9 for relevant discussion regarding the Iron Age sites of the 'Araba).

Summary

Technology-related remains constitute the bulk of Iron Age material culture in the smelting sites of the 'Araba Valley. These artifacts reflect social and cultural meanings that can, to some degree, be deciphered by careful investigation of the material culture of technology. This chapter has provided an overview of the most common artifacts in the Iron Age copper smelting sites of the 'Araba Valley and introduced substantial new data sets and new insights based on our recent excavations at various sites in Faynan and Timna. In addition to refining specific technological reconstructions (furnace height, tuyère length, etc.), the main conclusions of this preliminary investigation are as follows:

(1) Two *main* copper smelting technological traditions exist in the Iron Age southern Levant. The first, a continuation of Late Bronze Age smelting technologies, was in practice until the late tenth to the beginning of the ninth century BCE and is represented in all Iron Age sites investigated in the current research. The second technological tradition appears *abruptly* and replaces previous technological practices. This happens shortly after the first tradition ceased to be in use[19] sometime during the late tenth to early ninth centuries BCE. The introduction of the new and more effective technology was accompanied by a major reorganization of production: copper smelting was practiced in fewer sites (only in Khirbat en-Nahas, Timna 30, and Khirbat Faynan), and some sites were abandoned as part of this general change (Khirbat al-Jariya, Khirbat al-Ghuwayba).

(2) A third copper smelting technological tradition was probably practiced simultaneously with the large-scale Iron Age technologies. This was a marginal, small-scale production using simple ("primitive") smelting technology outside the main smelting centers of the Iron Age southern Levant. Currently, the evidence for this technology comes from a few sites in the southern 'Araba and Faynan (Ben-Yosef 2010:Chapters 5 and 6, and see especially Sections 6.2.3 and 6.2.4 for discussions).

(3) Each of the copper smelting technological traditions of the Iron Age southern Levant presents a distinct assemblage of material culture remains; these assemblages can be characterized by visual investigation of the artifacts (for analytic characterization, see Ben-Yosef 2010:Chapter 8). The most notable differences between the technological traditions are evident in *slag* and *tuyères*. Slag of the later (late tenth to ninth centuries BCE) tradition was significantly larger, and the tap slags were not crushed. They were produced in a standardized "slag pit," demonstrate flow marks, and are often layered, probably a result of more than one smelting cycle. The tuyères of the later technology are also significantly larger, more effective, and manufactured in a slightly different way than the tuyères of the previous Early Iron Age–Late Bronze Age tradition (for more details, and for differences in *furnaces*, *metal*, and artifacts, see text above). The simple copper smelting technological tradition can also be characterized by visual investigation of slag and tuyères (when available); these resemble remains of typical Early Bronze Age or earlier smelting technologies.

(4) Slag material in the Iron Age copper production system *was not* purely a waste product. After production, slag was crushed to extract copper prills, to be used as tempers in technological ceramics (mostly furnaces and tuyères) and in domestic ceramics, as a flux in the smelting process, and as foundation layers for building construction.

(5) The ubiquity of slag within the material culture of Iron Age smelting sites, even in nontechnological artifacts, indicates a specific *technological style* of the Iron Age craftpersons in the 'Araba Valley. The

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use of crushed slag in ceramic production was a tradition, an idiosyncratic quality of the societies engaged in copper exploitation that may have become a symbolic feature or emblematic cultural tradition, rather than only functional.

(6) Based on patterns of archaeometallurgical remains at Khirbat en-Nahas, a basic technology-related spatial model is suggested: the "slag mound" of Area M (one of over 20 visible at the site) was mostly a designated dump area for metallurgical waste with occasional activity surfaces that are represented by in situ installations; Layer M1 (the late tenth- to ninth-century BCE) represents the most advanced and efficient smelting technology. This layer was partially deposited on top of Room 1 (and maybe on some other parts of Building 1) after it went out of use, probably because of the heat and weight (pressure) impact of the adjacent production area and the accumulation of copper production debris against the walls. Most of the site surface of Khirbat en-Nahas is covered with large slabs of tap slag representing widespread smelting activities in the late tenth to ninth centuries BCE. The metallurgical complex in Area R also presents the most advanced technology at the site; this implies that most of it was dug into the courtyard of the early to mid-tenth-century BCE monumental structure. The loose walls in this area are *not* the remains of a previous occupation layer but rather represent installations contemporaneous with the smelting activities and were used mostly as retaining walls for holding back metallurgical debris and as dividers between designated spaces for different technological activities (and as support for some installations). Area F (and parts of Area T, although the relevant materials from this area are less exposed and were studied less in the current research) represents a specialized workshop for refining and/or melting and casting ingots.

(7) Charcoal was used as a fuel, and possibly also wood in some cases. The pattern of charcoal species used at Iron Age smelting sites (in particular the absence of acacia in the archaeological record of Faynan) possibly reflects the social values of semi-nomadic societies in a desert environment and supports the model of a *tribal kingdom* (confederacy/chiefdom) for Iron Age southern Jordan. This is based on comparison to ethnographic and ethnobotanical studies of modern Bedouin societies in the Sinai Peninsula.

(8) Growing evidence suggests the casting of copper ingots in clay molds (rather than in depressions dug in sand/wadi sediments). A relatively large amount of mold fragments has been uncovered in KEN-F, supporting our interpretation of this area as a workshop for refining and/or casting.

(9) Limited evidence from Khirbat en-Nahas indicates the casting of final products (a copper pin found intact in a clay mold and a clay mold of a female figurine).

(10) The composition of a typical "slag mound" is a mix of metallurgical-related debris; in fact, the slag content is less than 40 percent (by volume), and most of the deposits are clayey sediments, derived from decomposed furnaces, tuyères (cf. the full length of the original large tuyère body, exceeding 30 cm), molds, and so on.

As comprehensive as the archaeometallurgical assemblage might be (there are over 6 tons of this material stored at UCSD), many aspects of the technological practice are missing, such as associated ritual, magic, and other spiritual factors that leave very little, if any, physical evidence in the archaeological record. Nevertheless, some indications of associated cultic activities do exist in the Iron Age copper production sites, such as the figurine site of FBRS 27 near the copper mine complex of Ras al-Miyah East in Faynan, Area W in Khirbat en-Nahas, the kneeling bronze figure found in the Area A fortress gatehouse at KEN, and some sites in the Timna Valley (mostly dated to the Late Bronze Age, but see reservations about this date in Ben-Yosef 2010:Chapter 6). The descriptions of these sites and their finds are incorporated in Chapters 2, 3, 6, 7, 9, 10, and 12 (this volume).

The vast archaeometallurgical collections of ELRAP and the preliminary work presented here constitute a firm basis for future research. Many technology-related questions are still open, and further investigations of the various artifacts are a key to better understanding the Iron Age smelting technologies and the society or societies responsible for them. Some problems identified in the current stage of research, such as the presence of iron in the raw copper smelting product, the reconstruction of refining and melting installations (with their particular bellows pipes), the quality of the end products (ingots), and the use of clay molds, call for further collaborative research on the materials available in the archaeometallurgical collection at UCSD.

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Notes

1 This chapter is based on Ben-Yosef (2010:Chapter 7). The authors are especially thankful to Cindy Beck for her dedicated help in the laboratory work.

2 The UCSD Levantine Archaeology Laboratory is grateful to the Department of Antiquities of Jordan and especially its directors, who have supported our research: Dr. Ghazi Bisheh, Dr. Fawwaz al-Khrayshah, and Prof. Ziad Al-Saad.

3 The work on the archaeometallurgical collection took place during the spring of 2010 with the much appreciated help of students and other volunteers. Many of the observations presented here have been achieved during fruitful discussions with Cindy Beck (ELRAP's ceramic restoration specialist) and undergraduate Breanne Kebely.

4 It was beyond the scope of the current research to provide a restoration of such a system; however, the collection is well organized and ready for future research.

5 Both *ore* and *flux* are context-defined terms (as well as the term *gangue*); generally, ore is defined as an economically valuable mineral(s) (thus, ores defined by modern standards are very different from ores defined by ancient standards. This definition is in fact a derivative of *technology.*). Flux is another mineral (such as iron or manganese oxides) added to the copper ore as an agent that reduces the copper from the other components of the minerals, such as carbonates, sulfides, and silicates. In essence, it facilitates the smelting process; also here the definition is relative, and *flux* is a context-specific term that depends on the raw ore smelted and the technology used (e.g., if the ore is silica poor, *quartz* [sand] may be used as *flux*).

6 Just before the final submission of this work, we received some new species identifications of charcoal from ELRAP's 2009 field season. Interestingly, it included two charcoal samples of *Juniper* species, the first to be reported from ELRAP excavations so far (cf. Figure 13.10 for low quantities of juniper in KEN).

7 This intensive botanic research was conducted by the Institut für Systematische Botanik und Pflanzengeographie of the Free University of Berlin, in conjunction with the Deutsches Bergbau-Museum.

8 The workers used some of the material of the central "slag mound" to pave trails to the working areas and refill some excavated pits; the mound is clearly disturbed in its northern and northwestern sides and many of the Layer 1 tap slag there are not in situ (A. Avner, personal communication, 2009).

9 Hauptmann does not provide an explanation for these features in any of his publications. As mentioned below, the basic limiting factor that excludes the interpretation of such installations as furnaces is their size. After considering additional evidence from Faynan 5 and KEN-R, it became clear that the size of the depression is not a result of a secondary use for storage or a deformation of the original furnace (as suggested by Rothenberg for Timna 30), but rather the original size and shape of such installations.

10 Avner and Magness (1998) consider all of the "cake slag" (i.e., the massive, solid slag slabs) to represent later smelting activities, and this is the reason that they include Timna Site 30 in their Islamic site distribution map (Avner and Magness 1998:Figure 1). However, we have clearly shown here that this type of slag is typical of the ninth-century BCE smelting technology both in Faynan and in Timna (see in particular Ben-Yosef 2010:Chapters 6, 8).

11 However, slag is also a fluxing agent in clays (it eases the melting process; see Al-Shorman 2009:212).

12 Tite et al. (1990) also observed that the slag used as tempers for furnace clay in this context is manganese rich (our "Type A"; see Ben-Yosef et al. 2012) and not iron rich; this may be a deliberate choice, but the sample size is too small.

13 At the site of Rujm Hamra Ifdan, located a few kilometers from the main smelting sites (Chapter 10 this volume), most of the vessel types of the Early Iron Age (ca. 1200–800 BCE) pottery contained slag inclusions. Interestingly, in the pottery assemblage of the Late Iron Age (ca. 700–500 BCE) from this site *only*, pithoi contained slag inclusions (N. G. Smith, personal communication, 2010). This may represent some continuation of pottery traditions of the local societies. The pottery assemblage from the Late Iron Age fortresses of Ras al-Miyah (the only other Late Iron Age ceramic assemblage from Faynan, Chapter 12, this volume) was not thoroughly studied; presence of slag inclusions in vessels from this assemblage (as opposed to any vessel on the plateau at this period) will support local traditions of ceramic manufacturing practices and some dichotomy between the plateau and the lowlands also in the Late Iron Age activities.

14 The use of multilayer refractories has also been reported from the bronze working Iron Age site of

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Kh Edh-Dharih where calcareous illitic red layer and noncalcareous sandy white layer were used in the melting crucible manufacture (Klein et al. 1997). This suggests that the production of multilayer refractories was a local technological tradition (see Ben-Yosef 2010:Chapters 9 and 10).

15 Only one fragment from KAJ had the typical reed marks of the small tuyères (EDM 20227, L118, B3705), but this is the only fragment that represents the bulk of the body of the rear part of the tuyère in the entire archaeometallurgical assemblage from this site. This relatively well-preserved fragment represents a minimum external diameter of the rear parts of small tuyères, around 11 cm. This fragment also has around 40 parallel reed marks representing differently cut reeds (i.e., the marks are not equal in width). Similar fragments were found in KEN-M.

16 The way a sushi roll is made is somewhat similar to the procedure we suggest here.

17 Al-Shorman (2009) reports that back portions of tuyères from Sinai are made of noncalcareous clay with no slag inclusions. The front parts of the tuyères in Sinai have more or less similar composition, with lower amount of quartz, coarser grains, and higher feldspars (there are few reports on the quality of archaeometallurgical artifacts from Sinai).

18 Because the extraction of metal in the smelting technology associated with Type A slag was much more efficient than in the smelting technology associated with Type B (see Ben-Yosef 2010:Chapter 9), it is not clear if further processing of furnace slag was part of the *chaîne opératoire* of this technological phase. The evidence from Timna 30 indicates that Type A slag was crushed, at least to be used as a temper, but probably also for further extraction of prills (from the furnace slag), because Type B slag was abundant and could have been used as a source of temper in the later technological phase.

19 A short break between the practice of the two technological traditions, rather than a continuous practice of smelting activities (with only a reorganization of production), is supported by the stratigraphic layout of the archaeometallurgical deposits (in particular, Timna 30, Area S, where a distinct "abandonment" horizon has been exposed in the "slag mound") and by a change on a regional scale where abandonment of sites and a major reorganization of production exclude any possibility of organic, internal developments.

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14 The Iron Age Edomite Script and Language

Methodological Strictures and Preliminary Statements[1]

Christopher A. Rollston

This chapter reviews the basic contours of the Iron Age Edomite script and language. For much of the twentieth century, epigraphers had focused on delineating the diagnostic features of the major script and language traditions of the Iron Age Levant: Phoenician, Hebrew, Aramaic, and Moabite. During the final decades of the twentieth century, as the corpus of Levantine Northwest Semitic linear inscriptions continued to grow, it became clear that Ammonite, Edomite, and Philistine scripts and languages could start to be delineated. By 2009, the Edom Lowlands Regional Archaeology Project had hoped that some Edomite or other Northwest Semitic inscriptions would be retrieved in the surveys and excavations carried out in the Faynan region. Unfortunately, no such epigraphic finds came to light. However, the review presented here is important because it highlights the earlier date for a number of Iron Age Edomite inscriptions, advancing the date of Edomite literacy to the cusp of the ninth century BCE. It is argued here that the mother script of Edomite was Aramaic. This new assessment will have important implications for the study of secondary-state formation during the Iron Age in the southern Levant.

Introduction: Delineating a Fledgling Corpus—Methodological Problems

Certain salient features can function as partial bases for the assignment of an ancient inscription, or corpus of inscriptions, to a particular language or dialect. Among these features are the presence and nature of diagnostic linguistic features, the provenance of the inscription or corpus, the putative chronological horizon(s) of the inscription or corpus, and the personal, divine, and place-names that are present. The script (e.g., the morphology, stance, ductus of the letters, spatial relationships of letters) can also be very useful in assigning an inscription or corpus to a particular language or dialect (and eliminating possible assignments as well), but certain methodological caveats and provisos must be considered paramount, because a script can be used to write multiple different languages (Rollston 2006:50–61).

Regarding both language and script, the quantity and quality of the data are always fundamental components of linguistic and script classifications: the better the data, the more decisive the classification. Therefore, for languages and scripts that are well attested, newly found inscriptions can be

Opposite: Kheleifeh jar handle impression 528 'Qaws-'nl'. *Photo: Bruce Zuckerman and Marilyn Lundberg.*

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classified quite rapidly and with substantial certitude. However, for languages and scripts that are not well attested, classification of script and language can be difficult. Because there is a relative dearth of epigraphic Edomite, the initial portion of this article will be methodological in nature, and the final portion will be a cautious assessment of putative Edomite epigraphic material.

Scripts: Methodological Caveats

Nonspecialists sometimes assume that *script* and *language* are the same thing. That is, however, not necessarily the case. Thus, the alphabet used to write most Western European languages is the Latin alphabet. For example, the sentence "*Rien ne l'intéresse*" ("Nothing interests him") is written in the French language, but the script is Latin. Similarly, the sentence "*Daar wil ik niets mee te doen hebben*" ("With that I will have nothing to do") is written in the Dutch language, but the script is Latin. That is, the script used to write these languages is the same script used to write the Latin sentence "*Bis das si cito das*" ("You give twice if you give quickly"). Similarly, this sentence from Philo, "*Η μεν προτερα συνταξις εστι περι γενεσεως της Μωυσεως*" ("But the former treatise is about the generation of Moses"), is written in the Greek language and the Greek script, but "*Νετ-μοουτ*" ("those who are dead") is written in the Greek script but the Coptic language. The same phenomenon is attested for Northwest Semitic. For example, The Tel Dan (تل القضاة) Inscription is written in the Aramaic language but in the Phoenician script (Biran and Naveh 1995; Naveh 1987:78–80). The point is, therefore, that script and language are two different things.

For some Iron Age Northwest Semitic languages such as Phoenician, Aramaic, and Old Hebrew, the diagnostic aspects of the scripts can be delineated with substantial precision.[2] That is, the corpora are large enough to permit a high degree of certitude. Nevertheless, because of a general dearth of ancient epigraphic data for Ammonite, Edomite, Moabite, and Philistine, there are significant lacunae in our knowledge of the Iron Age Northwest Semitic scripts used for these languages. For inscriptions written in these languages, statements about the scripts can indeed sometimes be made, but methodological caution requires that some (many) of these statements be recognized as partial, not definitive. Furthermore, it should be noted in this connection that for the scripts used to write Iron Age Northwest Semitic languages, there are ancillary complications. Namely, the Phoenician script was the "mother script" of the Old Hebrew script (and its putative congeners) and also of the Aramaic script (and its putative congeners); moreover, during the Iron Age, the Phoenician script itself also continued to be used and also to develop. For these reasons, those scholars who are attempting to assess the fledgling features of a "new" national script (e.g., Ammonite, Edomite, Moabite, Philistine) must also control the Phoenician, Old Hebrew, and Aramaic scripts.

Lexemes: Methodological Caveats

It is sometimes assumed that certain lexemes can routinely be used as linguistic diagnostics within the Semitic languages and dialects (i.e., for determining the precise language of a text). For example, with regard to the verbs for "to do" or "to make" in Iron Age Northwest Semitic, some have stated that the presence of the verb *ʿšh* in an Iron Age epigraphic text would suggest (or demonstrate) that an inscription is Old Hebrew (because of the predominance of this verb in Hebrew for "do," "make"), that the presence of the verb *pʿl* in an Iron Age epigraphic text would suggest (or demonstrate) that the epigraphic text is Phoenician (because of the predominance of this verb in Phoenician for "do," "make"), and that the presence of the verb *ʿbd* in an Iron Age text would suggest (or demonstrate) that the text is Aramaic (because of the predominance of this verb in Aramaic for "do," "make").[3] Nevertheless, the fact remains that these verbs (or verbal roots) cannot be understood as definitive markers of, or diagnostic for, a particular Iron Age Northwest Semitic dialect. The reason is this: *ʿšh* is attested not just in Hebrew but also in Moabite, arguably in Phoenician, and even in Arabic; *pʿl* is attested not just in Phoenician but also (for example) in Hebrew, Aramaic (Egyptian Aramaic, Syriac), Arabic, and Old South Arabic (and in Ugaritic of the Late Bronze Age); and *ʿbd* is attested not just in Aramaic (e.g., Old Aramaic, Egyptian Aramaic, Palmyrene) but also in the dialect of the Deir ʿAllā (دير علا) Plaster Texts, Old South Arabic, and Ethiopic. On the basis of these data, I contend that it is not prudent to attempt to argue that the presence of the verb *ʿšh* in an Iron Age epigraphic text would suggest (or demonstrate) that an inscription is definitively Old Hebrew, that the presence of the verb *pʿl* in an Iron Age epigraphic text would suggest (or demonstrate) that the epigraphic text is definitively

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Phoenician, or that the presence of the verb *'bd* in an Iron Age text would suggest (or demonstrate) that the text is definitively Aramaic (Rollston 2011:71–76). To be sure, Rainey (2007:70) has criticized Garr (1985) for not considering lexical data (innovations in particular) in his (Garr's) work on dialect geography of the Iron Age Levant, but the reason for Garr's methodological strictures is quite compelling. After all, using lexemes to determine dialect is fraught with difficulties.

Two factors are imperative to remember in discussions of ancient Northwest Semitic lexemes: (1) the attested lexemes for ancient Northwest Semitic epigraphic languages are a fraction of the totality of the lexemes used in antiquity. Therefore, the epigraphic corpus for a particular Northwest Semitic language should certainly not be construed as approximating the full number of lexemes or morphemes of the target language. (2) Many lexemes in Northwest Semitic are preservations of lexemes used in Proto-Semitic; therefore, the same lexeme will often be preserved in multiple Semitic languages (and so attempting to argue that a lexeme can be considered diagnostic for a particular language may be problematic). To be sure, I think that it is tenable to refer to lexical tendencies (e.g., for usage of a particular verb) in a particular Semitic language, but to assert that a lexeme must be understood as a diagnostic for a particular language or dialect will require very strong, decisive evidence. Dramatic claims require dramatic evidence. Rarely are such data present. Along those lines, during her discussion of the difficult dialect of the Iron Age Deir 'Allā (دير علا) Plaster Texts, Hackett (1980) has articulated some basic methodological principles. Namely, she has stated that "it is usually difficult to distinguish the retention of rare but indigenous lexical items from valid borrowings." She goes on to affirm that "in the time period with which we are concerned, the scarcity of material dictates an even more cautious attitude toward categorizing any given lexical item as predominantly 'Canaanite' or 'Aramaic.'" She concludes that "to say that a word or root 'does not occur' in one language or the other may simply mean that it has *not yet* occurred, or that it has dropped out by the time of our more extensive materials" (Hackett 1980:120).

Naturally, however, it is important to note that sometimes (rarely) a lexeme can be quite useful in making determinations regarding the particular *branch of Semitic* of which an epigraph, or epigraphic corpus, may be a part. For example, it has normally been argued that there are two major divisions of Iron Age Northwest Semitic: Canaanite and Aramaic.[4] Within the Canaanite branch of Northwest Semitic, the lexeme *bn* is the norm for *son*, but in the Aramaic branch of Northwest Semitic, the word *br* is the norm. Among the various reasons that Phoenician, Hebrew, Moabite, and Ammonite are classified as "Canaanite" is the fact that the word *bn* is used for the word *son*. Along those lines, it is predictable, therefore, that Old Aramaic inscriptions, Imperial Aramaic inscriptions, Palmyrene inscriptions, (most) Nabataean inscriptions, Jewish Aramaic inscriptions, and Syriac texts use *br* for the word *son*. Therefore, although the presence of the lexeme *bn* cannot be used as the sole basis for assigning an inscription to a particular Canaanite language, it can be used as a component of an argument that an inscription is not Aramaic.[5]

Phonology and Orthography: Methodological Principles

Phonology is often a critical datum in the process of assigning an Iron Age Northwest Semitic dialect to the Canaanite branch or the Aramaic branch.[6] Here are some of the phonological data that are useful in determining language and dialect for Northwest Semitic: (1) within Canaanite, Proto-Semitic *ḏ* > *ṣ*. Thus, *ṣ'n* is the Canaanite form of a word for "sheep" (cf. Phoenician *ṣ'n* ; Hebrew *ṣ'n*; Moabite *ṣ'n*; Ammonite *ṣ'n* [Heshbon A1: 2; Cross 2003:71–79]; and also Ugaritic *ṣin*).[7] However, the *ṣade* of this word is not etymological. Rather, the Proto-Semitic root is *ḏ'n* (cf. Old South Arabic and Classical Arabic *ḏ'n*). Within Old Aramaic, Proto-Semitic *ḏ* > *q* (e.g., Old Aramaic *'rq* "earth" for an original Proto-Semitic *'rḏ*). Within later Aramaic, *ḏ* > *ʿ* (e.g., Palmyrene, Nabatean, and Jewish Aramaic *'rʿ*). Imperial Aramaic preserves both *'rq* and *'rʿ*.[8] Note the word *ʿn'* (sheep) in Jewish Aramaic, with *ʿayin* a reflex of the original *ḏ*, but with the metathesis of the *nun* and *'alep*. (2) The phonological evidence for etymological *t̲* can also be considered useful for the classification of a Northwest Semitic text as belonging to the Canaanite branch or to the Aramaic branch. Thus, within Canaanite, Proto-Semitic *t̲* > *š*. So, *šwb* is the Canaanite form of a word for "return" (cf. Hebrew *šwb*; Moabite *šwb*). The *šin* of this word is not etymological, however. Rather, the Proto-Semitic root is *t̲wb* (cf. Ugaritic *t̲wb*, Old South Arabic *t̲wb*, and Classical Arabic *t̲wb*). Within Old Aramaic, Proto-Semitic *t̲* > *š* (e.g., Old Aramaic *šwb*;

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Old Aramaic *yšb*), but within later Aramaic, *t* > *t* (e.g., Biblical Aramaic *twb*, *ytb*).[9] Within Ammonite, the seal of Šub'il (J 1195 = Aufrecht 1989:#41) contains a theophoric *'il* and (arguably) the verbal root *šwb*.[10] (3) The phonological evidence for etymological *ḏ* is also useful to Northwest Semitic linguists attempting to assign an inscription to the Canaanite branch or to the Aramaic branch. Within Canaanite, Proto-Semitic *ḏ* > *z*. Thus, *ʿzr* is the Canaanite form of a word for "help" (e.g., Hebrew *ʿzr*, Phoenician *ʿzr*). The *zayin* of this word is not etymological. Rather, the Proto-Semitic root is *ʿḏr* (cf. Ugaritic *ʿḏr*, Old South Arabic *ʿḏr*, and Classical Arabic *ʿḏr*). Within Old Aramaic, Proto-Semitic *ḏ* > *z* (e.g., Old Aramaic *zqn* "old" from an original Proto-Semitic *ḏqn*), but within later Aramaic, *ḏ* > *d* (e.g., *dhb* "gold" from an original Proto-Semitic *ḏhb* and Palmyrene *ʿdr* from an original Proto-Semitic *ʿḏr*). The Amman (جبل القلعة) Statue Inscription (J 1656 = Aufrecht 1989:#43) contains the personal name *yrḥʿzr*, thus arguably patterning with Canaanite and also with Old Aramaic, but against later Aramaic. This sort of phonological data will be important for current and future discussions of the nature and status of the Edomite language within Iron Age Northwest Semitic.

Some orthographic features can be used to assist in making determinations regarding the assignment of a language to the Aramaic branch of Northwest Semitic or to the Canaanite branch. Moreover, orthographic features also can assist in making determinations regarding dialectical differences within the same language (e.g., Old Hebrew). (1) Among the most important of the former is the "Canaanite Shift." The Cannanite Shift can be described in the following manner: within Canaanite, etymological *ā* becomes *ō*, but in Aramaic, etymological *ā* remains *ā*. With the word for "tongue," the *ā* is historical. Note the following evidence: Akkadian *lišānu*, Arabic *lisān*, Ethiopic *lisān*, and Tigre *lesān*. Within Aramaic, the etymological *ā* is preserved *lišān*, but within Hebrew, the *ā* > *ō*, thus the spelling of this word in Hebrew *lāšōn*. The reason for this is as follows: because Hebrew is a Canaanite language, *ā* > *ō*. Naturally, a difficulty that is present in the analysis of Iron Age Northwest Semitic is that the epigraphic texts are not vocalized with precision (Rollston 2006:61–65). (2) Also among the most important aspects of Northwest Semitic orthography is the contraction, or noncontraction, of dipthongs.[11] For example, within the Southern dialect of Old Hebrew, the *ay* dipthong does not contract.[12] However, within the Northern dialect of Old Hebrew, the *ay* dipthong does contract. Thus, within the Southern dialect, the word for "wine" is spelled *yyn* (*yayin*; Arad 1.3, 9), but in the Northern dialect, the dipthong has contracted and the word is spelled *yn* (*yên*; Reisner Samaria Ostraca, throughout). These sorts of orthographic discussions are already becoming important for the study of Edomite, and this will continue to be the case in the future, with the discovery of additional Edomite texts.

Provenance and Chronology: Methodological Caveats

For the purposes of the linguistic classification of a Northwest Semitic inscription (e.g., declaring an inscription to be Phoenician, Aramaic, Hebrew, Edomite, Ammonite, or Moabite), provenance can be a useful datum (cf. Rollston 2004:64–66; 2010:1–2). Nevertheless, it certainly cannot be the primary criterion. Furthermore, the putative chronological horizon for an inscription or corpus is also an important datum (and must be considered in conjunction with the issue of provenance), but neither should this be the primary criterion for linguistic classification. That is, provenance and date cannot be considered decisive a priori data for conclusions about linguistic classification. Among the reasons are these: (1) Multiple languages are sometimes attested at sites. For example, at Late Bronze Age Ugarit, texts written in Ugaritic, Akkadian, Sumerian, Egyptian, Hittite, and Hurrian have been excavated (Yon 2006:125–130). Similarly, at the site of Persepolis, large numbers of texts have been found that were written in Elamite and Aramaic, but languages also attested there are Neo-Babylonian, Old Persian, Greek, and Phrygian (Stolper and Tavernier 2007:2–11). Of course, bilinguals are also attested, with the Tell Fakhariyeh (أبو فخارية) Statue Inscription (with Akkadian and Aramaic) being a superb exemplar of this (Abou-Assaf et al. 1982).[13] (2) Note also that at Arad (عراد) there are texts written in both Hebrew and Aramaic (Aharoni 1981). True, the Hebrew and Aramaic texts from Arad do hail from consecutive periods (rather than being coterminous), but the fact remains that both Hebrew and Aramaic texts have been discovered at the same southern Levantine site. Of course, at Horvat 'Uza (حورفات عزى), some 30 Hebrew epigraphs were excavated, but Edomite is also attested there (Beit-Arieh 2007:122–187). (3) Also instructive is the fact that even though Iron Age Ammon was the capital of the Ammonite kingdom and

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the Ammonite language was the dominant language there, a tomb in the Ammonite capital itself was the locus for a stunning Moabite seal (Abu Taleb 1985). Obviously, there might be a temptation to consider this seal to be Ammonite, because of its provenance, but that would be problematic because the script of this seal is not the Ammonite or Aramaic script.[14] (4) Similarly, at the Mesopotamian site of Nimrud, several fragmentary Iron Age Aramaic inscriptions were found, but an ivory fragment was discovered, replete with an Old Hebrew inscription from the eighth century on it (Millard 1962:45). Ultimately, therefore, provenance and date are important, but these can never be considered a priori to be decisive data for linguistic classification.

Personal, Place, and Divine Names: Methodological Caveats

Sometimes the language of an inscription and the personal, place, and divine name(s) all dovetail very nicely. For example, the ostraca from Lachish II are all written in the Old Hebrew language and script, and the place-names are primarily Judean, the theophoric elements are Yahwistic, and the name Yahweh even occurs within this corpus (Tur-Sinai 1938:38). Therefore, all of the evidence aligns perfectly. However, it would be problematic to assume that this is always the case. For example, Eph'al and Naveh published a corpus of around 200 Aramaic ostraca from Idumea dating to the fourth century BCE. The most common theophoric element is Qaws (قوس), but El, Ba'al, and Yahu theophoric elements are also attested. In addition, there are some Babylonian and Egyptian theophoric elements as well (Eph'al and Naveh 1996:15). Qaws was arguably the national god of Edom during (at least certain horizons of) the Iron Age.[15] Thus, the fact that this is the most dominant theophoric is an important datum, but the epigraphs are written in Aramaic. To be sure, Edomites were arguably the ethnic group that was responsible for the production of the corpus, but these Edomites were writing in Aramaic script and language. Of course, sometimes the situation is even more complicated. A bilingual ostracon (third century BCE) was discovered at Khirbet el-Qom (خربة القوم) (Geraty 1975). The two attested scripts are Aramaic and Greek. However, the language of the portion of this bilingual written in the Aramaic script is arguably Edomite, not Aramaic. Obviously, therefore, the ancient evidence is complex: caveat eruditus.

Edomite: The Corpus, Linguistic Features, and Script

The Corpus

The corpus of Edomite epigraphic material is the subject of some debate. Bartlett (1989) refers to a total of around 25 inscriptions (considering the Qaws 'Anal impressions as one, as they seem to have all been made from the same seal). Within this segment of the chapter, I shall refer to some of the most important of these inscriptions so as to reveal something about the nature and variety of these inscriptions.

Various fragmentary inscriptions were found at Busayra (بصيرا) (Bennett 1974, 1975, 1977; Millard 2002:429–439; Puech 1977:111–120), with several different languages attested (e.g., Egyptian, Nabataean, and Edomite). Among the most important is an Edomite seal from the eighth century BCE (cf. Avigad and Sass 1997:388, 511 [seal 1050]) inscribed with the personal name *Mlklb' 'bd hmlk* ("*Mlklb'* the servant of the king"). This seal is aniconic (i.e., without iconography) and consists of four registers (see Figure 14.1). Nevertheless, the rest of the Northwest Semitic inscriptions from this site (mostly sherds with a few letters at most) cannot be described in a definitive fashion as Edomite. They are simply too brief and fragmentary



Figure 14.1 Busayra (Busayrah) seal.
Drawing: Millard (2002).

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(cf. also Vanderhooft 1995:141). Very modest epigraphic material has been discovered at Umm al-Biyara (أم البيارة) (cf. Bennett 1966; Bienkowski 1990).[16] Arguably the most consequential epigraphic find from Biyara is a bulla with the personal name *Qwsg[br] mlk 'dm* "Qaws-Gabri, the King of Edom" (Avigad and Sass 1997:388 [seal 1049]), replete with a winged sphinx icon (see Figure 14.2). That is, the seal was (and thus the bulla is) both iconic (i.e., with an image, icon on it) and also epigraphic (i.e., with writing). The seal can arguably be dated to the seventh century BCE, and the script can be classified as Edomite.[17]

One of the most important Edomite inscriptions discovered to date is an Edomite ostracon from Horvat 'Uza (Beit-Arieh 2007; Beit-Arieh and Cresson 1985). Both the script and the language are Edomite, and the inscription can dated to the late seventh or very early sixth century BCE (see Figure 14.3). Tell el-Kheleifeh (تل الخليفي) (Albright 1941; DiVito 1993; Glueck 1940, 1941, 1971; Naveh 1966, 1970b; Zuckerman 2004) was the locus for the discovery of an Edomite ostracon (on the reverse of a cooking pot).[18] This inscription consists of a series of personal names, four of which have the Qaws theophoric element (see Figure 14.4). The script and language are Edomite, and the inscription can be dated to the late seventh or early sixth century BCE. Also, numerous seal impressions with *Qws 'nl 'bd hmlk* ("Qaws 'Anal the servant of the king"; see Figure 14.5) were discovered at Tell el-Kheleifeh (تل الخليفي) (Avigad and Sass 1997:389–390 [seal 1051]), arguably all made with the same seal (so also Zuckerman 2004:249). Furthermore, Horvat Qitmit (حورفات قتميت) (Beit-Arieh 1995) has also produced a handful epigraphs (ca. seven or eight), but these inscriptions are very fragmentary. Significantly, however, the Qaws theophoric element is attested several times in this fragmentary corpus, but not much more than this can be said because of the fragmentary nature of the material. Nevertheless, it is important to note that the script of (at least) Qitmit 3 can most easily be assigned a date in the eighth century (see Figure 14.6; note the typologically early form of the *qop*). In addition, an Edomite seal was discovered at Hazeva (عين حصب) (Naveh 2001). The seal is iconic, with two standing figures (Figure 14.7). The script can be classified as Edomite, and Naveh has dated it to the sixth century BCE (based on the morphology of the presence of the "three-finger *šin*"), a date with which I am in substantial agreement (Naveh 2001:197). Finally, although not published at this time, some important epigraphic materials have been found at Malhata (ملحطا) and Beit-Arieh has stated (personal communication) that he considers them to be Edomite. I have collated some of these and concur with his assessment of these materials as Edomite.



Figure 14.2 Umm al-Biyara Bulla.
Photo: Benjamin Sass.

Edomite Phonology, Morphology, and Lexicon: Preliminary Musings

To be sure, there is a dearth of data regarding linguistic features of Edomite. Nevertheless, important linguistic data are extant and, on the basis of these, the consensus of the field is that Edomite should be classified as a Northwest Semitic language that patterns with Canaanite (rather than Aramaic). Among the most important linguistic studies of Edomite are those of Israel (1979, 1987), Garr (1985), and Naveh (1979). There is also a fine summary of the evidence by Vanderhooft (1995).

Several linguistic features of Edomite can be deduced with substantial certitude and should be emphasized. (1) Within Edomite, the article is the pre-positive article attested in Canaanite (e.g., Phoenician, Moabite, Hebrew, and Ammonite), namely, *he* (e.g., Horvat 'Uza *h'kl*, "the food"; and Kheleifeh Seal Impression *'bd hmlk*, "servant of the king"), not the post-postpositive *'alep* that is the norm for Aramaic.[19] Therefore, with regard to this feature, Edomite does not pattern with Aramaic but rather with Canaanite. (2) Within Edomite (e.g., Busayra, Kheleifeh, and 'En Hazeva), the word *bn* is attested for "son" (Naveh 2001).[20] Because

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this is a standard lexeme for "son" in Canaanite (but not in Aramaic), it can be argued that Edomite patterns with Canaanite, not Aramaic. (3) Within Edomite, the relative pronoun is *'šr*. The etymological form of this word is arguably *'ṯr*. Within Canaanite, etymological *ṯ* > *š*. Within Old Aramaic, Proto-Semitic *ṯ* > *š* (e.g., Old Aramaic *šwb*; Old Aramaic *yšb*), but within later Aramaic, *ṯ* > *t* (Biblical Aramaic *twb*, *ytb*). The fact that etymological *ṯ* > *š* in Edomite demonstrates that with regard to this phonological feature, Edomite patterns with Canaanite and Old Aramaic but not with Imperial Aramaic. Of greater import, however, is the fact that *'šr* is attested as a relative in just three Northwest Semitic languages: Hebrew, Moabite, and Edomite (Huehnergard 2006:105; cf. Garr 1985:85–87). The cumulative gravity of these data is sufficient to state that Edomite is indeed part of the Canaanite branch of Iron Age Northwest Semitic.[21]

Beit-Arieh (2007:134) read and translated the Horvat 'Uza Ostracon as follows:

1. 'mr lmlk. 'mr lblbl	(Thus) says Lumalak: Say to Blbl!
2. hšlm 't. whbrktk	Are you well? I bless you
3. lqws. w't. tn. 't. h'kl	by Qaus. And now give the food (grain)
4. 'šr. 'md. 'h'mh [ ]	that Ahi'ma/o-
5. whrm '[z]'l. 'l. mz[…]	And may U[z]iel lift [it] upon (the altar?)…
6. [ ]hmr. h'kl	[lest] the food become leavened.

Although not with the same import, several further features of Edomite merit reference as part of a general discussion of the Edomite language. (4) Within Edomite, the accusative marker is *'t* (Horvat 'Uza). Some might suggest that this should be understood as a feature that is demonstrative of Edomite's status as a Canaanite language. After all, the standard form in Imperial Aramaic, Nabataean, Palmyrene, and Jewish Aramaic is *yt*, not *'t*. However, the fact remains that *'yt* is attested in Old Aramaic (Hoftijzer and Jongeling 1995); therefore, the Edomite form of the accusative marker is not a definitive marker of Canaanite. (5) The H-Causative is used in Edomite (Horvat 'Uza); however, the H-Causative is used within Aramaic as well, so this is not a particularly useful datum for classification.[22] (6) Within Edomite, the interrogative *h* is used (Horvat 'Uza). (7) Within Edomite, the G-Imperative form of *ntn* is *tn* (Horvat 'Uza). (8) Finally, it should be noted that within Edomite, there is evidence (within Akkadian texts containing Edomite personal names) for the fact that the *aw* dipthong had not contracted prior to the seventh century BCE but by the late sixth and early fifth centuries BCE (Garr 1985:38). Furthermore, it has also been argued that the *ay* dipthong eventually contracted within Edomite as well (Young 1992). The primary point is that knowledge of Edomite continues to mount, but even at this juncture, Edomite can be confidently considered a branch of Canaanite, and some of the finer points of the Edomite language are discernible (e.g., contractions).

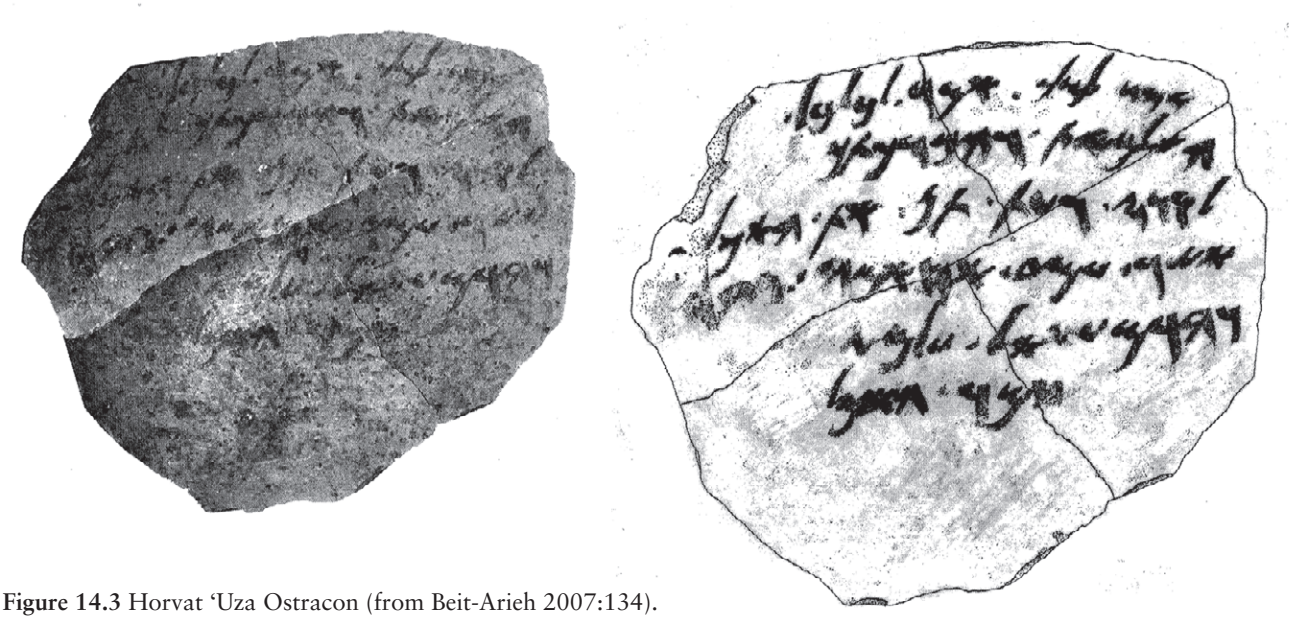

Figure 14.3 Horvat 'Uza Ostracon (from Beit-Arieh 2007:134).

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Script Origin and Script Features

Several decades ago, Naveh concluded that there was a distinct Edomite script (Naveh 1966). He concluded this, based on converging lines of evidence. Namely, the script of Kheleifeh (تل الخليفي) Ostracon 6043 was similar to but different from the Aramaic, Old Hebrew, and Phoenician scripts. Moreover, some of the distinctive features were similar to the meager corpus of Moabite. Furthermore, Ostracon 6043 consisted primarily of a list of names, several of which have the Qaws theophoric (again, Qaws being the name of the national god of Edom). Albright had previously discussed the typological features of the script of Ostracon 6043 in some detail (Albright 1941), but it was Naveh who came to the conclusion that the script was a distinctive national script that could be termed Edomite (Naveh 1966:29–30; 1987:104–105). Regarding the origin and development of the Edomite script, Naveh has stated that "under the political influence of Israel and Judah, respectively, the Moabites and Edomites, adopted the script used in those kingdoms, presumably along with other cultural features." Naveh goes on to state that "however, from the late 8th century, when the Assyrians appeared on the scene, the script of these peoples began to absorb Aramaic elements; by the 6th century, it was closer to Aramaic than to Hebrew." Finally, he concludes that "this development prompts the assumption that, in the Persian period, the Edomites and Moabites wrote texts in their native tongues (Canaanite dialects) using the Aramaic script." Then he states that the Moabites and Edomites "adopted the same script [and this] may be indicative of a common political fate. Both the Moabites and the Edomites may have been open to the influence of foreign writing traditions because their own cultural identity was not sufficiently well-established to foster native scripts" (Naveh 1987:104–105).

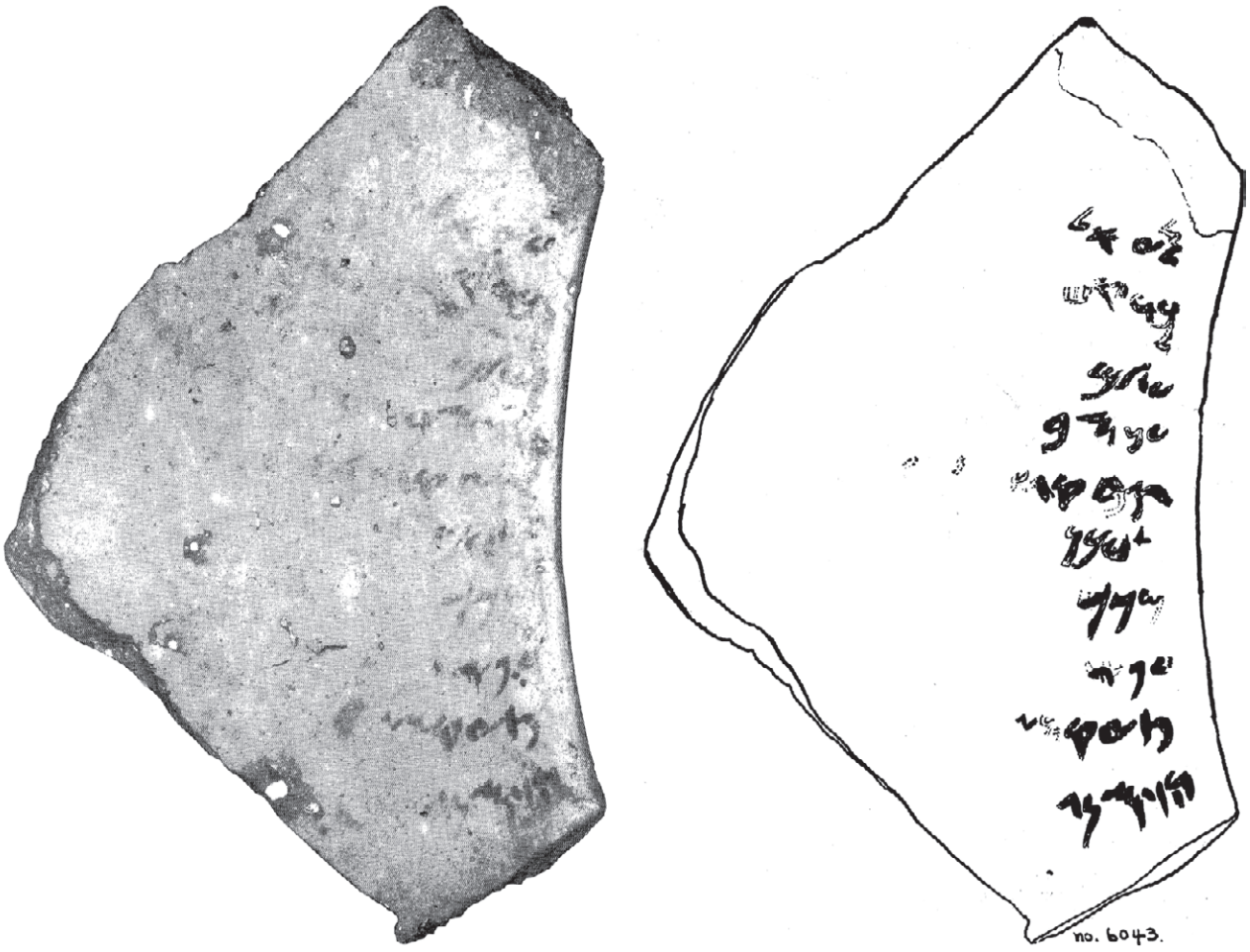

Figure 14.4 Kheleifeh Ostracon 6043. *Photo and drawing: Glueck (1941:4–5).*

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There has been substantial debate about the readings of Edomite Kheleifeh Ostracon 6043.[23] Moreover, the meanings of the personal names are also of interest.[24] In any case, regarding the readings, those of Naveh (1966:28) are accepted here:

1. r‘’l
2. bd—
3. šlm
4. qwsb-
5. pg‘qw[s]
6. –db-
7. škk
8. rp’
9. pg‘qws
10. qwsn-

I am in basic agreement with much of Naveh’s assessment but not with absolutely all of it. (1) Because of the dearth of data, it does not seem sage (from my perspective) to attempt to argue that the Edomite script hailed from the Old Hebrew script of Israel and Judah and then subsequently began to absorb Aramaic elements. After all, there are no Edomite inscriptions from the ninth century, and so there is no benchmark for comparison (and so no secure basis for asserting that the Edomite script derived from the Old Hebrew script). Ultimately, because many of the features of the Edomite script parallel the Aramaic script, I contend that the mother script of the Edomite script was the Aramaic script. (2) I am not willing to state that the Edomite cultural identity was not well established during the Iron Age. After all, there was a tradition of monumental architecture in Edom (references in this volume), an established Edomite monarchy (Bartlett 1989:204–207; Lipinski 2006:388–392), a rather impressive tradition of Edomite art and iconography (e.g., Qitmit; Beit-Arieh 1995), and a distinct Edomite language, with scribes capable of producing various types of epigraphic materials (such as name lists, seals, and standard epistolary texts) and arguably active at multiple sites. Moreover, from the epigraphic materials discussed within this chapter, it is apparent that bilingualism was arguably a part of the Edomite world as well. In essence, therefore, from my perspective, Edomite culture was rather sophisticated indeed.[25]

Several basic features of the Edomite script of the seventh and sixth centuries merit reference. (1) The *bet*, *dalet*, and *reš* are open-headed during the seventh century, as in the contemporary Aramaic script (e.g., Horvat ‘Uza, Tell el-Kheleifeh), but with closed heads attested for the eighth century (e.g., Busayra).[27] Note that the “tail” of *dalet* in Edomite could be initiated above the *dalet*’s “head.” Sometimes this is referred to as an “inverted” form (Avigad and Sass 1997:387), although this terminology is probably misleading.[28] (2) The head of *qop* can be completely open (e.g., Horvat ‘Uza, Kheleifeh), but closed-headed exemplars are attested in the Edomite script tradition (e.g., Qitmit 3, Figure 14.6, an inscription that I would date to the

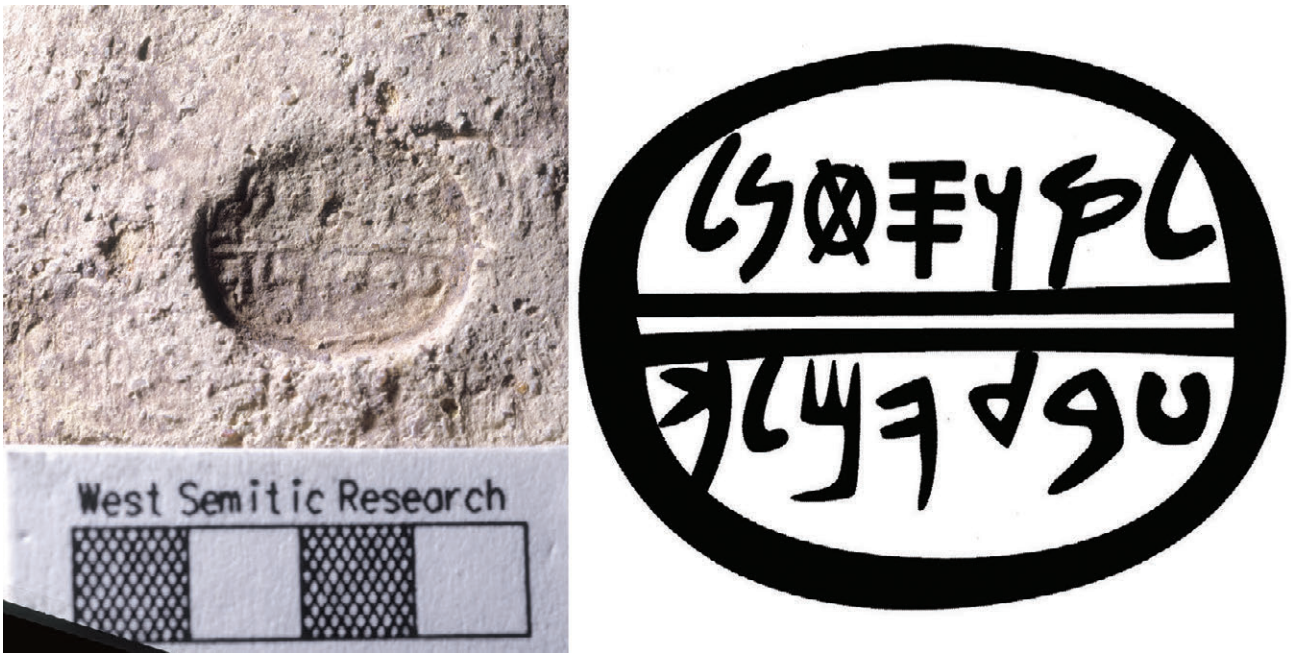

Figure 14.5 Kheleifeh jar handle impression 528 ‘Qaws-’nl’ .
Photo: Bruce Zuckerman and Marilyn Lundberg. Drawing: Bruce Zuckerman.[26]

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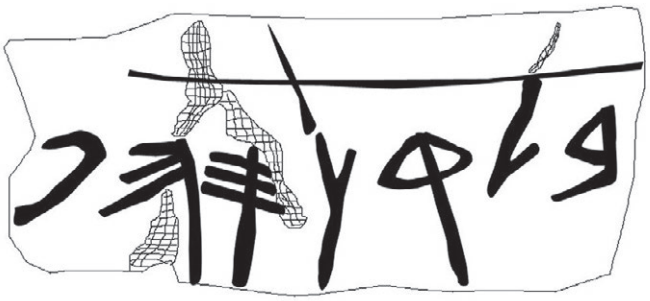

Figure 14.6 Qitmit 3.
Drawing: Christopher A. Rollston.

eighth century). (3) *Samek* reflects strong Aramaic influence, with the presence of the so-called zig-zag-headed morphology (e.g., Horvat ʻUza; Kheleifeh). (4) Both *waw* and *he* reflect basic Aramaic morphology and ductus. (5) *Mem* possesses a very large head in the Edomite script (Khleifeh, Horvat ʻUza), as also in the Moabite script.[29] Note that Naveh has argued that the large-headed *mem* was the "only independent feature" of the Edomite and Moabite scripts (Naveh 1987:104–105). (6) The two-bar *Het* is attested in Edomite (e.g., Horvat ʻUzza), but this feature is certainly not limited to Edomite.

Conclusions

The field of Edomite epigraphy is a fledgling field. The reason for this is the distinct dearth of data. However, the general contours of the Edomite language are known: it is a language that belongs to the Canaanite dialects, not to Aramaic. Furthermore, the script used to write Edomite inscriptions is most comfortably affirmed to be a script that shares many features with Aramaic. For this reason, I consider the mother script of Edomite to have been Aramaic. Of course, there are features that distinguish the Edomite script from Aramaic (e.g., the large-headed *mem*). For this reason, I consider the script used to write Edomite inscriptions to have been (at least at some points in its history) a distinctive Edomite script (i.e., distinguishable from Aramaic). It is certain that future discoveries will augment and refine our knowledge of Edomite, but the fact remains that the most foundational elements of Edomite are now discernible.

Notes

1 I am very grateful to Thomas Levy for the invitation to contribute to this volume, to Joel Burnett and Travis Weeks for bibliographic assistance, and to Adam Bean and Nathaniel Greene for proofreading a penultimate version of this article.

2 For Phoenician, see McCarter (1975) and Peckham (1968); for Aramaic, see Naveh (1970a); for Old Hebrew, see Cross (1961, 1962a, 1962b) and Rollston (1999, 2003, 2006).

3 For some discussion of these sorts of problems, see Rainey (2007:70–73) and Galil (2009:210–220). For a contrasting emphasis (to some degree) regarding these sorts of philological issues, see Millard (2011) and Rollston (2011).

4 John Huehnergard (1990) has argued that three major branches should be posited, not two, with the dialect of Deir ʻAllā Plaster Texts reflecting the third branch. From my perspective, this is certainly a viable means of integrating the Plaster Texts into our understanding of Northwest Semitic.

5 See Hackett's very fine discussion of the dialect of Deir ʻAllā and also the presence of */br/* before the patronymic "Beor" (Hackett 1980:122n.27).



Figure 14.7 Ayn Hazeva seal. *Drawing: Naveh (2001). Photos: Israel Antiquities Authority.*

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6 The term *phonology* can be defined broadly as the study of the elements and principles that determine how sounds pattern in a language. Along those lines, Blau succinctly describes phonology as "the subfield of linguistics that deals with phonemes" (Blau 2010, 72). Garr has summarized some of the difficulties associated with graphemic representation of phonemes in ancient epigraphic sources in the following manner: "These sources are written. Linguistic information, then, is gained through the intermediary of the written language. Phonetic differences in speech, exact phonetic realizations of phonemes, and regional variation must be filtered through the camouflage of the written language. Although the written and spoken languages were not necessarily different, the conventional practices of orthography did tend to obscure individual linguistic differences among speakers. The written language, then, had a leveling effect" (Garr 1985:10). Within the section of my chapter devoted to phonology, I am focusing on the different graphemes used within the various Northwest Semitic languages to represent certain Proto-Semitic consonants or consonantal phonemes that are not represented in the Iron Age alphabet (i.e., not represented in the alphabet used to write Phoenician, Aramaic, Old Hebrew, Moabite, Ammonite, Edomite, Philistine). See also Moscati (1980:28–45).

7 The fact that the Canaanite gloss in El Amarna 263.12 is written *ṣunu*, that is, without *'alep*, is a reflection of the general limitations of using Mesopotamian cuneiform to write certain Northwest Semitic graphemes and phonemes (for the Amarna Letters, see Garr 1985; Moran 1992; Rainey 1996).

8 Note that the MT of Jeremiah 10:11 is Aramaic and preserves both spellings, a deft piece of literary artistry also reflective of the fact that this was a period of phonological transition for *ḏ*.

9 Notice that Old Aramaic Tell Fakhariyeh Statue Inscription uses *samek* to represent *ṯ* (Abou-Assaf et al. 1982; Kaufman 1982:146–147). Kaufman astutely notes that, in a technical sense, this is an orthographic rather than a phonological issue. That is, the interdental *ṯ* was still pronounced and the scribe of Fakhariyeh chose the grapheme *samek* to represent the phoneme *ṯ*. However, within Old Aramaic, the normal custom was for the scribes to use the grapheme *š* to represent *ṯ*. See also Garr (1985:28–29).

10 I use the term *arguably* because it would be possible to suggest that the root is actually *yšb*, but because the *šin* of this root comes from an original *ṯ*, my point is not affected, regardless of whether one views the Ammonite personal name as employing the root *yšb* or the root *ṯwb*. For discussion of imperative forms in personal names, see O'Connor (1990:155–156).

11 The term *dipthong* can be defined here as a particular type of vowel–consonant combination. Note that I am not suggesting that dipthong contraction could not be used to differentiate languages. It can indeed be of use in such discussions. But in this case, I am simply arguing that such a feature can (also) be used to differentiate two dialects of the same language.

12 That is, regarding the contraction of dipthongs, the position of Cross and Freedman (1952) continues to be the most convincing (for further discussion, as well as interaction with the critics of Cross and Freedman, see Rollston 2006:61–65).

13 Of course, among the most famous of such texts are the Behistun Inscription of Darius the Great, with its trilingual text in Akkadian, Elamite, and Old Persian (Schmitt 1991), as well as the bilingual known as the Rosetta Stone, with its Egyptian (written in two scripts, namely, Hieroglyphic and Demotic) and Greek texts (Parkinson 2005). Naturally, lexical tablets are often bilingual and are certainly not rare.

14 The fact that this seal is Moabite, not Ammonite, is demonstrated by the stance of certain letters. In particular, note the stance of the *bet*. For further discussion of such features, see Rollston (2006:59–61).

15 For the data regarding Qaws (Qos), see Knauf (1999) and the references cited there.

16 Because of the faded nature of the (few) preserved letters, I do not wish to attempt to assess the palaeographic data of the Biyara "šmn" ostracon (Bennett 1966:399 [plate XXIIa]; cf. also Vanderhooft 1995:140–141).

17 Because a certain "Qausgabri the King of Edom" is mentioned in the annals of the Neo-Assyrian King Esarhaddon (Leichty 2011:23 [1 v 56]; cf. also 46 [5 vi 8']) and he is noted there to be a contemporary of King Manasseh of Judah (and because the script fits nicely in the seventh century), this bulla is normally dated to the seventh century BCE.

In terms of additional and important epigraphic finds, it should be noted that at the site of Tawilan, a cuneiform tablet hailed from Harran in Syria during the Persian period (Bienkowski 1990, 2001). Naturally, however, the language of this tablet is East Semitic (Akkadian), not Northwest Semitic. In any case, this is a very fine epigraphic find from an Edomite site. Note that there is a substantial amount of discussion about the attribution of this tablet, with Darius I, Darius II, and Darius III

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all having proponents (Bienkowski 2001:209). For the *editio princeps* of this tablet, see Dalley (1995).

18 A number of inscriptions were found at Kheleifeh (DiVito 1993; Glueck 1941, 1971). Albright dated Ostracon 6043 to the sixth century BCE, and this date continues to be reasonable (Albright 1941). Naveh was the first to make a sustained argument that Kheleifeh Ostracon 6043 was Edomite (Naveh 1966), and it is of import to note that this is the sole Edomite ostracon found at this site. The scripts of the rest are Phoenician and Aramaic.

19 The form of the article in Thamudic, Safaitic, and Lihyanite is also /*h*/. Therefore, this form of the article is not confined to Northwest Semitic. Nevertheless, for a Northwest Semitic inscription (i.e., one written in a Northwest Semitic script), the presence of the prepositive article /*h*/ is most consistent with the Canaanite branch of the Iron Age, not the Aramaic branch. For an authoritative discussion of the article, see Lambdin (1971).

20 Naveh has argued that the script of this seal is Edomite. It consists of a personal name and a patronymic, namely, /*mškt bn wḥzm*/. It would be plausible to argue that the word /*bn*/ is not demonstrative of Edomite necessarily but rather something that results from the fact that the names are putative Arabic names. Nevertheless, I am willing to argue that the *bn* is actually the Edomite word *son* in this case. This fact is supported by the fact that within the Edomite inscriptions of Malhata, the word /*bn*/ is used for "son" (I am grateful to Professor Beit-Arieh for allowing me to view some of these inscriptions at Tel Aviv University). Someone might note that there is a personal name "Barqos" (Ezra 2:53), but the presence of the morpheme *br* "son" in this name would be a tenuous basis for the suggestion that Edomite used this morpheme for "son" (especially in the face of the Northwest Semitic epigraphic evidence noted here).

21 Someone might suggest to me that the presence of the personal name /Qws'dr/ is evidence for Edomite's patterning, at least at times, with Aramaic. After all, they might suggest that the Proto-Semitic root is /'d̲r/ and so the fact this name patterns with Aramaic and against Canaanite proves this. However, I would counter that this name occurs in a Nabataean inscription, and so this could account for the presence of the *dalet* (rather than a *zayin*). For a fairly thorough list of Edomite personal names attested in the epigraphic record, see Bartlett (1989:204–207) and also compare Lipinski (2006:388–392).

22 Nevertheless, it is striking that the H-Causative is used with the root *brk*, as normally the D stem is used in Northwest Semitic to achieve this semantic sense.

23 For reference to different readings of this ostracon, see the discussion in Bartlett (1989:219–220).

24 Obviously, the predominance of the Qaws theophoric element in the names is of substantial interest. The meaning of some of these names cannot always be ascertained (because of the faded nature of this ostracon and because of the various lexical possibilities). However, *šlm* can certainly be regarded as the familiar root meaning "peace," "well-being." The root *rp'* can most readily be understood as the root meaning "healing." The name *pg'qws* (cf. the Hebrew Bible's Pag'i'el; Numb 1:13; 2:27, etc.) has been understood as meaning "Entreated of Qaws" (Bartlett 1989:220), although something such as "Qaws meets" or "Qaws encounters" is also most tenable. The name *r''l* must be considered more difficult as the lexical element that precedes the theophoric ('El) cannot be ascertained with certainty. That is, meanings such as "El shouts in jubilation," or "El shouts in war" (assuming a middle *waw* root), "El protects as a shepherd" (or the like), or "Friend of El" are among the possibilities.

25 Literacy is a subject that often comes up in this connection. To be sure, the definition of literacy for antiquity (and modernity) is the subject of substantial debate. Some might suggest that in "oral cultures," the capacity to use language (i.e., the spoken word) in a functional or sophisticated manner constitutes literacy. However, some would wish to argue that *literacy* is a term that is to be understood as referring to the ability to read and write texts. Occasionally, there are those who propose that functional literacy could be defined as just the capacity to write one's name. The United Nations Educational Scientific and Cultural Organization (UNESCO) has recently employed the following definition: "Literacy is the ability to read and write with understanding a simple statement related to one's daily life. It involves a continuum of reading and writing skills, and often includes also basic arithmetic skills (numeracy)" (UNESCO 2004). The bibliography for the subject of literacy in antiquity (and modernity) is vast and varied, but based on the epigraphic evidence from ancient Edom, it is apparent that there was a sophisticated Edomite scribal apparatus, just as was the norm in the rest of the Levant (Rollston 2006, 2010:85–135).

26 Note that Zuckerman (2004) has argued that these impressions should be read as Qaws-tnl, rather than Qaws-'nl. In keeping with the traditional terminology (and because I consider *'ayin* to be the preferable reading), I continue to refer to these as Qaws-'nl.

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27 For the Aramaic script, see especially Naveh (1970a).

28 For a nice drawing of this form of *dalet*, see Zuckerman (2004:274).

29 It should be remembered that the Mesha Stele does not use a distinct Moabite script but rather the Old Hebrew script. The Moabite national script developed after the production of the Mesha Stele.

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15 Conclusion

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The chapters in this volume present the final report on a major multiyear University of California, San Diego - Department of Antiquities of Jordan) interdisciplinary study of ancient mining, metallurgy, and society during the Iron Age (ca. 1200–500 BCE) in the Faynan region of southern Jordan. This Iron Age research project was initiated in 2002 and carried out in close collaboration with the Department of Antiquities of Jordan. The centerpiece of this study is the large-scale excavations at the Khirbat en-Nahas (KEN)—the largest ancient copper smelting center in the southern Levant. KEN has served as an "outdoor laboratory" for developing a digital archaeology methodology aimed at controlling space as accurately as possible to facilitate hypothesis testing concerning anthropological and historical questions using high-precision radiocarbon dating. Quantitative archaeometallurgical and ceramic data from the excavations at KEN and six other UCSD excavated sites are presented and are especially useful for exploring the interaction between society and technological change in this region, known in biblical and ancient Near Eastern Iron Age texts as Edom. Prior to the Edom Lowlands Regional Archaeology Project, Iron Age excavations focused primarily on the highlands of Edom, away from the Faynan copper ore resource zone. Seen in the context of the collapse of the Late Bronze Age civilizations of the eastern Mediterranean, at the end of the thirteenth century BCE, the intensive archaeological surveys in both the lowlands and highlands of Edom carried out for this project provide a new archaeological framework for understanding the rise of social complexity in the southern Levant during the first millennium BCE. Here the general conclusions of the project are summarized.

Introduction

As an anthropological archaeology study, the Edom Lowlands Regional Archaeology Project applied the same digital excavation and analytical methodologies developed for the investigation of Pre-Pottery Neolithic and Early Bronze Age sites as those from the Iron Age—a period linked to historical biblical archaeology. Accordingly, at the Iron Age industrial site of Khirbat

Opposite: Experimental archaeology trek with camels to transport copper ore and metal across the Faynan district carried out for a National Geographic/NOVA documentary about the ELRAP expedition, 2009 (see Quest for Solomon's Mines at http://www.pbs.org/wgbh/nova/ancient/quest-solomons-mines.html). *Photo: T. E. Levy.*

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en-Nahas, large open-air exposures were made so that the sociocultural context of the archaeological record could be retrieved in well-stratified contexts. This was coupled by an early commitment to the application of high-precision radiocarbon dating in each of the seven excavation areas at the around 10-ha site (Levy et al. 2008; Levy and Higham 2005). For ELRAP, the stratigraphic record, anchored in radiocarbon dating, provides the scaffold on which relative dating based on ceramic sequences is built (Smith and Levy 2008). This approach is contrary to typical "biblical archaeology" excavations where the long tradition of ceramic analyses in Cisjordan (cf. Finkelstein and Singer-Avitz 2009; Singer-Avitz 2009) gives primacy to pottery dating over radiometric dating frameworks established in relation to objective stratigraphic sequences. Simply put, ELRAP follows the methods of prehistoric archaeology, albeit on a larger scale. By developing a wide range of cyber-archaeology methods described in the introduction to this volume, the level of recording precision associated with prehistoric archaeology has been augmented and enhanced (see also Levy, Petrovic, et al. 2010; Levy and Smith 2007; Petrovic et al. 2011).

In addition to methodology, there are a number of major differences between ELRAP and other major recent research projects that have been carried out in Faynan and Edom. As noted earlier, pioneering archaeometallurgical investigations were carried out for more than a decade by the Deutsches Bergbau-Museum (DBM) under the direction of Andreas Hauptmann (Hauptmann 2007). This work provides the "gold standard" for scientific archaeometallurgical research in Faynan (and the southern Levant) concerning the pyrotechnology and history of mining and metallurgy in this region from the Neolithic to the Islamic periods. More geoarchaeology than archaeology, DBM excavations were carried out on a small scale, most often with technohistorical questions in mind. Consequently, questions concerning the social and cultural context of ancient mining and metallurgy were left unanswered. The Jabal Hamrat Fidan project, which evolved into ELRAP, was specifically designed as a "deep-time" anthropological archaeology study of the role of technology (ancient mining and metallurgy) in sociocultural change covering these same periods. Thus, the ELRAP research presented in this volume provides the cultural context in which the Iron Age archaeometallurgical and material culture record can be understood.

The other major recent archaeological investigations in Faynan were carried out under the auspices of the Council for British Research in the Levant (CBRL) with goals that are different from ELRAP. The Wadi Faynan Landscape Survey (WFLS), led by Graeme Barker, focuses on land use in the Wadi Faynan from prehistory to the recent past and its relations to desertification and copper mining. The emphasis of this regional project has been on a wide range of paleoenvironmental and ancient pollution studies in the region (Barker et al. 2007). Another major CBRL investigation focuses on documenting the early prehistoric settlement in the Faynan region (i.e., Pre-Pottery Neolithic A [PPNA]), establishing baseline data for explaining the paleoenvironmental context for early prehistoric settlement and especially a focused study on the origin of the PPNA in the region (Finlayson and Mithen 2007; Finlayson et al. 2000). This project is directed by Bill Finlayson, Steven Mithen, and Mohammad Najjar. There are other CBRL-affiliated projects in the Faynan (http://www.cbrl.org.uk/wadi_faynan.html). ELRAP especially builds on the WFLS project by providing the first large-scale post-PPNA excavations in Faynan. In terms of archaeological surveys and the Iron Age, ELRAP survey data are contextualized by being directly referenced to the stratigraphic excavations reported on in this volume.

Prior to ELRAP, the major Iron Age excavation work in Edom was done on the high plateau, far from the Faynan copper resource zone at sites such as Busayra, Tawilan, and Umm al-Biyara (Bennett 1982; Bennett and Bienkowski 1995; Bienkowski 1990, 1992). As noted elsewhere, this led to a "highland-centric" view of the Iron Age archaeology of Faynan with assumptions that the Iron Age was a relatively short period only beginning in the late eighth or seventh century BCE (Levy et al. 2004; Levy, Najjar, van der Plicht, et al. 2005). The highland-centric perspective also led to assumptions that Iron Age Edom only emerged as a state-level society due to its control of Arabian trade and status as a vassal polity of the Assyrian empire. As shown here, one of the major achievements of ELRAP is the large-scale application of radiocarbon dating to the different excavations carried out by our team in the Faynan district. The stratigraphic excavations and radiometric dating carried out in the lowlands conclusively push the Iron Age chronology of Edom back into the twelfth century BCE with the result that almost 500 additional years of Iron Age history are brought back to the table of scholarly discourse. These include key periods of biblical history such as the tenth and ninth centuries BCE, when biblical and historical figures such as David, Solomon, and the Egyptian Pharaoh Shoshenq I are alleged to have interacted with Edom. The

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higher Iron Age chronology established by ELRAP, with its implications for historical biblical archaeology, has led to the development of a more pragmatic approach to investigating the relationship between archaeology and ancient Near Eastern sources such as the Hebrew Bible (Levy 2010). Thus, the large-scale excavations and surveys reported on here have enabled our team to test some of the hypotheses outlined in the introduction to this study and summarized below. What has become clear with the 12 University of California, San Diego (UCSD)–Department of Antiquities of Jordan (DOAJ) Iron Age excavations and 6 regional surveys in the Faynan region (Tables 15.1 and 15.2), the collapse of Late Bronze Age civilizations in the eastern Mediterranean around the end of the thirteenth century BCE opened up new social and economic opportunities for the local population of Edom and other southern Levantine areas to grow into more complex polities.

Models Tested—Foreign vs. Local Control of Copper Production Through the Iron Age Sequence

This final publication presents a wealth of data for contextualizing and testing the social interaction models and hypotheses presented in the introduction. Our concluding remarks are more of a summary of what is now known about societies who interacted with the Faynan copper ore district during the Iron Age in light of the wealth of new archaeological data presented here. It is hoped that the large ELRAP Iron Age archaeological database published here will serve as a springboard for further, more detailed analyses. The large-scale excavations at KEN carried out in seven different areas at the site, coupled with the soundings at other ELRAP/Lowland to Highlands of Edom Project (L2HE) sites, show the cyclic nature of copper production in Faynan from the twelfth to the seventh/

Table 15.1 Summary of excavations carried out by the UCSD-DOAJ in the Faynan district.

Excavation (n=18)	Period	Function	Project Year
Tel Tifdan	PPNB	Village	1999
Wadi Fidan 61	PPN- Pottery Neo. Iron Age	Village; IA tombs	2012
Wadi Fidan 51	Late Neolithic - Early Chalcolithic	Village (small)	1999
Wadi Fidan 4	Early Bronze I Iron Age IIA	Village workshop; IA tombs	1997
Khirbat Hamra Ifdan	Early Bronze II-IV Iron Age	Copper production manufactory; smelting	1999, 2000, 2007, 2011
Wadi Fidan 40	Iron Age I-II	Cemetery	1997, 2003, 2004, 2009
Rujm Hamra Ifdan	Iron Age II	Watchtower	2003
Khirbat en-Nahas	Iron Age I-IIA	Smelting factory	2002, 2006, 2009
Khirbat al-Jariya	Iron Age I-IIA	Smelting factory	2006
Ras al-Miyah	Iron IIC	Fortress complex	2006
Khirbat al-Ghuwayba	Iron Age I-IIA Roman/Nabatean	Small scales smelting village	2009
Jabal al-Jariya Mines	Iron Age IIB/C?	Pit mines	2009
Khirbat Faynan	EB, IA II, Roman/Nab	Settlement center	2011, 2012
Khirbat Nuqayb al-Asaymir	Islamic (middle)	Smelting factory	2011, 2012
L2HL Khirbat al-Malayqtah, al-Kur, al-Iraq, Tawilan	Iron Age IIB	Settlements	2006, 2007, 2010

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Table 15.2 Summary of archaeological surveys carried out in the Faynan regions by the UCSD-DOAJ and other projects. As most sites in the CBRL survey are sherd scatters, the number is not calculated here.

Survey Project	Researchers	# of Sites
UC San Diego - Department of Antiquities of Jordan Projects (N=6)		
Wadi Fidan Survey - 1998, 2004	Levy, Najjar, Adams	162
Wadi al-Jariya Survey - 2002, 2007	Levy, Najjar, Adams, Knabb	218
Lowlands to Highlands Edom Project - 2006, 2007	Smith, Najjar, Levy	48
Faynan - Busayra Regional Survey - 2007	Ben-Yosef, Najjar, Levy	116
Wadi Feid Expedition - 2009 (DOAJ)	Knabb, Najjar, Levy	123
Buweirda Springs Survey - 2011 (DOAJ)	Knabb, Najjar, Levy	18
Total		**685**
Other Projects (N=5)		
Deutsches Bergbau-Museum Survey - 1983-1992	Hauptmann	160
Southern Ghors and NE "Araba - 1985-1986	MacDonald	240
Tafila - Busayra Archaeological Survey - 1999-2001	MacDonald	290
Wadi Fidan Lanscape Survey (CBRL)	Barker, Gilbert, Mattingly, Grattan	NA
Barqa Landscape Survey - 2010 (Hamilton - U of Wales)	Adams, Grattan	NA
Total		**690**

sixth centuries BCE (Chapters 1, 2, 9, 11, and 12, this volume). The rise of complex societies, capable of carrying out industrial-scale copper production, was not a monolithic process that occurred over a short period of several centuries as researchers working from the mid-1960s to 2001 believed (cf. Bennett 1992; Bienkowski 2000, 2002a, 2002b; Bienkowski and van der Steen 2001). ELRAP researchers have used the control of Iron Age copper production in Faynan as a proxy to measure the social complexity of the societies who were responsible for the organization of these technological activities (Ben-Yosef 2010; Levy et al. 2011). When these data are coupled with the in-depth study of ceramics found in the same archaeological deposits as the archaeometallurgical finds, insights concerning ethnicity can be gleaned (e.g., Chapter 4, this volume). To contextualize the local networks of copper extraction and production, the Iron Age settlement pattern data recorded in intensive pedestrian surveys for this study (Chapters 5 and 6, this volume, and previous published research) and an inventory of all the key Iron Age sites related to copper production in the Faynan district are presented here (see Chapter 11, this volume: Table 11.1 and Table 15.3).

When these data are coupled with new Iron Age chronology for Edom established by the ELRAP team and published here (Introduction and Chapter 1, this volume), it is possible to identify a cyclic process of copper production in Faynan with two peak periods of production in the tenth and ninth centuries BCE (IA IIA and IIB). Earlier ELRAP publications concerning KEN confirmed these periods of industrial-scale production through the application of high-precision

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radiocarbon dating methods of thick sequences of ancient copper production debris (Levy et al. 2008). In Chapter 1, additional (unpublished) radiocarbon dates are integrated in new Bayesian analyses of the date sequences for six of the seven excavation areas at KEN. The full sequence of dates from Area M, the chronological anchor for KEN, was recently tested (Levy, Najjar, et al. 2010), making it unnecessary to retest those dates. However, the dates and Bayesian analyses for all the excavation areas (A, F, S, R, T, M, and W) at KEN are presented here (Chapter 1) for the first time, confirming the two tenth- and ninth-century BCE spikes in copper production. It is striking that there is no evidence from KEN or any of the major copper smelting sites in Faynan (Khirbat al-Jariya, Khirbat al-Ghuwayba, the environs of Khirbat Faynan) for industrial-scale copper production during the eighth through sixth centuries BCE. Thus, it is crucial to keep these new facts in mind when considering the anthropological models presented in the introduction to this volume or any historical interpretations of the data.

Core Civilization and Peer Polity Interaction in Edom During the Iron Age in Light of ELRAP

Background

The absence of evidence of Assyrian interaction with the Faynan copper ore district during the twelfth to ninth centuries BCE has been established through ELRAP excavations and surveys. This conforms to the general history of Assyria that indicates interaction with the southern Levant intensive only during the late eighth century BCE (Bennett 1966; Grayson 1975; Millard 1992) and archaeological data (Na'aman and Thareani-Sussely 2006). It is false to suggest that "one of the intense periods of mining and production (in Faynan) dated to the late eighth and seventh centuries BCE. Like all other lucrative economic activities in the region, this industry was carried out under Assyrian auspices" (Finkelstein and Silberman 2006:174–175). As seen in the corpus of Iron Age archaeological and radiometric data presented in this volume, such statements are pure hyperbole. It is not until the seventh century BCE that Assyrian epigraphic finds and material culture confirm relations between sites on the highland plateau of Edom and Assyria. Thus, Assyria must be removed from any consideration of the sociopolitical situation in Edom during the earlier twelfth to ninth centuries BCE.

The situation with Egyptian core civilization and Edom is quite different from that of Assyria. As seen in Chapter 11 of this volume, a considerable collection of inscribed Egyptian amulets have been found in ELRAP excavations and surveys. The amulets, mostly scarabs, date from as early as the Middle Bronze IIB period. However, most of the finds date to the end of the Iron Age I to the beginning of the Iron Age IIA. Some items date to the immediate preceding period and complement the evidence of Egyptian–Edom interaction. The Egyptian data conform closely to the high-precision radiocarbon chronology presented in Chapter 2 at Khirbat en-Nahas where the majority of amulets were found (n = 10). As shown by Münger, many of these belong to the Early Iron Age Mass-Produced Series, which were probably produced during the reigns of Siamun and Sheshonq I around 980 to 900 BCE in the Eastern Delta in Lower Egypt (Münger 2003, 2005). These important epigraphic finds from Khirbat en-Nahas and other ELRAP surveys and excavations demonstrate some Egyptian involvement in Faynan during the middle to late years of the tenth century BCE. Particularly exciting is the discovery of a scarab bearing the throne name Sheshonq I (946/45–925/924 BCE), on the surface at Khirbat Hamra Ifdan (KHI), on the north bank of Wadi Fidan. In an earlier publication (Levy et al. 2008), we suggested that the disruption in late tenth-century BCE copper production observed in the Area M "slag mound" at KEN was a result of Egyptian military activities in the southern Levant carried out by Sheshonq I's troops. Significant tenth-century BCE copper smelting took place at the site (see Chapter 11, this volume). The ELRAP scarab (Chapter 10, this volume: see 10.6 Cat. No. 6: Scarab—Sheshonq I) provides only the second documented material reference to Sheshonq I in Cisjordan and Transjordan—an Egyptian leader well known from Egyptian (Fischer 1929; Jansen-Winkeln 2007; Ritner 2009) and biblical (1 Kings 11:40, 14:25–26, and 2 Chronicles 12:2–9) sources. Taken together, a case can be made for significant Egyptian–Edom interaction, especially during the tenth century BCE. In light of these data concerning core-civilization activity in Edom during the Iron Age IIA period, when copper production was at its zenith in Faynan at a level never paralleled in history, it is possible to evaluate aspects of the interaction models described in the introduction to this volume.

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Oscillations in Copper Production

To understand the impressive levels of copper production that emerged in Jordan's Faynan district during the Iron Age, it must be understood as part of the reaction of small-scale southern Levantine societies to the collapse of the great Late Bronze Age state-level societies in the eastern Mediterranean (Bachhuber and Gareth Roberts 2009). The Hittite civilization, the Mycenaean city-states, and Egypt during the reign of Ramesses VI all failed as complex societies at this time (e.g., Kitchen 2004). The collapse opened up new socioeconomic opportunities for these marginal societies, and one expression was the gradual intensification of copper production that reached its zenith in the tenth and ninth centuries BCE. The excavations at Khirbat en-Nahas, the largest Iron Age copper production site in the southern Levant, provide the best data concerning changes in copper production during the late second to first millennium BCE in the Faynan district. While Chapter 2 (this volume) presents a detailed comparative study of all the excavation areas at KEN, here we will use the largest building structures and the Area M chronological anchor to situate copper production in Faynan from the late thirteenth to ninth centuries BCE. To monitor settlement and production activities during the eighth to seventh centuries BCE, we will consider two other ELRAP sites that played a role in resource exploitation in Faynan during the late Iron Age: Rujm Hamra Ifdan (Chapter 10, this volume) and the Ras al-Miyah fortress complex (Chapter 12, this volume), above the 'Ain Ghuwayba perennial spring in the northeastern portion of the study area. The data are discussed in detail in the relevant chapters cited above and summarized in Table 12.1 in Chapter 12.

Thirteenth to Mid-Twelfth Centuries BCE. Evidence of Late Bronze Age activities in the Faynan area is slim (see Chapter 12, this volume). At ELRAP sites, there is some evidence of moderate copper production only in the deepest layers of the excavations at KEN Area M (Layer M5) (Chapter 2, this volume). Currently, there is no evidence from Faynan (and the entire 'Araba Valley) for copper production during the Middle Bronze Age, and as it seems, copper production during the Late Bronze Age was ephemeral and opportunistic, maybe mirroring the more substantial operation at Timna, the southern counterpart of Faynan, at this period (but cf. Ben-Yosef et al. 2012).

Late Twelfth to Eleventh Centuries BCE. The deep probe in Area M at KEN showed evidence of intensified copper production during the late twelfth to eleventh centuries BCE. The around 60 to 70 cm of metallurgical debris in near-virgin soil is an indication of this production (Layer M4, Figure 2.85). While the sample size for the earliest layers at KEN is very small, based on these data and the soundings at nearby Khirbat al-Jariya (KAJ), it can be suggested that by the eleventh century, the center of copper production in Faynan focused on KAJ, closer to the rich mining area of Wadi al-Jariya (Chapter 7, this volume). As shown by our team, there is no evidence of external control of copper production in Faynan during these centuries; on the contrary, it seems that copper production in Faynan started to flourish right *after* the Egyptians left Canaan, at the second half of the twelfth century BCE. The resumption in copper production at the end of the Late Bronze, which started on an opportunistic basis, should be attributed to local tribal societies—probably the "Shasu" tribes mentioned in ancient Egyptian texts and responsible for the Wadi Fidan 40 cemetery discussed in detail in Chapter 9 (this volume; see also Levy 2002, 2004, 2008a, 2008b, 2009; Levy and Najjar 2006). These tribes and their elaborated social organization created, at a certain point, the historical entity titled "Edom."

Early to mid-tenth century BCE. By the early tenth century BCE, the archaeological and archaeometallurgical data show that the center of gravity for copper production in Faynan shifted from Khirbat al-Jariya to Khirbat en-Nahas. The radiocarbon dated sequences show that during the early tenth century, both sites were in operation and part of a larger copper exploitation network. Some 3 m of metallurgical debris were recorded in the slag mound in Area M (Layer M3), and this coincides with the construction of the fortress at KEN with its four-chamber gatehouse. In addition to the large fortress (ca. 73 x 73 m), the monumental building in Area R was constructed as well as the large building in Area T. The fortress is an expression of power and concern for defense of the copper industry at KEN. The early tenth-century BCE buildings in Areas R and T seem to have functioned as elite residences for those who controlled copper production at this time. At this time in our research, it is difficult to pinpoint which ethnic group was responsible for the rapid increase in monumental construction activities at KEN and the

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concomitant first instance of industrial-scale copper production. However, as shown in Chapter 5 (this volume), the ceramic traditions found at Iron Age sites in the lowlands of Edom, from the eleventh to seventh centuries, are dominated by local traditions referred to as Edomite in style. Moreover, it should be emphasized that the bulk of archaeological material represents the primary component of the population at the site (i.e., the chief labor force); thus, in case of control by a minority of different ethnicity, it would be extremely difficult to recognize in the archaeological record, especially if the controlling group is also a tribal confederation from a nearby region (e.g., "Tel Masos Chiefdom" of Cisjordan, or ancient Israel). The industrial scale of production has been parsed out using the *chaîne opératoire* method for investigating traditional technological systems in the archaeological record (Figure 15.1). The local contextual data for this model were obtained from our Iron Age excavations and surveys and summarized in Figure 15.2.

Late Tenth to Ninth Centuries BCE. Toward the end of the tenth century BCE, human agency (cf. Flannery 1999), perhaps visible in the historical residue of ancient Near Eastern texts, becomes a key factor for explaining change observed in the archaeological record. During this phase, which takes place over a period of probably less than 30 years, two processes are visible in the archaeological record at KEN. As noted above, already at the end of the 2006 expedition, we identified a major disruption in the

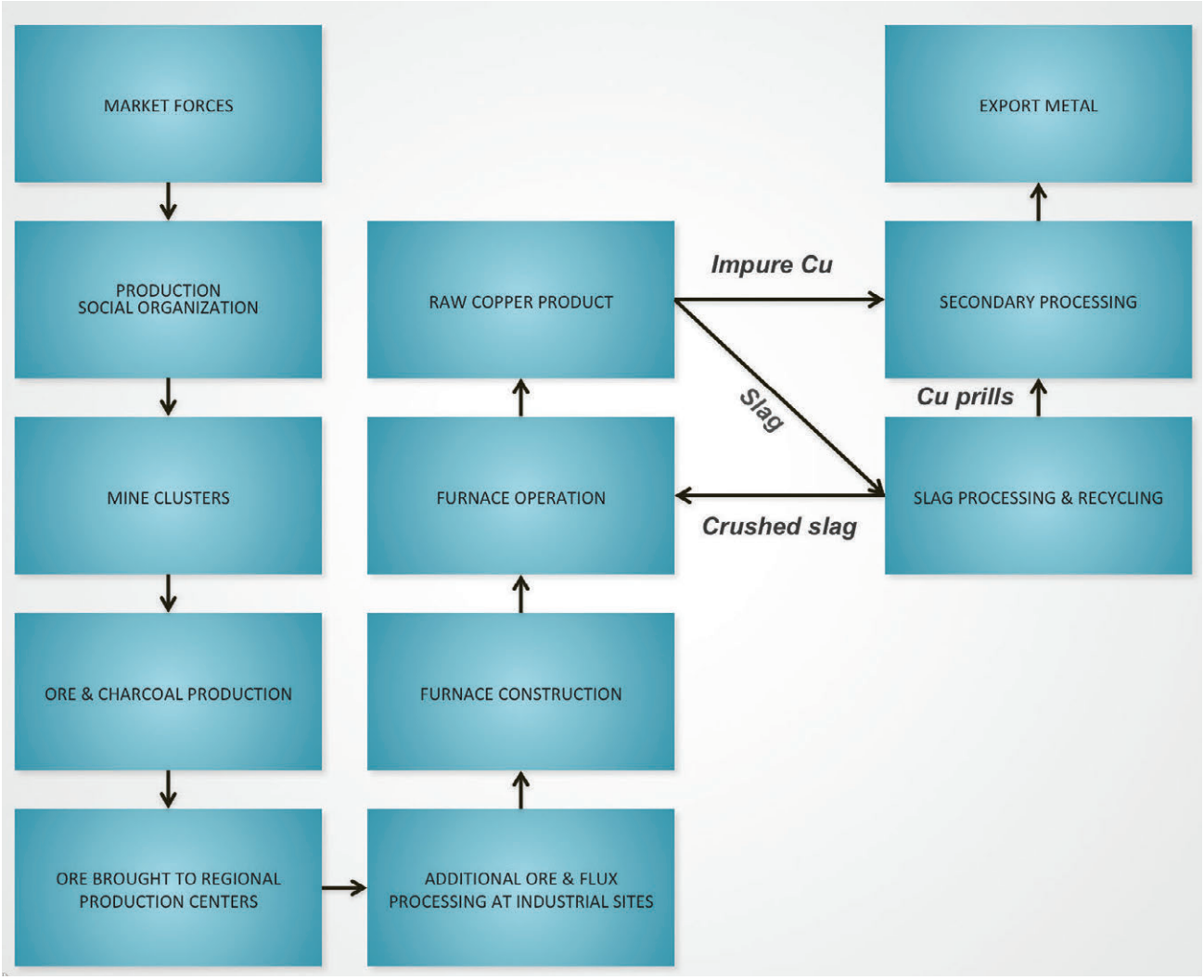

Figure 15.1 Generalized *chaîne opératoire* for tenth- and ninth-century BCE copper production in the Faynan region, Jordan.

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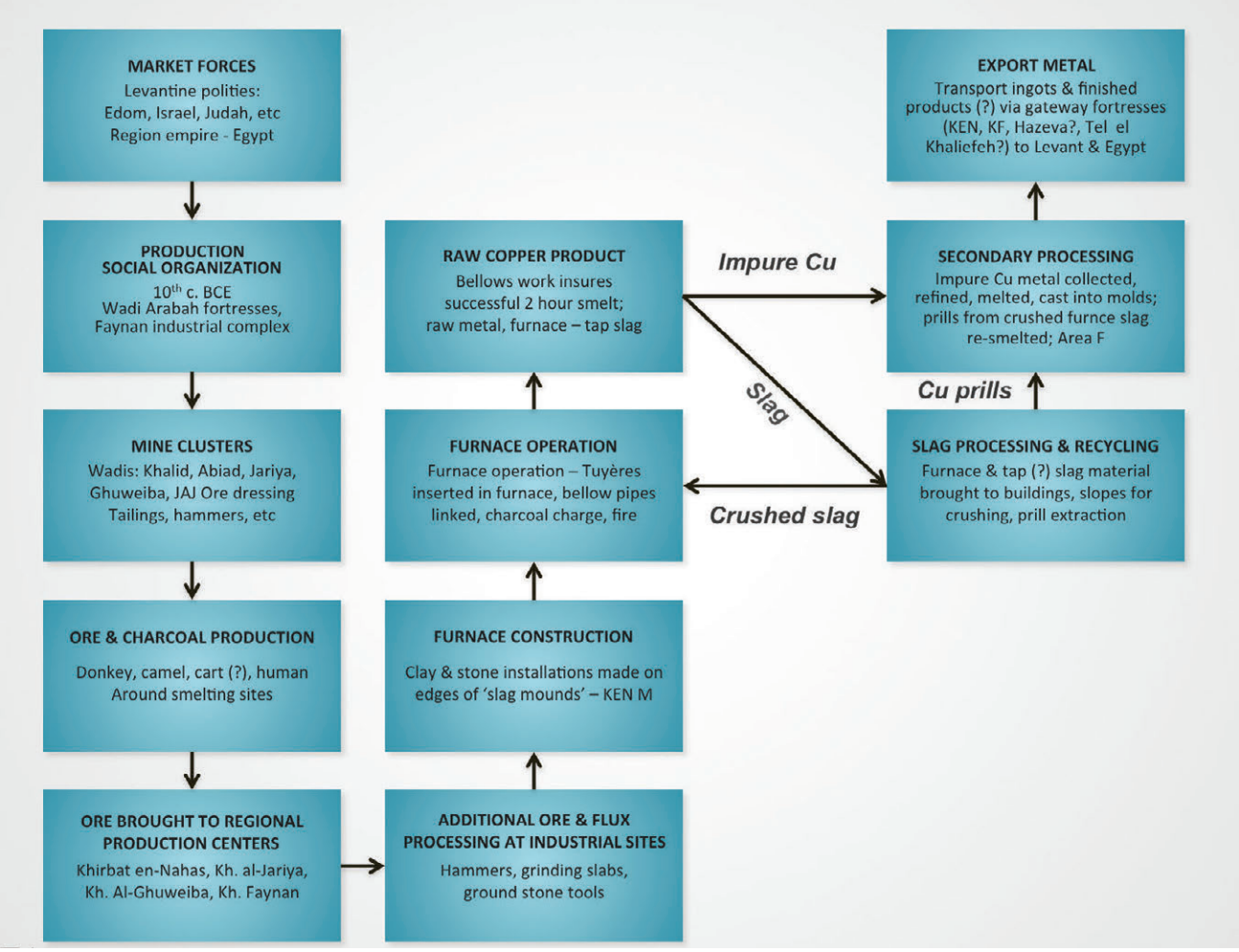

Figure 15.2 Generalized tenth-century BCE *chaîne opératoire* for copper production in the Faynan district, Jordan.

metal production record in Area M that was clearly visible between Layers M2 and M3 associated with Egyptian amulets (aegis scarab—see Chapter 2: Area M; Chapter 11). Our working hypothesis attributed this disruption in copper production to one of Shoshenq I's "flying column" military units that made their way across the northern Negev conquering Arad, moving south toward Hazeva and then southeast to Khirbat en-Nahas (Kitchen 2004:296–297; Levy et al. 2008 and supplemental material). Stein's (1999, 2005) notion of distance parity reviewed in the introduction to this volume best explains why the Egyptians did not establish a colonial enterprise in Faynan like they did along the coast of Palestine during the Late Bronze Age and they may have done at the Late Bronze copper mines at Timna (Rothenberg 1999). According to Kitchen (2004:287–294), in ushering in the twenty-second Dynasty, Sheshonq I was completely occupied with consolidating his power base in the Nile valley by reunifying Egypt and fighting many enemies stretching from Byblos and ancient Israel in the north to Nubia in the south. As long as there was a strong, well-armed Hebrew kingdom embedded in Syria-Palestine under Solomon (ca. 971/70–931/30 BCE—traditional chronology), Shoshenq left this small state alone (Kitchen 2004:293). It was only some five years after the death of Solomon (1 Kings 14:25) that Sheshonq carried out his famous campaign, but distance from the Egyptian core and troubles at home precluded the establishment of a colonial system in the southern Levant during the Third Intermediate period (Bruins et al. 2003; Finkelstein 2002; Finkelstein and Piasetzky 2006; Kitchen 1992, 2003, 2004; Shortland 2005). The archaeological data from KEN's neighboring copper

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production center at KAJ and Khirbat al-Ghuwayba suggest that following this late tenth-century BCE raid, copper production ceased at that site, and the center of production focused solely on Khirbat en-Nahas (in the larger Faynan area, copper production probably continued also at Khirbat Faynan itself; see Chapter 12, this volume).

Following the late tenth-century BCE disruption at KEN, there was a decommissioning of the gatehouse and fortress in the late tenth to early ninth centuries BCE. This change was accompanied by the abandonment of the symbols of rank and power reflected in the Area R and T buildings with their prestige objects, including Egyptian amulets, beads, metal weapons, Cypro-Phoenician fine ware imports (Chapters 3 and 4, this volume), and other finds. As shown in Chapter 2 (this volume), cultural formation processes left few of these prestige goods in situ. With change in the regional spatial organization of copper production at this time (i.e., the abandonment of KAJ) and centralization at KEN, the decommissioning of the KEN fortress, and abandonment of the structural symbols of early tenth-century BCE power and prestige (Areas R and T), it seems the occupants of KEN consciously rejected the organization of production that had preceded the disruption observed in the stratigraphy of Area M (Chapter 2, this volume). It is not possible in our research to suggest that the early tenth-century production system was controlled by the United Monarchy, as reflected in the Hebrew Bible (cf. Avishur 2007; Bartlett 1992a; Edelman 1995b; Knauf 1992; Knauf-Belleri 1995; Knauf and Lenzen 1987; Levy 2008b). However, other remarkable material culture changes followed the late tenth-century BCE disruption observed at KEN. These changes concern the pyrotechnology of "post-disruption" late tenth- to early ninth-century BCE copper production discussed in Chapter 12 (this volume). Specifically, tuyère and bellows tubes doubled in size and efficiency at this time, making the copper extraction process not only more standardized and efficient but also more profitable. Ben-Yosef (2010, chap. 8) demonstrated this by using X-ray fluorescence (XRF) to measure the copper residue left in slag in the various Iron Age phases that span the tenth to ninth centuries BCE.

With the discovery of the scarab bearing the name of Shoshenq I at Khirbat Hamra Ifdan (Chapter 11, this volume) and recent discoveries from Timna (Ben-Yosef et al. 2012), it is now clear that the 'Araba copper mines were one of the destinations of Shoshenq's military campaign, and probably the most important one. We can precisely identify the impact of the campaign in the archaeological record and thus provide, for the first time, high-resolution dating of this historical event (see Chapters 2 and 12, this volume). Whether the goal of Shoshenq's campaign was to boost copper production in the 'Araba or to destroy it (see discussion below), it seems that the new advanced technology of the late tenth to ninth centuries BCE was introduced by agents related to Egypt (Chapter 13, this volume).

Eighth to Seventh Centuries BCE. It is only in the highlands of Edom, at sites such as Umm al-Biyara (Bennett 1966, 1967; Bienkowski 1990, 1992), Tawilan (Bennett and Bienkowski 1995; Bienkowski 1990; Dalley 1995), and Busayra (Bienkowski 2002b), that there is definitive evidence of Assyrian–Edom interaction, and this occurs only in the late Iron Age (IIC) period. The general consensus is that in the late eighth century BCE, Edom became Assyria's vassal and, among other duties, had to pay regular tribute (Bartlett 1989, 1992b; Bennett 1982; Bienkowski 2000; Millard 1992; Na'aman and Thareani-Sussely 2006; Tebes 2007). However, prior to ELRAP's major Iron Age project, summarized in this volume, many archaeologists assumed (and some still do) that it was this core–periphery relationship that allowed the local Iron Age population of Edom to evolve their polity into a state-level political organization (Avishur 2007; Bienkowski and van der Steen 2001; Crowell 2004; Edelman 1995a; Finkelstein 2005; Hart 1989; Parr 1992; Porter 2004; Thareani 2010; Whiting 2007). The ELRAP data presented here and in other publications show definitively that the local population of Edom evolved into a complex society, perhaps as an archaic state (Feinman and Marcus 1998; Stanish and Levine 2011) or a complex chiefdom level (Levy 2009) that is archaeologically identifiable as early as the early tenth century BCE if not earlier, and with ancient texts, this kind of complex society may be identified in Edom as early as the thirteenth century BCE (Avishur 2007; Bartlett 1989; Edelman 1995b; Kitchen 1992; Knauf-Belleri 1995). ELRAP has tracked this process through the study of ceramics (Chapter 4, this volume) and it is summarized below.

The ELRAP data show that by the eighth to seventh centuries BCE, there was a marked decrease in copper production in the lowland copper ore region of Faynan (Chapters 2, 12, and 13, this volume). Some smelting

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activities possibly took place around Khirbat Faynan in the main valley system of Faynan, but the industrial-scale production documented for the tenth and ninth centuries BCE disappeared. The organizational center of this early Iron Age copper industry, Khirbat en-Nahas, was abandoned and never reoccupied. The only excavated sites with evidence of an eighth- to seventh-century BCE occupation in the vicinity of KEN are Rujm Hamra Ifdan (RHI) on the Wadi Fidan (Chapter 10, this volume) and Ras al-Maya fortresses and related sites overlooking the perennial spring at 'Ain al-Ghuwayba (Chapter 12, this volume; Ben-Yosef et al. 2009). While RHI served as possible watchtower linked to the tenth-century BCE copper industrial complex in Faynan, by the eighth to seventh centuries BCE, its enclosure wall around the site indicates that it probably was used as large corral for livestock that exploited the nearby fresh water spring at 'Ain Fidan. The rich ceramic assemblage is identical to that found at the late Iron Age highland sites of Edom described above. From a ceramics perspective, the fact that both early and late Iron Age ceramic assemblages are present at this lowland site provides an important developmental anchor for monitoring the full Iron Age sequence for the whole of Edom.

In summary, during the eighth to seventh centuries BCE, copper production and landscape use in Faynan were minimal. While limited smelting activities possibly took place around Khirbat Faynan (Hauptmann 2007), the well-defined networks of ore extraction and processing evidenced in the region for the eleventh to ninth centuries BCE ceased to exist. The establishment of the Ras al-Maya fortress complex in the rugged hills above the 'Ain al-Ghuwayba spring (cf. Chapter 12, this volume; Ben-Yosef et al. 2009) seems to have been a failed effort to revitalize the copper industry in Faynan at the industrial-scale levels seen in the Iron Age IIA phases. Our research shows that the impressive fortress at Ras al-Maya East was never completed, despite a great deal of effort and expense put into the construction process. By the end of the Iron Age, copper production was no longer a central economic pillar for the inhabitants of Faynan. Instead, Faynan's location on the trade routes from Arabia to the northern Levant and Mediterranean seaboard played a more important role in their economic system. Any relationship with the Assyrian empire at this time would have been based on an economy that focused on trade and trade routes rather than the copper industry (Chapter 6, this volume).

Ethnic Identity and Iron Age Faynan

Although it is still not possible to definitively identify the population who was responsible for the monumental building thrust at KEN during the early tenth century BCE or the spatial and organizational and technological changes documented at the site (Chapter 2, this volume), data from the in-depth ceramic analysis of the Iron Age ceramic at KEN (Chapter 5, this volume) and other sites by Smith (2009) and the mortuary analysis of the Wadi Fidan 40 cemetery (Chapter 9, this volume) by Beherec and others (Beherec 2011; Levy et al. 2004; Levy et al. 1999; Levy, Najjar, van der Plicht, et al. 2005) may shed light on the question of ethnic identity in Iron Age Faynan during the tenth through ninth centuries BCE. The following summarizes the ELRAP archaeological results concerning the problem of ethnicity and the Iron Age archaeological record in Faynan.

Iron Age Ceramics in Edom

For reasons discussed in Chapter 4 (this volume) and elsewhere, ceramics are not a perfect proxy for identifying ethnicity in the archaeological record but one of the best with which researchers have to work (e.g., Dever 1995; Emberling 1997; Jones 1997; Kansa and Levy 2002; Killebrew 2005; Shennan 1989). Ceramic data from seven excavations from both the lowland and highlands of Edom were analyzed for this ELRAP study. The centerpiece of the work was the deeply stratified assemblage from Khirbat en-Nahas. By using the analytical methods that meld digital recording with high-precision radiocarbon dating described in the introduction to this volume, early (ca. eleventh to ninth centuries BCE) and late (ca. eighth to sixth centuries BCE) technological ceramic styles have been defined for Iron Age Edom. The comparative and quantitative study of the early Iron Age ceramics from KEN show that all the dominant vessel types have their strongest parallels with sites on the plateau of Edom, such as Busayra, Tawilan, Umm al-Biyara, and Ghrareh, rather than Cisjordan. While the KEN assemblage is earlier, each of the KEN vessel types has specific later derivates in the highlands. Painting styles and decoration follow a similar pattern. As highlighted in Chapter 5 (this volume) and elsewhere (Smith and Levy 2008), the lowland ceramic and radiocarbon dating data demonstrate a much longer local Iron Age potting tradition than assumed by earlier researchers. If the late Iron Age settlements in the highlands of Edom do indeed represent the historical Edomites (see references above), then the local potting tradition can be used as a proxy to identify Edomite ethnic groups whose

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ceramics were widely used at the lowland mines and copper production centers from as early as the thirteenth century BCE. Thus, the tenth- to ninth-century BCE Iron Age ceramic assemblage from KEN should be considered a local regional Transjordanian ceramic tradition, deeply rooted in time, specific to Edom that developed in parallel to the many different technological styles found in Iron Age Cisjordan with stylistic and technological (Chapter 4, this volume) affinities to the later Iron Age ceramics found on the plateau of Edom.

Iron Age Mortuary Behavior in Edom

The ELRAP excavations at the Wadi Fidan (WFD) 40 site represent large-scale excavations in the most extensive Iron Age cemetery known to date in southern Jordan. Over 275 burial monuments were excavated during three excavation seasons at a site that may have more than 1,500 tombs and mortuary installations (Chapter 9, this volume). Radiocarbon dating samples were processed from a number of cist tombs located across the site. The calibrated dates put the peak period of use in the tenth century BCE—the period when copper production was at its zenith in the Faynan district. The final report on those excavations is presented in Chapter 9. The isolation of this massive cemetery from any habitation site, the circular cist graves, the paucity of pottery vessels, and the preponderance of wooden bowls and other burial goods all indicate that a nomadic or semi-nomadic population was interred in the WFD 40 cemetery. In the study presented here, the question of what it means to be Edomite is explored in relation to anthropological concepts of ethnicity and ethnogenesis (Faust 2006; Levy and Holl 2002). The analysis of the large mortuary assemblage from WFD 40 highlights the difference between this "non-pottery-using" tenth-century BCE mortuary population and the contemporary occupants of the copper production centers such as Khirbat en-Nahas. Keeping in mind the cyclic process of copper production and settlement in Faynan and the nearby Edom highlands that spans some 500 years, we are presented with a tenth-century BCE "snapshot" of settlement dynamics during this period. ELRAP researchers have characterized the WFD 40 nomadic group that buried their dead here as a component of the larger Shasu nomadic group known from ancient Egyptian texts such as the Papyrus Anasti that refers to the inhabitants of Edom as a nomadic people—"the Bedouin tribes of Edom" as early as the thirteenth century BCE from the time of Merneptah (ca. 1224–1214 BCE) and later (Pritchard 1969).

As noted above, based on the ceramic study presented in Chapter 4 (this volume) and elsewhere, we assume the deep-time Iron Age potting traditions that first appear in the copper ore Faynan district during the tenth to ninth centuries BCE (and perhaps earlier) reflect the same local "Edomite" population that manifests itself in the eighth- to seventh-century BCE settlement in the highlands. Thus, in analyzing the tenth-century BCE Faynan, researchers are faced with a dichotomy between a local "ceramics-using" population involved in copper production at Khirbat en-Nahas and other sites and a contemporary nomadic population interred at WFD 40. It is possible that this is a reflection of burial practices rather than evidence of "different" ceramics versus non-ceramics-using groups. If the former, it is important to ask what the relationship was between the two groups. For example, the in the Lake Chad region of the Sahel zone in Africa, the Shuwa Arabs use large quantities of pottery for their wet season villages that are produced by a different (fully sedentary) ethnic group (Kotokos; Holl and Levy 1993). In this case, two different ethnic groups use the same type of pottery in different settlement contexts (the Shuwa Arabs don't generally use pottery in their dry season camps because they are more mobile in the dry season). In any event, as shown by ancient Egyptian texts, what underlies all settlement in southern Jordan from as early as the Late Bronze Age is pastoral nomadism related to different degrees of sedentism. As first suggested by LaBianca and Younker (1995; LaBianca 1999), tribalism played an important organizational role in the formation of the Iron Age kingdoms in Transjordan—a socioeconomic principle linked to nomadism and transhumance that operated throughout history and even today (Gellner 1990; Lancaster 1997; Malamat 1973; Marx 2006; Muhammad 1999; Musil 1927; Walker 1999; Weinfeld 1987). Many of the Bedouin tribes that inhabit the Faynan district today practice a transhumance lifestyle with two residences—one in the agriculturally rich highlands of Edom and the other in arid Faynan lowlands. Historical data from the Ottoman period and later to the first half of the twentieth century CE document transhumance between the highlands and the lowlands of Edom (Bienkowski and van der Steen 2001; van der Steen 2012). Highland towns and villages such as Busayra, Wadi Musa, and other locales are situated near important Iron Age settlements. It seems likely that during the Late Iron Age, segments of the groups who occupied highland village sites

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such as Busayra, Umm al-Biyara, Tawilan, Khirbat al-Malayqtah, Khirbat al-Kur, and Khirbat al-Iraq (Chapter 3, this volume) may have also had sections in their tribal organizations that practiced seasonal transhumance or even full nomadism that involved movement between the highland and lowland zones of Edom. Similarly, in the earlier phases of the Iron Age, when settlement activities focused on the lowlands of Edom, animal husbandry needs would have required the movement of animals into the highlands during the hot and dry late spring and summer months (see Chapter 8, this volume). In short, the Iron Age ceramic data are indicative of a cyclic process of local social interaction between the highlands and lowlands of Edom. During the approximately 700 years of Iron Age occupation in Edom, for economic reasons, the intensity of settlement shifted from the lowlands during the early phases (thirteenth/twelfth to ninth centuries BCE), when copper was intensively exploited, to the highlands during the late phases (eighth to seventh centuries BCE) when control of the Arabian trade routes was more important.

Based on the above, there are a number of scenarios to explain the relationship between the Iron Age nomadic cemetery population (probably a complex chiefdom organization; Levy 2009) that shows very little use of ceramics versus the pottery-using copper producers at Khirbat en-Nahas and other Faynan sites (also organized as a complex chiefdom, or archaic secondary state). This must be viewed in a dynamic fashion in terms of a long Iron Age chronology for Edom and ELRAP's ability to distinguish subcentury change in the "early" and "late" tenth-century BCE phases documented in the excavation sequences at KEN (Chapter 2, this volume) and supplemented at Khirbat al-Jariya and other sites (Chapters 10 and 12, this volume). Based on radiocarbon dates (Chapter 9, this volume), the WFD 40 cemetery was certainly used throughout the tenth century BCE, perhaps beginning in the preceding late eleventh century BCE and extending later into the early ninth century BCE. The presence of a large nomadic population in Faynan during the Iron Age must be factored into cultural models used to interpret the archaeological data. Based on the different data sets analyzed from ELRAP presented in this volume from Iron Age production, settlement, military, mortuary, and other sites, a number of interaction scenarios are presented below for the thirteenth to seventh centuries BCE in northern Edom, where Faynan and its nearby highland zone are situated (for a review of the study area environment, see Introduction, this volume).

Cycles of Social Interaction

Thirteenth to Mid-Twelfth Centuries BCE

The occupation evidence recognized at the basal layer of KEN Area M includes fine crushed slag mixed with the sediments of the oldest horizons, demonstrating that copper production was the *raison d'être* of the site. However, the limited exposure and almost complete absence of identifiable ceramics do not allow elaboration on the quality of this incipient industry.

Late Twelfth to Eleventh Centuries BCE

The scale of settlement in Faynan at this time is unknown. However, data from the deep probes at KEN Area M and KAJ Area A suggest that copper production was carried out on a considerable scale. The lack of clearly defined late twelfth- to eleventh-century BCE settlement pattern data (Chapters 6 and 7, this volume) may be a result of ELRAP's inability to distinguish ceramics from these very early IA sequences. However, given the excavation data and Egyptian amulet evidence dating to the Iron Age I period (Chapter 11, this volume), we assume nomadic or semi-nomadic groups occupied Faynan, practicing herding, limited copper craft production, and movement throughout the southern Levant, northern Arabia (indicated by Qurayra ware ceramics at KEN and KHI Sounding A; Smith 2009), and into the Nile delta. According to the Egyptian textual data discussed above, the occupants of Faynan were known to the Egyptians as "Shasu" nomads (Pritchard 1969) and the biblical writers as the predecessors of Edomites in Edom (Gen. 36:20–29 and 1 Chronicles 1:38–42). During this early phase, Faynan was dominated by these pastoral nomadic groups whose concern with territoriality increased at the end of the eleventh century BCE when the Wadi Fidan 40 cemetery was established near the Wadi Fidan gorge and the gateway to Faynan.

Early Tenth Century BCE

The first exponential increase in copper production at Khirbat en-Nahas occurred during the early tenth century BCE and probably as early as the late eleventh century BCE. This was accompanied by the construction at KEN of one of the largest tenth-century BCE desert fortresses in the southern Levant. In addition to the

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well-designed four-chamber gatehouse associated with the fortress, other large-scale construction activities took place such as the monumental building in Area R at KEN. This two-story building, surrounded by a stone-wall enclosure with attached dais or "throne," resembles the "buttress buildings" found at tenth-century BCE sites in the central Negev desert to the west (Chapter 2, Area R discussion). However, the KEN example is considerably larger than the Negev examples. When the fortress, Area R buttress building, Area T elite residence, and the rapid increase in industrial-scale copper production at KEN and smelting activities at KAJ are considered together, early tenth-century BCE settlement and production at KEN may be described as radically different from the nomadic/semi-nomadic settlement pattern that characterized Faynan in the preceding late thirteenth to eleventh centuries BCE. Based on the increase in the number of tombs built and used in the WFD 40 cemetery, the nomadic population in Faynan seems to have grown exponentially, or at least the material culture signature on the Faynan landscape became much more pronounced than at any previous time. It is not yet clear why this increase occurred or from where the people came. The buried population from the Wadi Fidan 40 mortuary complex is currently being examined with geochemistry methods for evidence of ancient pollution and indications that the buried population was involved in copper working (Y. Erel, personal communication, 2013). Preliminary ancient pollution studies by the CBRL team show the negative effects of copper smelting on the Iron Age people of Faynan. However, existing geochemical data do not clarify the nature of the relationship between the nomadic/semi-nomadic Faynan population and the boon in copper production characterized by radically new organizational principles expressed in monumental construction activities and industrial-scale manufacturing processes.

Two general models can be suggested that both relate to early tenth-century BCE peer polity interaction (cf. Introduction, this volume; Levy and van den Brink 2002).

Model 1: The local nomadic/semi-nomadic population in Faynan responded to the growth of neighboring complex societies in Moab to the north and ancient Israel to the west by innovating in a number of production areas: industrialization of copper production (Chapters 2, 12, and 13, this volume) and embellishment of specialized ceramic crafting with local styles (Chapter 5, this volume). Ceramics were needed in the lowlands to facilitate food consumption, water storage, and other activities linked to prolonged months of sedentism associated with the copper industry. Through peer polity processes of competition and competitive emulation, the accoutrements of power such as the construction of the KEN fortress, monumental buildings, and other structures were built and operated by the local population of Edom. In accord with this model, early tenth-century BCE burial practices at WFD 40 retained the "nomadic ethos" of the same population that carried out and controlled copper production at this time.

Model 2: Two different population/ethnic groups occupied Faynan during the early tenth century BCE. The rapid increase in industrialization at KEN, four-chamber gatehouse and fortress, buttress building, and select Israelite-style ceramics (Chapter 5, this volume) was a result of the influx of the neighboring United Kingdom polity from the west. The peer polity interaction processes that initiated these changes included competition, warfare, and transmission of innovation. According to this model, the administration of copper production at this time was organized by the outsiders; the expansion of the WFD 40 cemetery reflects the increased presence of the local population in Faynan as a subjugated workforce or some other form of labor. Different types of opportunistic labor choice are typical of nomadic communities when interacting with settled populations (Khazanov 1994). This process has been documented for the Bedouin of the Negev, Sinai, and southern Jordan since the nineteenth century CE (van der Steen 2012). The imposition of external control over the copper industry does not preclude the local stylistic development of ceramics in Edom. Material culture (ceramics, mortuary practices) served as mechanisms to promote local (Edomite) identity in contradistinction to the outsiders—a process that is typical of ethnogenesis (e.g., see Faust 2006; Levy and Holl 2002). This model is supported by different passages of the Hebrew Bible that relate to early United Monarchy activities in Edom (cf. 2 Samuel 8:14; 1 Kings 11:14; 1 Chronicles 18:13).

Late Tenth to Ninth Centuries BCE

At the end of the late tenth century BCE, there was a major disruption in the copper production industry in Faynan, evidenced in the excavations of the "slag mound" at KEN and the abandonment of the secondary copper production center at KAJ and Khirbat al-Ghuwayba (KAG). The working hypothesis described above is that Egyptian forces under Sheshonq I were responsible for

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this dramatic change that led to the decommissioning of the fortress and abandonment of the buttress building in Area R and the other administrative building in Area T. Despite this "downsizing" in the architecture of power (Chapter 2, this volume), the technology of copper production quickly became more efficient and larger in scale. This suggests several different scenarios concerning social interaction in late tenth-century BCE Faynan:

Model 1: Following the Sheshonq I disruption of copper production around 925 BCE at KEN (Chapter 1, this volume; see Levy et al. 2008), Egyptian administrators took control of copper production in Faynan. This model is similar to Rothenberg's (1988) suggestion that during the Late Bronze Age, during the reign of Pharaoh Seti I at the end of the fourteenth century BCE, Egyptian administrators controlled copper production in the southern Araba valley. This core civilization interaction model seems unlikely for reasons described above, and the fact that many of the accoutrements of Egyptian power that would be expected if copper production was under their control are absent. The absence of Egyptian temples (like the LB sanctuary at Timna), fortresses, and food consumption activities (such as the abundance of Egyptian bread molds found at colonies dated to the late fourth millennium BCE in the Negev desert [Levy and van den Brink 2002] or pig bones in the faunal remains [e.g., Sapir-Hen et al. 2013; cf. Chapter 6, this volume]) argue against an Egyptian presence in Faynan and in favor of a short military campaign to upset the economic power that emanated from Faynan at this time—power that would have been perceived as a threat to Shoshenq I (Kitchen 2004). Distance–parity at this time in Egyptian history precluded their ability to establish a colony in the southern Levant (cf. Stein 1999).

Model 2: The Sheshonq I campaign opened up new opportunities for the local population of Faynan. The hegemonic system of control over copper production that characterized the early tenth century BCE (regardless of who was in control) collapsed enabling components of the local society to reorganize production and remove all the major symbols of oppression. This is reflected in the conscious decision to decommission the fortress, clearly evidenced in the gatehouse excavations at KEN Area A (Chapter 2, this volume) and the abandonment of the monumental and other buildings at the site. There is a more egalitarian ethos reflected in the spatial organization of ninth-century BCE Khirbat en-Nahas. Based on excavations in Areas S, M, and W, single-story courtyard buildings, mostly with four rooms, were built to facilitate copper production that was now carried out on a larger scale and more efficiently. While the WFD 40 cemetery was still intensively used during the late tenth century BCE, burials decreased at the beginning of the ninth century BCE. This shift may indicate organizational changes toward increasing sedentism within the local Faynan nomadic/semi-nomadic society. By the end of the ninth century BCE, village settlement began to blossom on the steppe edge of the Edom highlands at plateau sites such as Khirbat al-Malayqtah, Khirbat al-Kur, Khirbat al-Iraq, and further east in the Mediterranean plateau zone at Tawilan (Chapter 3, this volume). This reflects a peer polity emulation process that is reflected not only in the construction of villages in the highland but also the increasing importance of local "Edomite" ceramic styles that came to fruition in the following seventh- to sixth-century BCE phase of the Late Iron Age. Model 2 also resonates with passages from the Hebrew Bible, in particular the revolts of the Edomites against Judean rule, traditionally dated to the mid-ninth century BCE, that continue several decades after the Sheshonq I campaign in the southern Levant (cf. 2 Kings 8:22, 2 Chronicles 21:10; and also Rogerson 1999).

The Oscillating Tribal Segmentary System

The "nomadic imperative" for subsistence in southern Jordan during the late second to early first millennia BCE discussed by Levy (2009) is relied on here to help summarize the Iron Age investigations in socioeconomic terms described in this volume. In discussing the emergence of "tribal kingdoms" in the Iron Age of Transjordan, some scholars (LaBianca 1999; LaBianca and Younker 1995) have noted the role of nomadism in the rise of these complex polities. Part of the problem may be an overreliance on late nineteenth- and twentieth-century CE ethnographic and ethnohistorical research that results in a static picture of the nomadic and semi-nomadic Bedouin Arab tribes of the region. Similar assumptions have been made in other parts of the Middle East, such as Iran, in Helgott's (1980) study of the Qajjar state. As pointed out by Khazanov (1994), while pastoralism is a key component of nomadic societies, their relationship with neighboring polities—mostly settled—opens up

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a wide range of other economic pursuits by nomadic peoples. Rather than focus on the notion of herds and herding as the central variable for promoting change in nomadic people's social organization through time, it may be more useful to spotlight some aspects of the segmentary lineage model that underlies tribal genealogy and kinship structure. The segmentary lineage system has been defined as a particular form of higher order descent group organization: "a part of a wider system of kinship in specific societies and part of kinship analysis in cultural systems" (Bastug 1998:95). The segmentary lineage system model was conceived by Evans Pritchard in the 1940s and, like all general models, has been both embraced and critiqued as not applicable in some areas of the Middle East (Munson 1989) or of little value. Without going into this long-standing anthropological controversy, most scholars find value in the focus on the principle of "segmentation" structures (such as lineages) this principle in tribal societies—especially those nomadic societies in the Middle East. This was first articulated by E. L. Peters, who worked with camel herding tribes of Cyrenaica (Peters 1967) and showed the segmentary linage model to be more of a tribal ideology than an indicator of behavior. The "segmentary tribe" is portrayed by Sahlins (1968:20) as the basic structural building blocks that enable chiefdoms to emerge, where at the lower end of social complexity, tribes are inherently decentralized, and at the higher end, chiefdoms (still organized along kinship and decent) work toward integration of the segmentary system at its highest levels. With the establishment of chiefdoms, segmentary tribes are consolidated into more complex social organizations with more developed ritual, ideology, and economic structures. Without assuming a teleological "social evolutionary step-ladder" of band-tribe-chiefdom-state (Yoffee 1998), it is the segmentary principle (Eickelman 1981:131–138) embedded in tribal societies that allows them to evolve and devolve, to adapt to changes in both the natural and cultural environments and oscillate between small decentralized tribes to complex chiefdoms, to chiefly confederacies and back. According to Barfield (1993:75), the patrilineal lineage model is exemplified in the Bedouin Arab tribal systems of the Middle East where "within the tribe, the relationship between each lineage or clan rested in theory on segmentary opposition, that is, they were expected to support or oppose one another based on their degree of relatedness." The oscillating tribal segmentary system was consistently at play with the expansion and consolidation of the Saudi tribes in the formation of the Kingdom of Saudi Arabia in the early twentieth century CE (Kostiner 1990:229ff) who were in conflict with other chiefdom organizations, most notably the Hashemites. Thus, the process of social fusion and fission provides nomadic tribal societies with an adaptive mechanism, which along with the principle of social "resistance" in ethnogenesis and the notion of political ecology may help explain the rise of Iron Age complex societies in Edom.

As noted above, political ecology aims at understanding how access to natural resources plays a critical role in structuring the political and economic life of societies, especially how food and other basic resources are procured. One of the guiding studies for political ecology research is Piers Blaikie's (1985) *The Political Economy of Soil Erosion*, which examined how land degradation in sub-Saharan Africa was linked to colonial land appropriation, rather than overuse by local traditional farmers. As an analytical tool for archaeologists, political ecology can help (a) clarify decisions that communities make about their natural environment in the context of their changing political environment, economic pressure, and cultural context; (b) explore how unequal relations among societies in a research area affect the natural environment; and (c) investigate how unequal sociocultural relations affect the environment. In the case of Iron Age Faynan, the incorporation of copper production into the basic socioeconomic fabric of local nomadic societies contributed to creating a political ecology that led to social complexity. The oscillating tribal segmentary system (Levy 2009) is outlined in Chapter 1 (this volume).

In the context of a distinctive civilization collapse of all eastern Mediterranean ancient "superpowers" at the end of the Late Bronze Age and increasingly aridity, nomadic peoples residing in the southern Levantine desert zone and the Hejaz region in northwest Arabia took advantage of a power vacuum created by the collapse of world (eastern Mediterranean) markets and colonial systems. For the southern Levant, one of the most significant impacts was the collapse of Cyprus as the main supplier of Late Bronze Age copper for the region. During the Iron Age I to IIa periods, new social groups converged on Canaan (such as the Sea Peoples) and Transjordan that gradually evolved into

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distinct ethnic groups such as the Philistines, Israelites, Moabites, and Edomites. New archaeological data from the lowlands of Edom show a relatively rapid process for the formation of a local complex chiefdom already in the tenth century BCE that was nomadic in both practice and ideology but, in the context of the political ecology of the region, increased their production strategies beyond animal husbandry to include sophisticated mining, metallurgy methods, and control of the copper trade to boost their economies and dominate neighboring peoples. The prominence of mining and metallurgical activities in the Faynan district created a highly specialized Iron Age industrial landscape infused with local nomadic Edomites who formed part of a complex chiefdom or archaic state. Through processes of fusion and fission related to the dictates of carrying out metal production activities in this Saharo-Arabian desert zone in an environment with less rainfall than today, the Edomites carried out metal production activities in the cool fall months and winters and moved up to the highlands in the summer months. A burial with tenth-century BCE gold jewelry found at Tawilan and stylistically similar to samples found at KEN and the WFD 40 cemetery at Tawilan may be an indicator of such lowland–highland interaction (Levy, Najjar, Muniz, et al. 2005; Ogden 1995). By developing a highly successful metal industry in the tenth century BCE, it is possible the Edomites attracted the interest of neighboring polities such as Israel and, toward the end of the century, perhaps the Egyptians, as evidenced by ornaments dating from the time of Siamun and Sheshonq (Shishak) I found in a securely dated context in a metal production building at Khirbat en-Nahas. As suggested by models of the ethnogenesis model (Faust 2006; Levy and Holl 2002), Edomite resistance to neighboring polities such as the Israelites, as well as the Egyptian state, may have been another key factor in stimulating the expansion of eleventh- to ninth-century BCE copper production and their social and ethnic identity as an expanding chieftaincy at this time.

The following summary points can be made concerning the data that indicate the formation of the Edomite chiefly confederacy that begins in the eleventh century BCE and peaks in the ninth century BCE:

- High-precision radiocarbon dates demonstrate the deep-time history of Iron Age Edom, from at least the twelfth through ninth centuries BCE (Higham et al. 2005; Levy, Najjar, van der Plicht, et al. 2005; Levy et al. 2004). Most recently, a new sequence of high-precision radiocarbon dates from the first controlled excavations of a slag mound at Khirbat en-Nahas demonstrate intensive industrial-scale metal production during the tenth and ninth centuries BCE (Levy et al. 2008). The mining and smelting activities associated with these archaeometallurgical data indicate that complex societies were responsible for industrial-scale metal production during these centuries. While it is not yet possible to identify who controlled metal production in Faynan during these centuries, the dominance of local "Edomite" pottery from the excavation samples indicates the centrality of the local population in metal production at this time (Smith and Levy 2008). When these data are linked to archaeological materials such as Qurayra ware, Egyptian scarabs and amulets, Cypro-Phoenician ware, black burnished juglets, and other ceramics types, there is evidence of interaction between a number of different ethnic groups at KEN, including Edomites, Phoenicians, Israelites, Egyptians, and "Midianites" (see Levy et al. 2004; Rothenberg 1998; Rothenberg and Glass 1983), during the Iron Age from production and other sites in the Faynan district of the Edom lowlands. The establishment of a radiocarbon-based chronology from stratified excavations in southern Jordan adds some 300 more years to the Iron Age chronology of Edom. This new framework requires that researchers reengage the Hebrew Bible and other historical data sets concerning pre–eighth-century BCE Edom to test and model the nature of socioeconomic change at this time.
- Excavations in the Iron Age WFD 40 cemetery indicate the presence of a large nomadic population in the Edom lowlands with economic specialization in pastoralism, as well as possibly mining and metallurgy (see Chapter 9, this volume). Chemical analyses of human remains will be carried out to test the hypotheses that this population was involved in the industrial-scale metal production in the Faynan region. The potential for such studies exists for human and animal remains in Faynan and the Negev desert (see Grattan et al. 2003; Grattan et al. 2007; Hunt et al. 2004; Pyatt et al. 1999; Pyatt et al. 2000; Pyatt and Grattan 2001). Preliminary analyses

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with Yigal Erel provide promising results (Y. Erel, personal communication, 2013). Contamination of the environment with toxic metals (e.g., lead, cadmium, and copper) has been a worldwide problem since the Industrial Revolution. However, there is ample evidence that the global pollution by metals started long before then, as shown by Grattan et al. (2007). Among other issues, our research will trace through the Iron Age how humans have been polluted from metal production and how this may have related to the rise of ranked societies at this time in the southern Levant.

- Although studies of the Wadi Fidan 40 cemetery have been preliminary (Levy et al. 1999; Levy, Najjar, Muniz, et al. 2005; Chapter 9, this volume), the layout of the circular and cist grave mortuary structures shows no centralized burial monuments and probably reflects a segmentary society social organization (see Chapter 9, this volume). The burial patterns reflect local "folk" religious beliefs and practices. Based on historical Egyptian data, the Egyptians referred to these people as "Shasu" nomads (Avishur 2007; Kitchen 1992; Levy and Najjar 2006). At this time, we do not know what name this population referred to themselves as. However, based on numerous studies of the Hebrew Bible, the name "Edomites" is most likely.
- The typical decorated painted ceramic wares from Iron Age Edom, sometimes referred to as Busayra ware, were typically ascribed by earlier researchers as dating only to the seventh century BCE or later. However, new studies of this material found at sites in Israel have pushed the dating of this ware back to the eighth century BCE (Singer-Avitz 2004). Our recent excavations at Iron Age sites in the lowlands of Edom demonstrate Busayra ware is also found in tenth- and ninth-century BCE stratified sequences. Taken together, the new data imply long-term development of aesthetic cultural patterns between the lowlands and highlands of Edom, providing a possible indicator of Edomite ethnicity and the process of ethnogenesis.
- Twelfth- to ninth-century Edomite identity was shaped by local peer polity interaction (Renfrew 1986; Renfrew and Cherry 1986) and resistance to neighboring social groups, as well as rejuvenated by Egyptian state expansionary projects in the twenty-first and twenty-second dynasties. While Egypt was unable to reinstitute its Late Bronze Age–style colonization of Palestine, the Pharaoh Shoshenq I was keen to disrupt the socioeconomic order that David and his son, Solomon, had established (for a newly reported scarab attributed to Shoshenq I, see Chapter 11, this volume). The recent excavations and analyses of an industrial copper slag mound at KEN document a major disruption in production at the end of the tenth century BCE that may be attributed to the Shoshenq I campaign (Levy et al. 2008). Due to processes of oscillations in core civilization power during the twenty-first and twenty-second Egyptian dynasties, they were unable to reinstate the colonial model, probably due to what Gil Stein (1999) refers to as the "distance parity model." With the dissipation of core civilization influence from both Mesopotamia and Egypt at this time, peer polity interaction between Edom, Israel, Moab, Philistia, and other small local complex societies became a major platform for the negotiation of power.
- Early resistance to neighboring peer polities and conflict within the Shasu segmentary society of Iron Age Edom led to processes of fission within Seir/Edom. Soleb temple and Amarah inscriptions "*Yhw* (in) in the land of the Shasu" date from the late fifteenth century BCE, suggesting the "tetragrammaton" name of the Israelite god "Yahweh." Biblical tradition suggests that Yahweh came "forth from Se'ir" and originated in Edom (see Redford 1992:273), who calls them the Shasu/Israel group), and thus early Israel may have been one of the Shasu clans.
- As outlined here, and especially as articulated in Faust's (2006) work for ancient Israel, different processes of ethnogenesis were followed by the different ethnic groups in southern Jordan/Hejaz and northwest Arabia (i.e., Midianites, Edomites, and Israelites). This is an extremely fertile problem area for future investigation.
- Language: The development of an Edomite script may represent the tail-end of ethnogenesis among elite groups in Edomite society (Porter 2004).
- Finally, maintenance of Edomite ethnicity in the Neo-Assyrian period (seventh to sixth centuries BCE) led to resistance and negotiation with a core civilization, effecting social changes that went well beyond those caused by peer polity interaction.

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In conclusion, the "oscillating tribal segmentary social system" model proposed here can help explain how a tribal society, in a marginal desert environment under the push and pull of neighboring polities and ancient core civilizations, could adapt and grow into a small secondary state-level society. By focusing on three interrelated processes—ethnogenesis, political ecology, and the oscillating tribal segmentary social system—we are on the road to understanding how social evolution in the late second and first millennia could occur. Much more work needs to be done that is rooted in archaeological field research and scientific approaches to the Iron Age archaeological record of the southern Levant.

Concluding Remarks

Jordan's Faynan district is home to one of the world's best-preserved ancient mining and metallurgy regions. The vibrant natural beauty of Faynan's Saharo-Arabian desert environment, coupled with its hundreds of impressive archaeological sites, makes it worthy of international conservation efforts, perhaps as part of a national park or UNESCO World Heritage site (Levy and Najjar 2007). The best preserved, extensive, and most impressive archaeological remains in the region concern the Iron Age ancient metallurgical landscape. With the conclusion of the UCSD ELRAP Phase I research (2002–2009) published in final form here, the scholarly community, Jordanians, and the world community can explore the southern Levant's first industrial revolution in the context of systematic archaeological surveys and state-of-the-art cyber-archaeology investigations. The new research directions taken in this interdisciplinary study would not have been possible without the Iron Age doctoral dissertation projects published in great part here (Beherec 2011; Ben-Yosef 2010; Smith 2009). Other UCSD graduate student and former graduate student research is also contained in this volume. However, without the energy, hard work, and devotion of the hundreds of undergraduate students, both the fieldwork and laboratory studies presented here would not have been possible.

Table 15.3 Main excavation areas at Khirbat en-Nahas and selected ELRAP sites indicative of Iron Age sociopolitical organization in Faynan. The schematic correlation presented here is based on ^{14}C dates and ceramic assemblages.

St. at KEN	^{14}C BCE	KEN-A	KEN-A description (2002, 2006)	KEN-M	KEN-M description (2002, 2006)	KEN-T	KEN-T description (2006)	KEN-R	KEN-R description (2006, 2009)	Khirbat al-Jariya (Area A)	Khirbat al-Ghuwayba (Area E)	Rujm Hamra Ifdan	Ras al-Miyah Fortresses
NA	8-7th	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Sounding B (lower) Structural enclosure	Fortresses and mines operate for a short period of time; east fortress building operation interrupted
I		A1a A1b	Post-abandonment	-	Post-abandonment	T1a	Post-abandonment (unoccupied)	R1a R1b Post-abandonment (unoccupied)	Post-abandonment	KAJ-A1a Post-abandonment (unoccupied) / Small scale copper production ?	Post-abandonment	NA	NA
II	9th	A2a	Ephemeral metal production outside gate	M1; 1a	Smelting; (1a after building abandonment ?)				R3 - Courtyard Copper production complex				
		A2b	Intensive metal production	M2a	Intensive smelting, late phases in building								
III	Late 10th-early 9th	A3a	Decommissioning gatehouse Residential?	M2b	First phase of building; intensive smelting	T1b T2a	2nd occupation phase floor						
IV	10th	A3b	Building of gatehouse	M3 [IV-V]	Industrial horizon: intense copper production	T2b	Main building phase, residential	R2a	Some additions to structure	KAJ-A1b (last phase of copper production) KAJ-A2 (building)	Stratified sequence of copper production debris (Area E, southern probe)	Sounding A (upper) A watchtower at the entrance to the district; limited copper smelting (opportunistic)	NA
								R2b	Main building phase, residential				
V	Early 10th	A4a	Crushed slag/ below gate			T3	Crushed slag below building	R3aR3b	Crushed slag below building	KAJ-A3; -A4 10th; copper production; occupation - surfaces			
VI	Late 12-11th	-	Unoccupied	M4	Copper production	-	Not excavated	-	Not excavated	KAJ-A5; Copper production		NA	
										KAJ-A6 Crushed slag			
VII	13-12th			M5a M5b	Installations; small scale production					Unoccupied			
-	-	A4b	Virgin sediment	-	Virgin sediment					KAJ-A7 Virgin sediment	Virgin sediment		

Color key: white = unoccupied/post-abandonment contexts; orange = mainly smelting and other pyrotechnological activities; green = mainly architectural remains (buildings); blue = unexcavated contexts; pink = virgin soil. NA = not applicable.

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