Title
Long-term socioeconomic strategies in ancient Jordan : rural perspectives from the Iron Age through the Roman Period

Author
Knabb, Kyle Andrew

Publication Date
2015

Peer reviewed|Thesis/dissertation

UNIVERSITY OF CALIFORNIA, SAN DIEGO

Long-term socioeconomic strategies in ancient Jordan: rural perspectives from the Iron Age through the Roman Period

A dissertation submitted in partial satisfaction of the requirements for the degree
Doctor of Philosophy

in

Anthropology

by

Kyle Andrew Knabb

Committee in charge:

Professor Thomas E. Levy, Chair
Professor Guillermo Algaze
Professor Paul Goldstein
Professor David Goodblatt
Professor Jurgen Schulze

2015

The Dissertation of Kyle Andrew Knabb is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

Chair

UNIVERSITY OF CALIFORNIA, SAN DIEGO

2015

DEDICATION

For my parents.

EPIGRAPH

"The idea of nature contains, though often unnoticed, an extraordinary amount of human history."

Raymond Williams, "Ideas of Nature"

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

This dissertation is the product of several years of research. Though I am the sole author, it would not have been remotely possible without the help and support of a great many people. First and foremost, I would like to thank my doctoral advisor and committee chair Thomas E. Levy for his contributions to both my research and to my development as a scholar. His dedicated support and constant availability has been an overwhelmingly positive experience of my graduate education. Tom encouraged me to pursue goals I would not have known were within my grasp, and he opened numerous doors for me in the process. Beyond his role as graduate advisor, Tom has been my friend and colleague – supporting me in my professional and personal achievements – a relationship I look forward to continuing in the future.

I would also like to thank the rest of my committee, Guillermo Algaze, Paul Goldstein, David Goodblatt, and Jurgen Schulze, for their tireless support and dedication to my research. This dissertation would not have been possible without their input. Through a variety of classes, meetings, research collaborations, and casual conversations, they have made countless improvements to my work. Having said that, any errors in the present work must be attributed to me and me only.

Graduate school can be a grueling and arduous experience that I would not wish on anyone, but given the opportunity I would still choose the same path I've taken to get here. Along the way I've made some of the closest friends of my life and truly amazing colleagues. In particular, I would like to thanks my friends and Levantine lab mates: Aaron Gidding, Ian Jones, Kathleen Bennallack, Sowparnika

Balaswaminathan, Matthew Howland, and Brady Liss. To be friends with your peers is not uncommon, but the friendships we've developed are unique, envied, and indomitable. Likewise, my friends and peers in the anthropology department are deserving of my energetic thanks. I would especially like to extend my sincere gratitude to Alicia Boswell, Sarah Baitzel, Beth Plunger, Ben Volta, Nancy Peniche May, Misha Miller-Sisson, Mikael Fauville, Kiri Hagerman, and Adam Schneider, whose unwavering support and friendship through the ups and the downs in my life as a graduate student will not be forgotten.

The UC San Diego Department of Anthropology, my home department, is not perfect but was my home nonetheless. I am grateful for the support that they offered during my last two quarters in the form of positions as a TA and a Reader for two anthropology courses. Above all I would like to thank Nicole Gee, who was always friendly, knowledgeable, dependable, and professional.

For the work on ancient lead pollution I am indebted to Professor Yigal Erel of the Hebrew University in Jerusalem's Earth Science Institute. Yigal is a true authority on environmental geochemistry and his support, as well as that of his laboratory staff and students, was essential to the success of my work. My experience living and working in Jerusalem for two months was exceedingly positive thanks to their generosity. The interdisciplinary collaboration with Yigal and Tom has been one of the most productive and exciting aspects of my research and one that I hope will continue for some time.

All of the fieldwork for the dissertation was conducted as a part of the UC San Diego Edom Lowlands Regional Archaeology Project (ELRAP), directed by Thomas E. Levy and Mohammad Najjar. I am grateful to both of them for the kind permission to use materials from this project and from its predecessor, the Jabal Hamrat Fidan project, and for the training I received as a staff member on their field school. I owe them great thanks for assisting me in obtaining a permit for the Wadi al-Feidh survey, which was carried out under the auspices of the ELRAP. Many other people were involved in the ELRAP that contributed to the current research. To my fellow staff members and friends, Erez Ben-Yosef, Craig Smitheram, Sowparnika Balaswaminathan, Ian W.N. Jones, Marc Beherec, Yoav Arbel, Kathleen Bennallack, Neil G. Smith, Matthew Vincent, Caroline Hebron, Aaron Gidding, Aladdin Mahdi, Fawwaz Ishakhat, Ben Volta, Caity Connolly, Lauren Hahn, and Adolfo Muniz, I extend my sincere thanks and gratitude.

I wish to acknowledge the essential help and great company provided by the local Bedouin staff of Faynan and Qurayqira, who were employed to work in our camp and in the field and many of whom became my good friends. Without their efforts much of the research presented here would not have been possible. Hawayth Sayyideen, Juma Azazme, Hani Amareen, Nile Amareen, and Mohammad Defala were incredibly knowledgeable and hospitable colleagues to have working with us in the field.

I would also like to acknowledge the research contributions made by the Department of Antiquities of Jordan and its Director (at the time of research), Fawwaz al-Khereisheh, whom I sincerely thank for their support of the fieldwork conducted as part of the current research, including various excavation probes, surveys, and large-scale excavations. The American Center of Oriental Research in Amman has been a welcoming and hospitable home for me during long stretches of fieldwork, on top of the invaluable support they offered to me as I was learning to navigate the idiosyncrasies of fieldwork administration. I am especially grateful to Barbara Porter, Christopher Tuttle, and the ACOR staff for their generosity and expertise.

The Judaic Studies Program at UC San Diego provided generous support to my research, and I will always be grateful for the financial and other resources they provided. It has been a pleasure to be a part of this program and I have been lucky to be able to meet and work with many of its fantastic scholars. Along these lines I would also like to thank the Qualcomm Institute (formerly the California Institute for Telecommunications and Information Technology) and the Center of Interdisciplinary Science for Art, Architecture and Archaeology. For two years I worked as a Chancellor's Interdisciplinary Collaboratories Fellow with Jurgen Schulze and Thomas E. Levy on my master's thesis research on the application of 3D modeling and virtual reality to archaeological fieldwork. Since then our research has continued with the added guidance and expertise of Tom DeFanti and Falko Kuester, and I am truly proud of the research we have produced together.

I am indebted to the Eleanor Roosevelt College Making of the Modern World program, which was one of my homes for the last four years. They provided me with the opportunity, resources, and encouragement to hone my skills as an effective

teacher. But above and beyond that I am thankful for the sense of community and belonging that the program fostered between faculty, staff, graduate student TAs, and undergraduates, and in many ways the program embodied all the qualities I found lacking in my home department. Being an MMW TA has been one of the most meaningful experiences of my graduate student career, and for this I wish to thank Matthew Herbst, Heidi Keller-Lapp, Jacqueline Giordano, Eberly Mareci, Edmond Chang, Mollie Martinek, and Vilaya Roberts. You all do incredible work incredibly well.

To the students who have participated in the UC San Diego field school in Jordan, as well as those who volunteered in the Levantine Archaeology Lab, I hope you got as much out of the experience as I did teaching and leading you in your learning. I would like to call special attention to Gregory Horvath, Ian Jones, and Jesse Lerner, who worked with me during my first independent fieldwork project in the mountains of Wadi al-Feidh. Thank you for your hard work and dedication to the survey; your contributions were invaluable. Greg, in particular, kept us alive during the time we spent rappelling down cliffs and waterfalls thanks to his expert rock climbing skills. The physical and cultural situations we found ourselves in were, shall we say, unusual for most archaeological surveys, and despite all of that Greg and Ian are still my friends, and Jesse married me, so I am tremendously thankful for how things worked out. I hope their experiences were as unforgettable as my own.

All of the figures should be credited to the UCSD Levantine Archaeology Lab unless otherwise noted. A great deal of the laboratory work presented here was done

with the assistance of others. At the Hebrew University's Earth Science Institute I am indebted to Professor Yigal Erel for hosting me and supervising my research. In addition, I would like to thank Ofir Tirosh, Ori Kedar, Michal Ben-Israel, Daniel Palchan, Amani Zoubi, and Suzana Natour for their patient assistance with my training and questions. The OSL measurements (Chapter 4) were carried out in the Luminescence Lab at the Utah State University Geology Department by Tammy Rittenour and her staff and students. I've been very fortunate to have access to the intellectual support and experienced scientists with whom I have worked.

This work is more than an intellectual achievement – it is also a personal one. And I could not have come this far without the love and support of my parents, my family, and my friends, who have had my best interest in mind and on whom I have always been able to depend for their unwavering encouragement. My wife, Jesse, has been the single most influential person in my adult life. I cherish the life we have crafted together and the bright future we have as a family.

My research has received generous support from a number of sources: the National Science Foundation (Doctoral Dissertation Improvement Grant #BCS-1347658), the National Geographic Society/Waitt Foundation (Field Research Grant #W56-09), the US-Israel Binational Science Foundation (Travel Grant for Young Scientists #T-2012-122), the UC San Diego Institute for International, Comparative, and Aerial Studies, the UC San Diego Judaic Studies Program, the Chancellor's Interdisciplinary Collaboratories Fellowship program, and the UC San Diego Anthropology Department (F.G. Bailey Fellowship).

Chapter 2, in full, is a reprint of the manuscript as it was submitted for publication in Knabb, Kyle A., Mohammad Najjar, Thomas E. Levy (In Press“Characterizing the Rural Landscape during the Iron Age and Roman period (ca. 1200 B.C.–A.D. 400): An Intensive Survey of Wadi al-Feidh, southern Jordan.” Journal of Field Archaeology. The dissertation author was the primary author of this manuscript.

Chapter 3 is an edited manuscript (excepting the Buweirda springs data) of the material as it appears in Knabb, Kyle A., Ian W. N. Jones, Mohammad Najjar, and Thomas E. Levy (2014) “Patterns of Iron Age Mining and Settlement in Jordan’s Faynan District: The Wadi al-Jariya Survey in Context” in New Insights into the Iron Age Archaeology of Edom, Southern Jordan, Volume 2. Eds. Thomas E. Levy, Mohammad Najjar, Erez Ben-Yosef. Pp. 577-625. The dissertation author was the primary author of this manuscript.

ABSTRACT OF THE DISSERTATION

Long-term socioeconomic strategies in ancient Jordan: rural perspectives from the Iron Age through the Roman Period

by

Kyle Andrew Knabb

Doctor of Philosophy in Anthropology

University of California, San Diego, 2015

Professor Thomas E. Levy, Chair

Between 1200 BCE – 400 CE, the Levant was situated in the shadow of powerful ancient empires – Egypt, Assyria, Persia, and Rome. Under these conditions, we see two episodes of independent state formation in southern Transjordan: the Iron

Age kingdom of Edom and the early Nabatean state. This dissertation examines the relationship between these two archaic societies in southern Jordan and the physical, social, and ideational landscapes they inhabited. The broad goal of this dissertation is to contribute to a better understanding of culture change through the lens of ancient landscapes. This approach has an explicitly spatial orientation that lends itself to understanding the myriad relationships between human societies and the spaces they created, maintained, and occupied. Focusing on a period of 1600 years, from the beginning of the Iron Age (c. 1200 BCE) through the end of the Roman period (c. 400 CE), my research tracks the history of socio-subsistence practices, human impacts on the environment, and political organization in the arid environments of southern Transjordan. Based on the results of systematic surveys and archaeological excavations in the highlands and lowlands of southern Transjordan, I argue: 1) that socio-economic organization shifted from relatively autonomous, agro-pastoral communities during the Iron Age (1200–500 BCE), to highly integrated, agriculturally specialized producers during the Roman period (100 BCE –400 CE); 2) that these Iron Age communities strived for political autonomy from the state, whereas during the Roman period political autonomy within the territory of the Nabataean kingdom was no longer tenable; and 3) that intensive copper production in the lowlands of Wadi Faynan did not lead directly to environmental degradation, but instead, was probably the result of a combination of post-abandonment factors, including erosion and the collapse of mining and smelting infrastructure.

Chapter 1: Introduction to the Dissertation – Theoretical Models, Methodological Approach, and Outline of Chapters

I will surely make you least among the nations;
    You shall be utterly despised.
Your proud heart has deceived you,
    You that live in the clefts of the rock,
    Whose dwelling is in the heights.
You say in your heart,
    "Who will bring me down to the ground?"
Though you soar aloft like the eagle,
    Though your nest is set among the stars
    From their I will bring you down.

-Obadiah 2-4

Now the eastern parts are inhabited by Arabs, who bear the name of Nabataeans and range over a country which is partly desert and partly waterless, though a small section of it is fruitful. And they lead a life of brigandage, and overrunning a large part of the neighbouring territory they pillage it, being difficult to overcome in war. For in the waterless region, as it is called, they have dug wells at convenient intervals and kept the knowledge of them hidden from the peoples of all other nations, and so they retreat in a body into this region out of danger… Consequently the Arabs who inhabit this country being difficult to overcome in war, remain always unenslaved; furthermore, they never at any time accept a man of another country as their over-lord and continue to maintain their liberty unimpaired. Consequently neither the Assyrians of old, nor the kings of the Medes and Persians, nor yet those of the Macedonians have been able to enslave them, and although they led many great forces against them, they never brought their attempts to a successful conclusion.

-Diodorus 2.48.1-5

The thirty-fifth station, Selmona. The thirty-sixth, Fynan: these two are not found in the order of history.

-Fetellus, ca. 1130 AD

Outsider's descriptions of the people and landscape of what is today southern Jordan convey a strong sentiment of isolation and chaos, lacking the familiar qualities of a civilization worthy of history. As the homeland of the Edomite and Nabataean societies, however, the area holds rich and spectacular remains of these ancient polities. Since they lack a surviving narrative history of their own, one frequently turns to the commentaries of outside observers to better understand these enigmatic civilizations, who often portrayed the cultures and environments as above: barbaric, dry, ahistorical. Even today, much of southern Jordan can be characterized by its harsh, arid desert environments.

Equally important, however, is to see these societies on their own terms, as active participants in creating their own destinies. In many ways, the societies that have come and gone have not fit into neat sociopolitical categories created by archaeologists and anthropologists working in other parts of the world (e.g. Fried 1967; Service 1975). The best way to transcend the 'tyranny' of ancient text-based views of ancient societies is to take a materialist view of the spatial signatures on the landscape where those ancient inhabitants lived. These spatial signatures reflect the cultural practices of ancient societies examined in this dissertation.

As a result of the 'lack of fit' with neo-evolutionary models, archaeologists working in the southern Levant have both struggled with and made great strides in understanding and describing Edomite and Nabataean societies. For those interested in the diversity and variation in forms of human social organization, southern Jordan is rich with examples of sociopolitical organizational types that test our current models of human culture change. Along these lines, the broad goal of this dissertation is to contribute to a better understanding of culture change through the lens of landscapes. This approach has an explicitly spatial orientation that lends itself to understanding the myriad relationships between human societies and the natural environment.

Applying a Landscape Approach to Spatial Organization

In applying a landscape approach to the late 2nd millennium BCE to 4th century CE, I use the concept of landscape as it has been employed in anthropology and other fields. Accordingly, landscapes should be viewed as a human construct that plays an essential dialectical role in the constitution of human cultures. Landscapes are not synonymous with natural environments (Anschuetz *et al.* 2001: 160-161), but instead, are cultural systems that structure and organize peoples' interactions with the natural environment (Ingold 1993), and in mediating between nature and culture, are "an integral part of Bourdieu's *habitus*" (Knapp and Ashmore 1999). As cultural constructs that organize how people perceive of and make meaning from their environments, landscapes are physical and non-physical, objective and subjective (Anschuetz *et al.* 2001). These defining characteristics aid in the interpretation of fluid spatial patterning so common in borderlands and frontiers (Parker 2006a). As variation and change in cultural and historical patterning are often the most visible on the peripheries (Feinman 1994; Marcus 1998; Schortman and Nakamura 1991), a focus on landscapes is a productive avenue for understanding social change.

Landscape is an important concept for this work because of its inherently spatial orientation. Space matters for archaeology as one of the two variables we aim to control that, along with time, make up the nuts and bolts of archaeological interpretation. A majority of the fieldwork conducted for this dissertation is comprised of the sites of ancient human activities and material remains. Altogether, these data constitute settlement patterns – a mainstay of archaeological spatial analysis tracing its roots to the early work of Willey (1953), Sanders, Parsons, and Santley (1979), and Adams (1965). Along these lines, this dissertation seeks answers to the question of how to best study and understand the role of landscape in culture change?

In answering this question, landscape is approached from three interrelated loci of interpretation: subsistence practices, historical ecology, and political organization (Figure 1.1). Throughout these loci is one important concept that I argue applies universally to human culture and the landscapes they inhabit – that they are mutually constituted and recursively interrelated. For example, political decisions affect the local ecology when environmental conditions are not taken into consideration, are misunderstood, or simply disregarded; certain kinds of subsistence practices are encouraged or forced on a local population by a centralized political regime, even if not particularly well suited to the environment. Thus, the dissertation builds on previous work in human ecology and related fields (cf. Butzer 1982; Crumley 1994b; Redman 1999; Steward 1968) to contribute to a better understanding of the interrelated dimensions of landscape analyzed during the course of my research. The following section is a theoretical introduction to each of the three loci discussed in the dissertation. In addition, each chapter also presents a detailed overview of the theoretical models and how they specifically relate to the landscape of southern Jordan during the two periods under study.

The Subsistence Landscape

One of the main topics to be addressed is fluctuations in subsistence practices and social organization. These fluctuations are the main subject of Chapter 2 and Chapter 3 of this dissertation. Two general issues must be addressed here: first, the perceived dichotomy between types of subsistence practices; and second, the characterization of the rural countryside. Regarding the first, scholars of the ancient Near East have made extensive use of the two common ethnographic subsistence categories of sedentary agriculturalism and nomadic pastoralism (Bar-Yosef and Khazanov 1992; Barfield 1993; Holl 2013; Khazanov 1984; Marx 1967, 2013; Rosen 2008). However, the common assumption that subsistence practices dictate social practices is giving way to the realization that the reverse is also true: that social relations may lead to changes in subsistence practices (Porter 2012: 16), complicating the common dichotomies between agriculture and pastoralism, sedentism and nomadism, and state and tribe.

Sedentary agricultural subsistence strategies are often associated with increasingly complex forms of socio-political organization (Kirch 1994; Service 1962; Wittfogel 1957). This is particularly the case for the southern Levant, where subsistence is seen to fluctuate between sedentary agriculture during periods of increasing political centralization, while during periods of collapse the population reverts to nomadic pastoralism (Finkelstein and Perevolotsky 1990; LaBianca and

Younker 1998). Recent studies have demonstrated that as a broad, general overview of social and subsistence change this is generally accurate, but used as a causative explanation for each instance of subsistence and social change it becomes problematic as more exceptions are discovered (cf. Blanton 2005; Crumley 1995; Fowles 2010; Frachetti 2012; McGuire 1983; Peterson and Drennan 2005; Porter 2013; Schwartz and Falconer 1994b; Stein 1994; Tainter 2006; Trigger 1990). This dissertation aims to contribute to a better understanding of the relationship between subsistence practice and social practice through the investigation of settlement pattern from southern Jordan's Wadi al-Feidh.

Second, the characterization of the rural countryside as homogeneous, simplistic, and compliant suppliers of goods and labor to political centers has been criticized by scholars on three points (Fall *et al.* 1998; Schwartz and Falconer 1994b): first, by neglecting political and economic tensions between urban and rural populations, villagers are portrayed as passive recipients of core hegemony (Stein 2002); second, the idea of social complexity in small-scale societies is undermined when they are viewed as a reflection of core complexity (Hastorf 1990; Netting 1990, 1993); and third, many economic and political aspects of rural social organization cannot be explained in terms of the core (Roseberry 1989). Alternative approaches have focused on variability in small-scale communities and processes of local historical change (Bender 1990; Feinman 1991; Feinman and Neitzel 1984; Hastorf 1990; Netting 1990; Pauketat 2004; Upham 1990). This focus on agency, variability, and small-scale diachronic change is an important thread of my dissertation research, as it seeks to understand the processes of subsistence change in a landscape of environmental and social marginality. These topics are the primary subject of Chapter 2 and Chapter 3, which focus on settlement pattern analysis and archaeological survey.

Settlement pattern studies recognize that there are political, economic, and ecological implications to the way people distribute themselves across the landscape. Data for these types of studies come from archaeological surveys. Gordon Willey asserted that settlement patterns "reflect the natural environment, the level of technology... and various institutions of social interaction and control which the culture maintained. Because settlement patterns are, to a large extent, directly shaped by widely held cultural needs, they offer a strategic starting point for the functional interpretation of archaeological cultures" (1953: 1). Thus, this dissertation examines the role of ecology and political economy on ancient land use, subsistence strategies, and socioeconomic organization through the lens of archaeological settlement patterns. In so doing, the following questions are examined: What changes in subsistence practices are observed through time, and how can these changes be explained? While there are many possible ways to go about answering these questions, for the present dissertation two models of subsistence change are especially relevant, one which ties change to fluctuations in political complexity, while the other views subsistence practices in relation to the formation of decentralized communities or groups. These models are described below and displayed graphically in Figure 1.2.

Community based model – this model views changes to the subsistence practices of a region as related to bottom-up process of community formation and influence (e.g. Erickson 2006; Knapp 2003; Peterson and Drennan 2005; Porter 2013; Schwartz and Falconer 1994a). While these communities may be quite complex in their social organization, this complexity is often heterarchical or non-hierarchical in structure (Crumley 1995; Marshall 2010). Fluidity in subsistence practices is more common than rigid agricultural structures imposed by states, and resilience is more desirable than high-output (Spielmann *et al.* 2011). Small-scale communities make use of the local landscape and tailor subsistence practices to the local ecology. Elite groups may arise and wield some political authority, but this is not always permanent and often their leadership abilities are severely restricted.

Political centralization model – compared to the community based model, this model views change in the subsistence practices of a region in relation to the presence or influence of a centralized state or other complex polity (Adams 1978; Kirch 1994; Service 1962; Wittfogel 1957). Overall, one of the primary goals of the state is to promote agricultural production in order to procure a surplus that it can control and redistribute. When the presence of nomadic groups threatens agricultural production and social stability, there are conflicts between non-sedentary populations and the state. When nomadic groups maintain productive relations with agricultural villages, there is mutualism that may be of benefit to both settled groups and nomadic groups alike (Banning 1986; Barker 2012; Marx 2007; van der Steen and Saidel 2007). In reality both probably occurred frequently. Shifts to widespread agricultural production in the rural countryside or along the periphery are explained as a product of state influence, mandated subsistence practices cultivated by the need for increasing amounts of crops. Local farmers aren't necessary deprived of agency in this model, but an important factor in the adoption and spread of agriculture is the top-down order of the new political economy.

Case-studies from other Regions of the southern Levant – Examples of these models "on the ground" can be found in the contexts of the eastern Mediterranean and globally, though not necessarily in these exact terms. Dryland farming systems found throughout the eastern Mediterranean reflect the actions, needs, and strategies employed by farmers living in low-precipitation environments (cf. Barker *et al.* 1996; Mithen and Black 2011). In the face of adverse conditions, indigenous peoples developed irrigation-based farms to cope with tough, arid climate systems (Barker and Gilbertson 2000). In the southern Levant, irrigation farming in drylands began as early as the 4th century BCE and continues through the present day (Barker *et al.* 2007b; Rosen 2007). Most commonly, the development of political complexity is understood in relation to the socioeconomic context of water management and irrigation (Adams 1978; Scarborough 2003b; Stanish 2006; Wilkinson 2010). But this is not always the case. In the deserts of northeast Jordan, the site of Jawa was occupied twice: first, in the late fourth millennium during the Early Bronze Ib period, and in the second millennium BCE during the Middle Bronze IIA period (Betts 1991). Each settlement period was very short – only a few decades – and there is no evidence that the settlement served any purpose other than to provide for the subsistence needs of the community. The size and the architectural components of the EBIb settlement suggest substantial complexity: a population of four to five thousand are estimated to have lived there, who constructed public architecture such as gates and fortifications, as well as complex hydrological systems for capturing runoff precipitation. Jawa illustrates the complex social formations that were possible in the arid zones without the direction or influence of more centralized political and economic institutions.

In other cases, the presence of regional states and empires was clearly a major factor in the adoption and continuation of agricultural production. For example, Rosen (2000) has argued that the ultimate collapse of large-scale agricultural production in the Negev desert of Israel during the 6th-7th centuries CE was the result of the withdrawal of political and economic support from the Byzantine core. Whereas previous scholarship has pointed to climate factors during the Byzantine period (e.g. Issar and Zohar 2007), or the expansion of the newly formed Islamic empire, Rosen emphasizes the importance of human decision-making strategies (*vis-à-vis* the Byzantine empire) in the process of environmental degradation. He demonstrates that the Byzantine support of agricultural production was essential for the stability of the entire agricultural system. Only after the Byzantine Empire withdrew support from the Negev did the fields, and much of the environment, began to deteriorate.

Landscape and Ecology

Archaeologists have long held an interest in the relationship between humans and their natural environment, and this is the primary topic addressed in Chapter 4 of this dissertation. Over time, this focus has shifted from questions of how humans adapted to a variety of natural conditions and how societies responded to environmental change, to seeking out a more complex understanding of society and environment together. Some early applications of this research postulated more complex environments are capable of supporting more complex societies. Determinist explanations like this are now largely discredited, but these and other studies established a long standing link between social complexity and the environment within the archaeological literature.

The study of human impacts on the environment has become one of the most important areas of study in archaeology, driven by perhaps the most fundamental question in this field – is the evolution of human culture maladaptive? This somewhat determinist point of view may seem outdated, but in fact has been applied in recent studies by Chew(2001), Hong *et al.* (1994), Diamond (2005), and others. It goes without saying that archaeology's diachronic perspective lends itself extremely well to the study of human impacts on the environment throughout our history as a species, but only so long as determinism, whether environmental or cultural, are kept in check. Recent strides in subfields like historical ecology (Balée 1998b; Blaikie and Brookfield 1987; Cronon 1995; Crumley 1994b; Hill 2006) and socio-natural studies (Fisher *et al.* 2009a; Gunderson and Holling 2002; Kohler and Leeuw 2007; Redman 2005; van der Leeuw and Redman 2002) have extended our understanding of these processes from early prehistoric times up to fairly recent history, and have included topics such as deforestation, erosion, climate change, mass extinction, saltation, and pollution.

Two important and related revelations have emerged from the fields of historical ecology and socio-natural studies – field that have traditionally focused on both physical landscapes (e.g. landforms, sediments, soils, plants, animals), and social and ideational landscapes (e.g. arrangements of people, communities, fields, monuments. cf. Balée 1998a; Butzer 1982; Crumley 1994b; Descola and Pálsson 1996b; Henry 1995; Redman 2005; Redman *et al.* 2004; van der Leeuw and Redman 2002; van der Leeuw 1998). First, is the idea that nature, or the natural environment, is *not* an object that can be understood as independent of human actions and intervention (Blaikie and Brookfield 1987; Cronon 1995; Descola and Pálsson 1996b; Fisher *et al.* 2009b; Zimmerer 1994). Concerns with the relationship between humans and the environment were systematized by the work of Julian Steward (1955) and his cultural ecology approach. Over time cultural ecology has evolved significantly, producing offshoots such as historical ecology and ecological anthropology, among others. Certain elements of the cultural ecology approach have been criticized as being environmentally deterministic (cf. Descola and Pálsson 1996a; Scarborough 2003a). The cultural relativism approach, however, has deterministic elements as well relating to the binary opposition of nature and society, which are seen as universal opposites. This dualism has been deconstructed, some even arguing that the nature-culture dichotomy hinders true ecological understanding:

> Leaving aside the initial comparative ambition of Julian Steward, cultural ecology tends to treat each society as a specific homeostatic device tightly adapted to a specific environment. On the other hand, culturalist perspectives see each society as an original and incommensurate system of imposing meanings on a natural order, the definition and boundaries of which are nevertheless derived from

> western conceptions of nature. Paradoxically, the purported universality of geographical determinism thus leads to an extreme form of ecological relativism, while self-claimed cultural relativism leaves unquestioned its assumption of a universalistic conception of nature (Descola and Pálsson 1996a: 4).

Accordingly, recent approaches to the study of society and nature have attempted to break down this barrier, instead emphasizing the study of human environmental interrelatedness. The fields of historical ecology and socio-natural studies are important examples of this attempt.

Second, perceptions of environmental change are culturally constituted and historically contingent. Any examination of human impacts on the environment must take into account the dimensions of human intervention, knowledge of environmental factors, and perception of change. For example, Van der Leeuw (2009) writes that an environmental crises can be defined as an extreme degradation of the relationship between a society and its natural environment, in which that relationship function very poorly, or not at all. The burden of maintaining this relationship falls on humans because we do not directly communicate with our environment. Instead, humans communicate with each other about the environment, how to define it, what to do with it, and how to deal with perceived problems. Problems arise from the relationship between humans and the environment, and are never solely a natural environmental issue. In this regard, environmental crises come about because humans lack a complete understanding of the natural environment, and how to deal with perceived crises. Humans, here, are the main actors, but the environment also has agency to lead humans to act in response to what they perceive in the environment.

Applying many of these notions to the environmental history of the Mediterranean, Butzer (2005) has observed a cyclical pattern of social complexity and environmental change. According to Butzer, Mediterranean societies have gone through cycles of intensification of subsistence strategies, metallurgy, and commercial exchange. The primary surges of intensification (in ca. 3000 BCE, 1300 BCE, and 100 CE), were followed by processes of 'disintensification,' or ruralization. Environmental degradation, according to Butzer, can occur at any point during this cyclical process. In the Faynan region, cycles of intensification coincide with the peaks in socio-political complexity that occurred at the start of the Iron Age and Roman period (ca. 1300 BCE and 100 CE). The question of whether or not complex polities had a significant, measurable negative impact on the environment is difficult, as correlating the sequence of events with environmental data is not at all straightforward. Butzer's model tackles long timescales and allows us to see broad, macro-regional patterns, but at the cost of precision to identify causal factors.

To better understand the origin and cause of environmental changes in the Faynan region, we have conducted research targeting small-scale, micro-regional patterns in human-environmental relations. In doing so, we have attempted to increase the precision of environmental research to a scale where it is possible to better identify causal factors. The two models below distinguish two forms of human-induced environmental degradation, which are not mutually exclusive. The models are also displayed graphically in Figure 1.3. The general overview of land degradation presented below is also discussed in detail in Chapter 4 of the dissertation.

Direct degradation model – in this model human actions have direct and immediate consequences on the environment. Whether intentional or unintentional, societies create changes that produce positive or negative effects on the environment that are beyond the means of individuals or groups to halt once started (cf. Chew 2001; Diamond 2005; Issar *et al.* 2011; Issar and Zohar 2007; Rollefson 1996; Rollefson and Köhler-Rollefson 1992). Growing social complexity leads to the intensification of extractive industries and subsistence strategies, which in turn leads to environmental degradation. Natural environmental change may also play a role, with the effects depending on the human response to new challenges. In Butzer's model described above, this would be most likely to occur during periods of intensification, when humans are actively modifying the environment.

Indirect degradation model – this model predicts a more indirect relationship between humans and environmental degradation. As human societies naturally modify the environment because they are a natural part of it, balance and/or equilibrium is more likely. While some environmental change is likely, the immediate effects will not be large in scale or outright detrimental (cf. Dearing 2008; Fisher *et al.* 2009b; Holling 2001; McAnany and Yoffee 2010; Redman and Kinzig 2003; Scarborough 2009; van der Leeuw 2009). In Butzer's model described above, this would be most likely to occur during episodes of disintensification, or when humans are not actively modifying the environment on such a large scale. Degradation of the environment is delayed by supportive infrastructure that people have constructed and maintained, and only when abandoned and left derelict does the environment begin to degrade or collapse.

Overall, the two models distinguish two forms of human-induced environmental degradation, which are not mutually exclusive. As applied to our study of environmental lead contamination resulting from copper metallurgy, they provide a heuristic from which to understand a small part of the complex process of environmental change in the region.

The Political Landscape

Landscapes are not merely expressions of political organization; they are essential elements of political order (Smith 2003). That this relationship is recursive is a foundational aspect of understanding political change and secondary state formation through the analysis of settlement patterns and a spatial approach to the political landscape (Billman 1999; Fall *et al.* 2002; Joffe 2002; Kowalewski 2008; Parsons 1972; Price 1978; Stanish 1999; Willey 1953). Thus, Chapter 5 of this dissertation places significant emphasis on the spatial qualities of state formation and political centralization. Much archaeological fieldwork has been dedicated to understanding the emergence of politically complex polities based on excavations at major settlements and capital cities, as well as from historical records (Earle 1997; Feinman and Marcus 1998; Kirch 1994; Yoffee 2005). These studies have approached political complexity from a top-down perspective that focus on the strategies and interests of elite authority and the tendency toward centralization, intensification and incorporation of the hinterlands – processes that result from the need to fund an expanding bureaucracy and to build up surpluses that are the mainstay of elite authority.

A second, bottom-up approach to political change views communities in the rural hinterland as important agents in the formation and maintenance of urban centers, as well as active creators of their own destinies (Alcock 1993; Falconer and Savage 1995; Kohl 1992; Levy and van den Brink 2002; Schwartz and Falconer 1994a; Stein 2002). This approach has focused on the tensions that exist between urban and rural populations, and the internal differentiation that sometimes, but not always, exists within these small-scale communities. Communities might opt into exchange relationships with a nearby city, trading basic agricultural surpluses for items not available locally, or they may shift subsistence strategies to avoid losing their autonomy to cities. Both approaches have their merits in elucidating processes of state formation and the development of political complexity.

It has been suggested that in the history of the state, failure has been more common than success, and the examples we have of states are all (or mostly) instances of success (Scott 2009; Yoffee 2005). Failure, however, should be regarded as equally, if not more, important for archaeological study if it is true that failure is more common. Why do societies fail? There are, of course, whole books written on this subject (McAnany and Yoffee 2010; Tainter 1988), which is too broad to discuss further here, but one answer that is relevant to this dissertation is the concept of resistance – resistance to control, authority, incorporation, etc. This is not the appropriate place to describe the myriad classifications or strategies of resistance (e.g. overt/active, covert/passive, systemic resistance) but there is a growing body of literature on these issues (cf. Clastres 1987; Fowles 2010; Given 2004; Miller *et al.*

1995; Morrison 2001; Scott 1990; Yoffee 2005). This dissertation examines strategies of resistance in the marginal landscapes of southern Jordan during the Iron Age and Roman period.

In analyzing the spatiality of political organization, Chapter 5 of this dissertation looks at strategies of authority as well as the limits of political order through time. As ancient political complexity varied widely in the southern Levant, so did the state's ability to manage and control the people within its territory (cf. Feinman 1994; Marcus 1998; Parker 2006a, 2013; Rothman 1994; Scott 2009; Smith 2003; Smith 2005; Stein 2001; Yoffee 2005). One way to conceive of this is the model of sociopolitical complexity in Figure 1.4. This model measures complexity along the axes of centralization and integration. Within the "low" complexity areas of the model are significant opportunities for polities, communities, tribes, and so on, to express some form of resistance, which increasingly becomes more difficult as complexity increases. The archaeological correlates of these forms of resistance are discussed in more detail in Chapter 5. The model of sociopolitical complexity is applied to better understand political organization during Iron Age and Roman period of southern Jordan, and to identify the opportunities presented by political regimes and the landscape for local groups to resist state sovereignty in zones of resistance or autonomy.

Regional and Methodological Discussion

Spatially the dissertation focuses on an area in southern Jordan that spreads across two major topographical zones (Cordova 2007: 34). The lowlands are defined by the Wadi Arabah depression, the main north-south drainage that separates modern day Israel and Jordan. The Wadi Arabah flows north to the Dead Sea and is fed by waters from the Edom Mountains to the east and the Negev Highlands to the west in Israel. At the foot of the Edom Mountains are vast alluvial plains that have built up with erosion from the mountains. The alluvial fans are also a source of sand that is entrained by strong winds that create sand dunes in the Wadi Arabah. The Jordanian plateau, also known as the Edom Mountains, extends from the Wadi al-Hasa to the Ras an-Naqb escarpment to the south (Figure 1.5). The geographical division of highlands and lowlands play a significant role in the ecology of the Faynan region (Figure 1.6), as rainfall and vegetation are strongly influenced by topography. These ecological zones are discussed in more detail in later chapters, and have been thoroughly described in previous studies of the region (Baierle *et al.* 1989; Cordova 2007; Levy *et al.* 2014a; Mithen and Black 2011; Palmer *et al.* 2007). Chapter 2 of this dissertation thoroughly describes the ecology of the highlands and steppe regions, while Chapter 3 and Chapter 4 present the ecological background of the lowland zones.

The landscapes of the southern Levant have been witness to numerous archaeological surveys. Following traditional approaches of Near Eastern archaeology (Adams 1981; Wilkinson 2003), these surveys covered large areas using extensive pedestrian or vehicular methods. With few exceptions, such as the Negev Archaeological Surveys (see Haiman 1989; Rosen 1987b), most surveys targeted flat areas with easily traversable relief and climates favorable for agricultural production (cf. discussion in Banning 1996). The result has been a focus on large, obtrusive sites, such as agricultural settlements. More recently, a focus on systematic archaeological survey to better understand ancient settlement patterns and social change has become an important part of archaeological research in other areas of the world (see chapter 2). Remote areas, often with relatively difficult terrain, are increasingly being targeted as a result. A systematic approach is less common in these cases due to the difficulties and costs associated with employing such a rigorous methodology. In the southern Levant this is especially so, and the surveys presented in Chapters 2 and 3 attempt to address this issue.

The data for this dissertation were collected during three seasons of fieldwork and countless hours of lab work and analysis. Beginning in 2007, I led a systematic survey of Wadi al-Jariya in southern Jordan's Faynan region. This survey was carried out over a period of five weeks with students and staff from the UC San Diego Edom Lowlands Regional Archaeology Project (ELRAP), with the goal of mapping the mining landscape during periods of copper production. Next, during the summer of 2009 I carried out a systematic survey of the Wadi al-Feidh, just south of the Faynan region in the mountainous transitional zone between the lowlands of the Arabah valley and the highlands of the Jordan plateau. This survey was carried out over a period of approximately two months with staff from ELRAP, and with the goal of mapping the settlement patterns of this remote and rugged zone.

Finally, during the 2011 ELRAP season I led two small projects in both the transitional mountain zone and in the Faynan region. First, I led a two week survey in the Buweirda springs, an oasis and locus of sand dune accumulation in the western margins of the Faynan region. This short survey was also aimed at exploring and understanding the history of human occupation there and the suitability of the region for further study. Second, I conducted 10 test excavations in the agricultural terraces of the Faynan Valley, adjacent to the large tell site Khirbat Faynan. These excavations comprised the bulk of my data and analysis for the work on environmental degradation due to anthropogenic lead released into the environment. During the summer of 2013 I spent two months working at the Earth Science Institute of the Hebrew University in Jerusalem to analyze sediment samples from the agricultural fields and to determine their elemental composition and the concentration of heavy metals.

Outline of the dissertation

Following this introduction, Chapter 2 presents a methodological overview of systematic survey around the world. The chapter describes the settlement pattern data from the 2009 survey of Wadi al-Feidh, southern Jordan, to trace changes to political organization and subsistence practices in politically and environmentally marginal landscapes. Employing a systematic survey methodology, we recorded a range of sites and features previously unrecognized in this region. Based on the survey results, I argue that socio-political organization at the margins of Levantine states shifted from relatively autonomous, agro-pastoral communities during the Iron Age (1200–586 BCE), to highly integrated, agriculturally specialized producers during the Roman period (100 BCE –400 CE). The results provide new insight into regional socioeconomic change in the southern Levant from the perspective of peripheral communities.

Chapter 3 presents the results of an intensive pedestrian survey along a four kilometer stretch of the Wadi al-Jariya, conducted in 2007. This work completed an earlier ELRAP survey of the southern portion of the Wadi al-Jariya. A total of 96 new sites were recorded in Wadi al-Jariya. The chapter is a preliminary analysis of the settlement pattern data collected that season. In addition, results are presented of a small survey of Wadi Fidan that was carried out in 2004 and of the Buweirda spring zone in 2011. Our surveys have uncovered significant Iron Age settlement devoted to metal extraction and processing in copper ore bearing regions, whereas in the spring zone no traces of Iron Age settlement were observed. This chapter summarizes the settlement pattern data from two catchment areas (the Wadi al-Jariya-Wadi Ghuwayb catchment and the Wadi Fidan catchment) and its relationship to Iron Age settlement in the Faynan district and surrounding regions, as well as the results of the Buweirda springs survey in general.

Chapter 4 addresses the common perception that large production activities lead directly to landscape degradation, based on a study of ancient pollution in the Faynan Valley of southern Jordan – an area rich in copper ores – during the most intensive episodes of production: the Iron Age and Roman period (ca. 1000 BCE – 400 CE). The results indicate that minimal pollution occurred during these time periods, though some was detected in a small number of samples. I argue that intensive copper production did not directly lead to environmental degradation, but instead, was probably was the result of a combination of post-abandonment factors, including erosion and the collapse of mining and smelting infrastructure. Our results have significance for theorizing the complex relationship between human society and landscape degradation, and for understanding how the archaeological knowledge we produce may affect local inhabitants and their relationships with archaeological sites, national government, and global mining corporations.

Chapter 5 uses survey data from the 2009 survey of the Wadi al-Feidh, plus regional settlement pattern data from southern Jordan to examine the relationship between regional states and local communities living in politically and environmentally marginal zones. Overall, the findings suggest that Iron Age communities strived to maintain relative autonomy from the state through their choice in settlement locations, subsistence practices, and local social organization. Later, during the Roman period, increasing political centralization reached a point where political autonomy within the territory of the Nabataean kingdom was no longer tenable. Localized zones of autonomy, however, may have shifted spatially to the areas east of the Nabataean kingdom, where tribal polities inhabited the deserts for millennia.

Limitations of the Current Study

In any research field a consideration of the limits or constraints on the data and their interpretation is important for further development of the research, and the original research contributions of this dissertation are no different. It is my hope that the conclusions drawn in later chapters will lead to future research opportunities because of the fact that not all questions have been decisively answered.

Sample size may be the first thing to come to mind, as this is an issue in so many research project. The survey data, primarily presented in Chapter 2 (but also to some extent in Chapters 3 and 5) provided only partial coverage of the landscape. This issue is familiar to survey archaeologists around the world – that survey coverage and survey intensity are trade-offs that are made in designing a project. The Wadi al-Feidh survey, for example, was a relatively high-intensity survey, with surveyors spaced at close intervals (5-25 m). As a result of the high intensity and rugged mountainous landscape, the survey covered 10 sq km in total. This micro-regional perspective permits has permitted detailed data analysis and 'thick' description of the local settlement and landscape, but at the cost of a larger macro-regional perspective – what Richard Blanton (2001) has pejoratively referred to as a Mediterranean myopia in archaeological survey that focuses on a microscopic perspective of the ancient landscape.

Of course, both micro- and macro-level approaches have their virtues, and for the research presented here a micro-regional perspective is better suited to the recovery of settlement data for the extreme periphery. Overall, our understanding of past settlement changes will be enriched by the application of archaeological surveys of both varieties and the comparative analysis that results (cf. Alcock and Cherry 2004). For much of the history of archaeological research in southern Jordan a macro-level approach has been prevalent, so the small-scale surveys described in Chapter 2 and Chapter 3 are an attempt to provide a different perspective and to demonstrate that micro-level surveys can make valuable and unique contributions. Chapter 5 aims to contribute a synthetic approach by combining data from micro-level survey with macro-regional settlement pattern data from other project in southern Jordan to better understand sociopolitical changes during the Iron Age and Roman period.

A micro-level perspective is also applied to the research on environmental change in Wadi Faynan, discussed in Chapter 4. A major hurdle in the analysis of environmental degradation has been in the identification of causal factors (cf. Butzer 1982; Redman 1999; van der Leeuw 1998). There are two important factors that contribute to these difficulties: the complexity of coupled socio-natural systems, and imprecision in absolute dating techniques. The interpretation of ancient landscapes confronts archaeologists with myriad variables contributing to environmental change. Singling in on specific variables is complicated by the partial nature of the archaeological record, while identifying causal change is made problematic by the 100 or more years of uncertainty inherent in absolute dating techniques. Hence, our analysis of environmental change has attempted to overcome some of these issues by narrowly focusing on a single environmental impact in detail.

Numerous environmental changes occurred in the Faynan region, but the analysis presented in Chapter 4 examines how and to what extent lead was added to the local environment of Wadi Faynan. Many environmental factors from previous research are considered (cf. Baierle *et al.* 1989; Cordova 2007; Crook 2009; Grattan *et al.* 2007; Hunt *et al.* 2007; McLaren *et al.* 2004; Mithen and Black 2011; Palmer *et al.* 2007; Pyatt *et al.* 2000), as these provided an important baseline for the interpretation of the data we collected. However, other topics important for building a more complete archaeological narrative – including agricultural production, deforestation, climate change, and sociopolitical change – are beyond the scope of the ancient pollution study. The results of our research, however, contribute to a better understanding of the processes behind ancient lead pollution and its connection to other socio-natural phenomena. On the subject of ancient pollution there is still considerable potential for future research on the local and global effects ancient metallurgy.

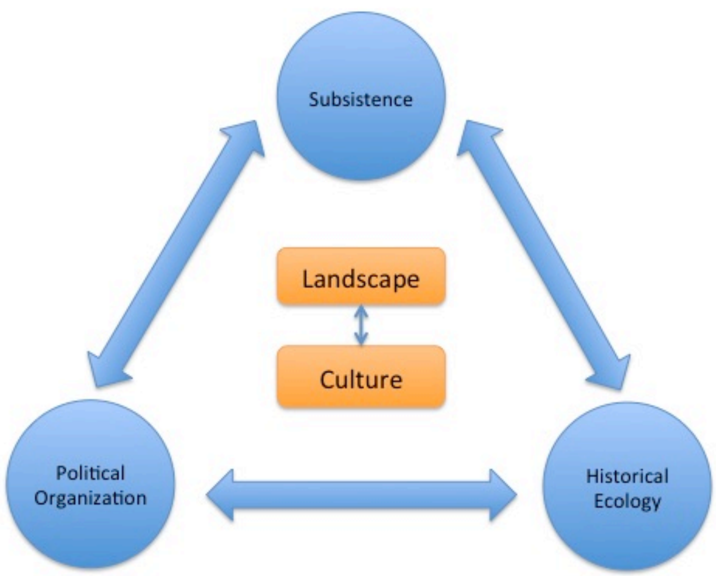


Figure 1.1: The three interrelated loci if interpretation discussed in the dissertation. In applying a landscape approach, one can divide the landscape into heuristic categories as is done with subsistence, historical ecology, and political organization. Each of these categories provides a different perspective on the human-landscape relationship.

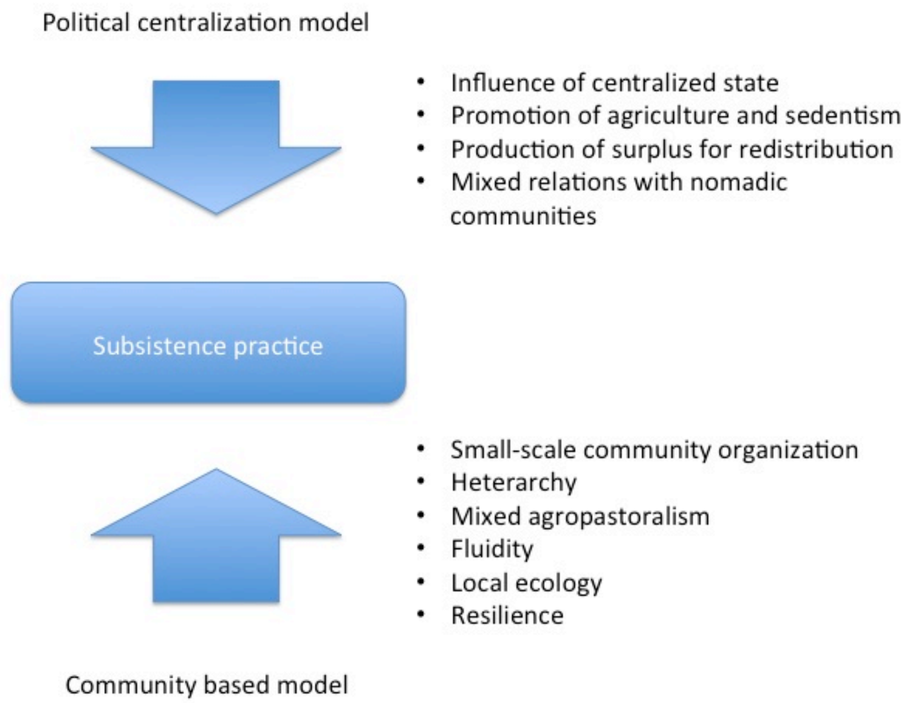


Figure 1.2: A graphical depiction of the community-based model and political centralization models. Bottom-up and top-down political economic organizations differentially structure human interactions with the environment and subsistence practices.

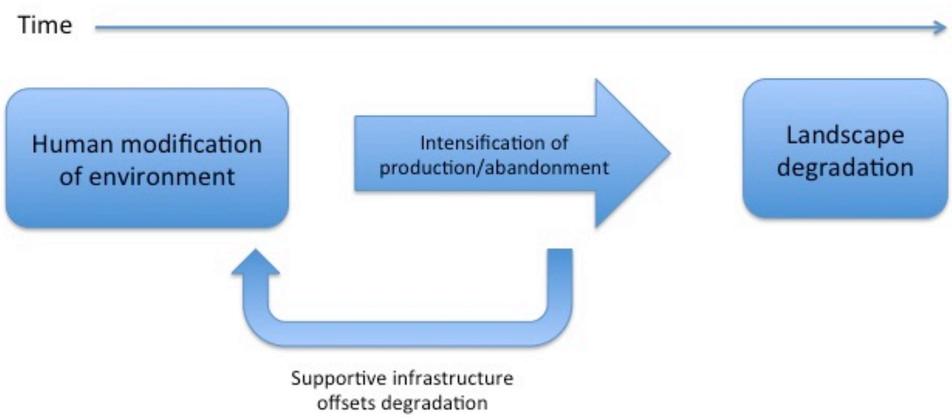


Figure 1.3: A visualization of the two degradation models. Direct degradation sees human interaction with the environment as inherently destructive, whereas indirect degradation predicts human environmental modifications have the ability to preserve as well as destroy.

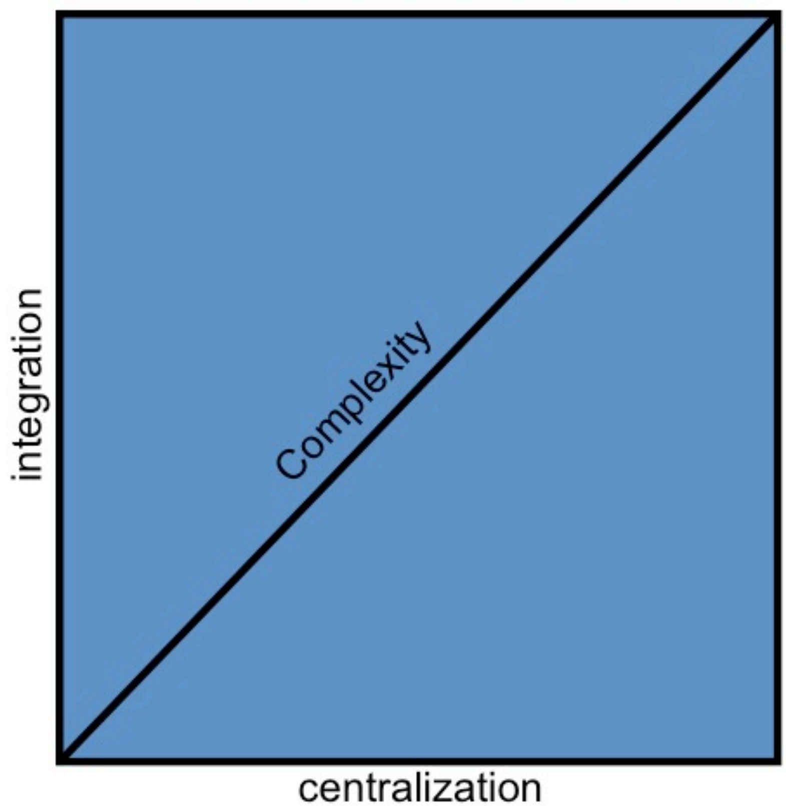


Figure 1.4: Model of political complexity based on centralization and integration. Increased opportunity for resistance are to be found in 'low' complexity areas of the model, while higher complexity reduces opportunities for resistance.

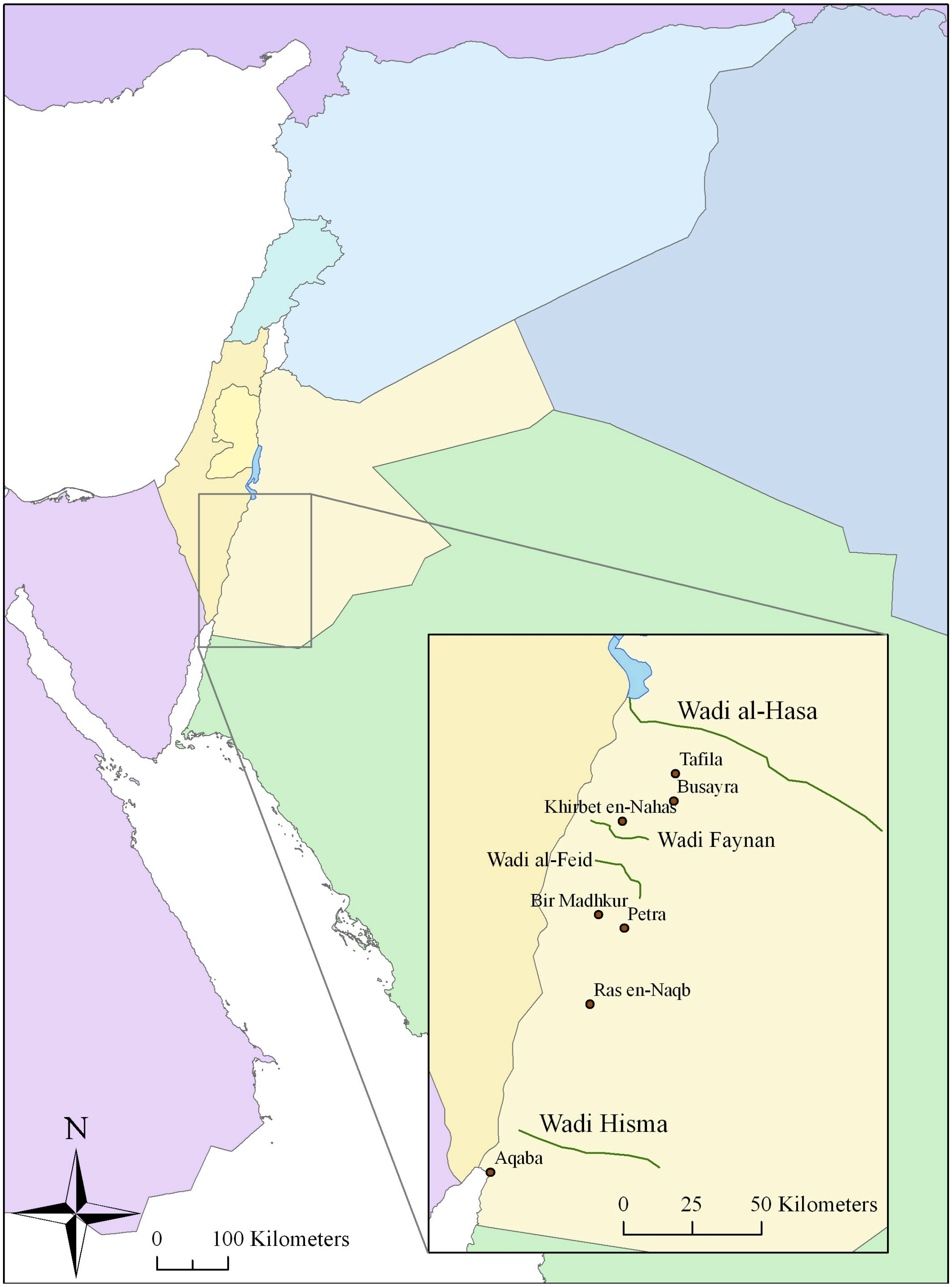


Figure 1.5: Map of southern Jordan showing areas under study in this dissertation.

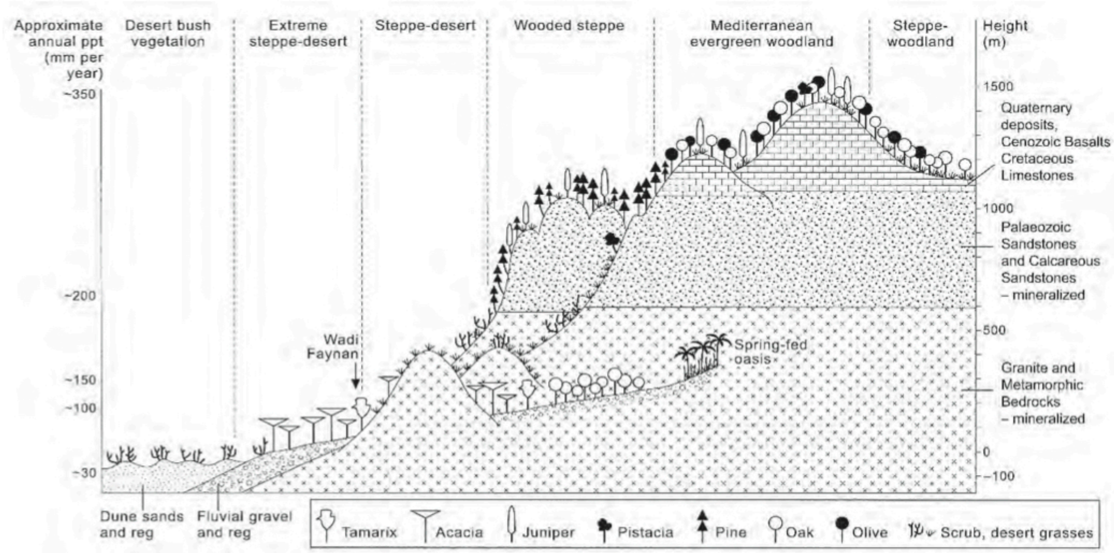


Figure 1.6: Ecological cross section of Faynan area showing biozones and precipitation from Palmer *et al.* 2007, Fig. 2.12, p. 36, and after Baierle *et al.* 1989. See also (Levy *et al.* 2014a).

Chapter 2: Settlement Patterns, Social Organization, and Subsistence: Systematic Survey of Wadi al-Feidh, southern Jordan

Introduction

The use of systematic, regional survey has been a mainstay of archaeological research on settlement patterns and the development of complex societies in many areas of the world. Surveys in Mesoamerica (Balkansky 2006; Balkansky *et al.* 2000; Feinman *et al.* 1985; Ford and Fedick 1992; Healy *et al.* 2007; Killion *et al.* 1989), South America (Drennan *et al.* 1991; McAndrews *et al.* 1997; Wilson 2009), the northern Mediterranean (Ammerman *et al.* 2013; Bevan and Conolly 2002; Bintliff 1997; Given *et al.* 1999), the Near East (Ur and Hammer 2009; Wilkinson 2000; Wilkinson *et al.* 2007), in the southern Levant (Levy and Alon 1987), and east Asia (Drennan 2010; Linduff *et al.* 2002; Underhill *et al.* 1998) have made significant contributions to our understanding of changing patterns of settlement and land use, particularly with relation to changing political, socioeconomic, and environmental conditions. These projects have been successful in delineating the relationships between urban centers and their hinterlands, and recent research has continued to expand our understanding of peripheral areas through the study of non-sedentary pastoralism (Frachetti and Mar'yashev 2007; Rosen 1987a; Ur and Hammer 2009), local adaptation to ecological niches (Bevan and Conolly 2009; Ford and Fedick 1992), small-scale metallurgical production (Ben-Yosef *et al.* 2010; Georgakopoulou 2014), and movement across landscapes (Gibson 2007; Snead *et al.* 2006). Remote areas, often with relatively difficult terrain, are increasingly being targeted as a result. A systematic approach is less common in these cases due to the difficulties and costs associated with employing such a rigorous methodology. In the southern Levant this is especially so, and the Wadi al-Feidh survey presented here attempts to address this issue.

Many surveys carried out in the southern Levant have been influenced by the work of Adams and others in Mesopotamia (Adams 1981; Wilkinson 2003). These surveys covered large areas using extensive pedestrian or vehicular methods, and while not ubiquitously, often employed systematic, full-coverage methods. With few exceptions (e.g. Haiman 1989; Rosen 1987b), most surveys targeted flat areas with easily traversable relief and favorable climate conditions. The result of this extensive survey methodology has, in many cases, been a bias toward large and highly visible sites such as tells and other large agricultural settlements.

Archaeological research in southern Jordan is a case-in-point in which survey projects have targeted the well-watered Jordanian plateau or the lowlands of the Arabah Valley (Banning 1996). Extensive survey methodologies are ill-suited for many parts of modern day Jordan and Israel, where sites tend to be smaller in size, and the terrain is less conducive for visually locating sites using more extensive survey techniques (i.e., >50–100 m spacing between surveyors or "windshield surveys"). In a similar vein, though many projects have adopted an approach that acknowledges the important role of hinterlands, fewer have attempted to study the issue directly. Some notable exceptions from the southern Levant include the work of el-Khouri (2008) on the Roman countryside of northwest Jordan, Fall (1998) on Bronze Age rural economies in the Jordan Rift Valley, and Barker (2012) on nomad-farmer interactions in southern Jordan.

In recent years there has been a trend in Mediterranean archaeology to focus on the role of non-urban communities in regional-scale socioeconomic processes (Barker 2012; Frachetti 2012; Honeychurch 2013; Hritz 2013; Knapp 2003; Levy 2009; Porter 2012; Porter 2013; Rosen 1987a; Ur and Hammer 2009). Archaeologically, the diverse historical and social evolutionary trajectories of these groups is sometimes visible in regional surveys and excavations, but more often their presence is inferred from historical sources. With recent studies targeting these societies directly, we have a better understanding of their basic social organization and varied responses to climate change and processes of environmental degradation (Chepstow-Lusty 2011; Crumley 1994a; Hill 2004; Høgestøl and Prøsch-Danielsen 2006), as well as the degree of variability and complexity of these systems across time and space, and the need for further research (Casana 2013; Crumley 1994a; Porter 2011). Despite the lack of archaeological studies in Jordan that directly address this issue, it is an excellent place to study the evolution of non-urban communities because of its long history at the periphery of ancient states and empires. Nomads and farmers have resided in this peripheral location throughout history, and although researchers working in the southern Levant have grappled over the nature of these interactions and other interpretive issues for some time (e.g. Banning 1986; Finkelstein 1992; Finkelstein and Perevolotsky 1990; Parker 1987a; Rosen 1992), substantial work remains to be done.

In order to explore the community based and political complexity models described in chapter 1, this chapter presents results from the 2009 Wadi al-Feidh Survey in southern Jordan – a rugged, mountainous zone between the Arabah lowlands and the highland Jordanian plateau (Figure 2.1). Previous surveys have not systematically covered this region (e.g. Hart and Falkner 1985; Hübner 2004; MacDonald 1992), in part because of the rough and rocky landscape. Due to this terrain, along with the fact that sites are smaller and unobtrusive, traditional site-based survey methods are ill-suited for this area. Based on new survey data, I examine settlement patterns from the Wadi al-Feidh in relation to existing settlement patterns identified previously in southern Jordan. These new results suggest that subsistence patterns shifted from small-scale, mixed agro-pastoralism in the Iron Age (1200 − 586 BCE) to a more intensive, top-down administrative strategy of agricultural production in the Roman period (ca. 100 BCE - 400 CE). Overall, the settlement pattern data for the Iron Age are inconsistent with settlement patterns known from the Jordanian plateau. Settlement pattern data for the Roman period, however, are fairly consistent with known patterns from the southern Levant. This discovery implies substantially more heterogeneity in the subsistence economics of Iron Age societies, followed by a relatively homogenous strategy of agricultural expansion and management. In both cases, the results reflect human adaptations to local ecological factors, albeit at different scales. My approach emphasizes the role of the local landscape and environment in how groups structure and organize their use and occupation of places.

Regional Background

The ecologically marginal zones of southern Jordan have received little attention compared to well known political centers on the Jordanian plateau. By ecologically marginal, I mean that these areas are characterized by aridity, rough terrain, and little arable land. Until recently, the primary surveys and excavations in southern Jordan focused on examining the development of the Edomite and Nabataean kingdoms (Bennett and Bienkowski 1995; Bienkowski 2002; Glueck 1939; Joukowsky 1998; MacDonald *et al.* 2004). Based on historical sources, scholars argued that these polities traced their origins from pastoral nomadic societies (Edelman 1995; Graf 1990). However, few traces of these nomadic origins have been found in Jordan, perhaps due to the lack of surveys targeting this kind of ephemeral settlement.

The beginnings of the Iron Age in southern Jordan are found in the Arabah lowlands of the late 13th-early 12th century BCE (Levy 2009; Levy *et al.* 2008; Levy *et al.* 2014b). This time corresponds roughly with the late Iron I through early Iron IIA elsewhere in the southern Levant (Table 2.1). Though initially fraught with contention this data is now well supported, but the connection between this early polity and the later historical Edomite polity is uncertain. Survey and excavation in the Wadi Faynan, Wadi Fidan, and tributary valleys revealed that the early Iron Age settlement was primarily organized around the mining and smelting of copper ores (Ben-Yosef 2010; Ben-Yosef *et al.* 2010; Ben-Yosef *et al.* 2009a; Hauptmann 2007; Levy *et al.* 2003;

Mattingly *et al.* 2007). There is little evidence for permanent settlement or agricultural production. Instead, these ancient copper producers lived a semi-nomadic lifestyle, as evidenced by the many campsites and other ephemeral sites they left behind.

Settlement of the Arabah valley continues through the 9th century BCE, corresponding with the Iron IIA through IIB periods. Excavations and survey of sites in the Faynan and neighboring valleys has shown that during the 10th – 9th centuries there was a peak in settlement density and size, as well as in the production of copper (Hauptmann 2007; Hauptmann and Weisgerber 1992; Levy *et al.* 2004; Levy *et al.* 2008; Levy and Najjar 2006). Little evidence of the subsistence strategies has been published, but we now know from the results of intensive surveying in the Wadi Faynan and Wadi Fidan that mixed agro-pastoralism was practiced throughout the lowlands. Agricultural terraces and other features for the retention of water and soil were recorded on the north banks of the Wadi Faynan (Newson *et al.* 2007), and in Wadi Fidan surveyors discovered similar, but smaller agricultural features (see Chapter 3). The surface ceramics collected from these sites date to the Iron IIA/B period, and are contemporaneous with the semi-nomadic settlements also found in the lowlands.

The political organization of this early polity is not well understood, and current models are based on a combination of historical sources, ethnographic analogy, and archaeological evidence; this is out of necessity because of the sparsity of excavations from this time period. Simply put, the political organization of Iron IIA/B society is believed to have been a segmentary chiefdom, comprised of multiple groups of tribal polities affiliated by kinship (Levy 2009). The primary archaeological support for this model comes from excavations at the Wadi Fidan 40 cemetery and Khirbat an-Nahas, the fortified copper production center. Cemetery excavations revealed a plethora of burials that support the assertion of nomadism in the lowlands (Levy *et al.* 1999; Levy *et al.* 2005a). Only a few ceramic vessels were recovered, while some individuals were buried with wooden bowls instead. The preliminary osteological data also reveal pathologies expected of nomadic pastoralists. Evidence for political leadership and social hierarchy is also found at the cemetery. One particular individual, perhaps a chiefly figure, was uncovered in a relatively elaborate cist, ornamented with copper jewelry, and found with other grave goods, such as desiccated pomegranates, shell and stone beads, and a wooden bowl.

Architectural evidence from the site Khirbat an-Nahas also supports the idea of a political hierarchy, as two distinct styles of construction are evident from recent excavations there (Levy *et al.* 2014c). First, there are sometimes haphazardly constructed buildings associated with copper smelting. These are multi-room, one story buildings no more than a single course thick. The second style is characterized by much larger buildings, multiple courses thick, and sometimes two-stories high. It has been suggested by the excavators that these buildings were constructed for the management and surveillance of copper production technology, which may have been a closely guarded secret. In addition to the material wealth generated by copper production, the knowledge and mastery of copper mining and smelting technologies may have been a source of political power for elites.

This system operated until the end of the 9th century, after which point copper production abruptly halts. Some have attempted to connect the lowland polity with that of the 7th century Edomite polity of the highlands. This is mostly based on two pieces of evidence: the presence of two late 9th century sites on an important route between the Arabah valley and the highland plateau (Ben-Yosef *et al.* 2009b), where small-scale attempts at copper production were made; and perceived stylistic similarities between certain vessel forms from Khirbat an-Nahas and some 7th century sites (Smith and Levy 2008). While this is certainly a possibility, the current evidence for this transition is tenuous at best. In any case, during the late 8th century BCE the lowlands are mostly abandoned, and a new Iron IIC polity emerges on the Jordan plateau.

The Iron Age IIC in southern Jordan marks the emergence of the first indigenous politically complex polity in the region. The current evidence from southern Jordan suggests that Edomite settlements were composed of agricultural villages founded at the beginning of the 8th century BCE, at least 200 years later than those on the north and central Jordanian plateau (Bienkowski *et al.* 1997; Bienkowski and Sedman 2001; Bienkowski and van der Steen 2001; Herr and Najjar 2001; LaBianca and Younker 1998). This late Iron Age society has been described as a tribal state with nomadic origins, (LaBianca and Younker 1998; Levy 2009; Porter 2004) that became a settled, agricultural society in the highland plateau region of southern Transjordan by the 8th century BCE. In this model, elites garnered political power through their roles in transitioning pastoralists to settled, agricultural lifestyles, spreading a ritual ideology, constructing a political center at Busayra, redistributing wealth and prestige, and expanding the territory of the Edomite polity.

The settlement pattern during this period comprises roughly two tiers. The political center Busayra is the largest site on the Jordan Plateau at 8 ha and makes up the first tier (Bienkowski 2002), while the second tier is composed of small agricultural villages of approximately 1 ha. These settlements are located in ecologically favorable areas with abundant farmland. Based on excavations at some of these villages, production is mostly focused on domestic activities, including small-scale processing of agricultural crops and textile manufacture.

It is important to point out that mechanisms behind the settlement of previously nomadic peoples are not well understood, nor is the role of elites in fostering the transition to sedentary life. The transition from nomadism to sedentary life is based on historiographical sources and the absence of archaeological evidence for village society prior to the 8th century BCE. In other words, the trope of the "invisible nomads" plays a significant explanatory role. Overall, this is a significant weakness for the model of sedentarization and political formation of the Edomite polity, as previous archaeological studies have shown that presuming a nomadic population on the basis of absent material remains is problematic (Rosen 1992).

A second and related issue can be found in the methodology and design of previous surveys in the region. Early surveys on the Jordanian plateau (e.g., Glueck 1935; Hart 1992; MacDonald 1988, 1992) were carried out using extensive, and often unsystematic survey methodologies. Even more recent surveys have not incorporated methodologies capable or likely to recover the remains from nomadic peoples. In addition, a majority of work has taken place in relatively flat, easy to access regions, and has excluded mountainous areas with high relief and difficult terrain. Such areas are significant because of the possibility that they may have been home to nomadic or semi-nomadic populations, and these areas are less likely to have been destroyed by later occupation phases because of the sparsity of settlement there. Previous reconnaissance surveys in the mountainous regions of southern Jordan have identified a small number of mountaintop sites and small agro-pastoral villages (Hart 1992; Lindner and Farajat 1987; Lindner *et al.* 1997; Lindner *et al.* 1998; Lindner *et al.* 1996a). Their relationship to the Edomite kingdom is not well understood, but from the ceramics they appear to be contemporaneous with the sedentary occupation. The issue of how these settlements fit into the political landscape will be addressed in Chapter 5.

Following a brief gap in settlement, historical sources describe how the Nabatean kingdom emerged in southern Jordan during the end of the Hellenistic period (ca. 3rd century BCE)(Graf 1990; Schmid 2001). However, the earliest archaeological evidence for the Nabateans dates to the 1st century BCE ('Amr *et al.* 1998; Graf 1992) from their capital city of Petra on the Jordanian plateau, and while some evidence of settlement from the 3rd century BCE has recently been found, its relation to the later Nabatean culture is uncertain (citation needed). The 1st century BCE evidence reveals a complex, state level society — one that minted coins, constructed monumental architecture, trained expert hydraulic and agricultural engineers, and controlled the overland trade of spices and incense from the Arabian Peninsula to the eastern Mediterranean (Schmid 2001).

The traditional model of hinterland settlement patterns under the Nabataean state describes how the flourishing economy of Petra led to the expansion of hinterland agricultural settlements during the early Roman period (ca. 100 BCE - 100 CE). This trend continued after the Roman annexation of the Nabataean kingdom in 106 CE, and is further attributed to the growing demands of Roman annexation and the kingdoms' increasing wealth from long distance trade (Knodell and Alcock 2011; Kouki 2009; Sartre 2005; Schmid 2001). Near the end of the late Roman period (ca. 400 CE) agricultural settlement in the Petra hinterlands began to contract as the city's economy declined. A major part of this contraction was a reversion to ruralism in the Petra region and the abandonment of many small sites (Fiema 2003). At present, our understanding of this process relies on evidence from Petra and its immediate hinterland, so intensive surveys in the marginal zones can further augment the urban-rural relationship.

The Landscape of Wadi al-Feidh

Wadi al-Feidh is located approximately 90 km south of the Dead Sea and 120 km north of the Red Sea in the transitional zone between the Arabah lowlands and the highlands of the Jordan plateau. The area is close to the ancient settlements Petra and Khirbat Faynan (khirbat = possessive form of khirba, the Arabic word for ruins), whose origins trace back to the Iron Age and earlier (Bienkowski 2011d; Mattingly *et al.* 2007). Wadi al-Feidh flows in a westerly direction and spans the heights of the plateau in the east, reaching elevations of 1400 masl, down to the Arabah Valley more than 1000 m below.

As precipitation is strongly influenced by topography, Wadi al-Feidh encompasses a variety of ecological zones ranging from Mediterranean woodland in the east, to semi-arid desert in the west (Cordova 2007). It is also one of a few wadis in the area with a perennial source of potable spring water. This microenvironment provides an above ground source of fresh water that encourages the growth of many plant species, such as almond, Atlantic pistachio, fig, olive, and wild grasses and herbs. The spring also attracts a variety of animal species, including carnivores, ungulates, small mammals, birds, reptiles, amphibians, and freshwater crab.

The eastern half of the survey zone is characterized by Mediterranean and steppe woodland climates, with annual rainfall averages of up to 350 mm (Palmer *et al.* 2007). The geology is composed of beds of yellow and green limestone, green clay, and marl, which make up the yellow Mediterranean soils characteristic of the south Jordanian plateau (Rabb'a 1994). Here the topography alternates between flat terrain and steep slopes, creating a stairway up to the plateau (Figure 2.2). Due to these factors, the flat areas were productively farmed throughout antiquity, while the steep slopes were terraced to increase the amount of arable land.

The survey zone follows the steppe westward for about 2.5 km, before reaching its western boundary at the foothills. The foothills are a rugged, mountainous terrain, difficult to navigate, and marked by high, rocky outcrops, steep slopes, and cliffs (Figure 2.3). Geologically, this area is composed of various types of sandstone beds

(Rabb'a 1994). The climate here is semi-arid steppe-desert, with annual rainfall amounts averaging 200 mm (Palmer *et al.* 2007). The amount of arable land decreases in this area, though we still observed agricultural terraces on some of the surrounding hills and in small valleys.

Our survey boundaries end where the foothills make a rapid descent toward the Arabah Valley. Here, the geology changes abruptly to red and purple rhyolite, quartz porphyry, and tuff that comprises the Ahaymir Volcanic Suite (Rabb'a 1994). The paleo-topography of this formation has resulted in jagged relief, making the area impassible except in a few locations. From here, there is a descent of 800 m over approximately 2 km to the lowlands of the Wadi Arabah, where Pleistocene and Holocene alluvial fans and aeolian sands continue to accumulate.

Survey Methodology

More intensive survey methods developed in other areas of the eastern Mediterranean are often underutilized in the southern Levant, and exceptions (Barker *et al.* 2007b; Dark 2008, 2013; Knodell and Alcock 2011) have not included terrain as severe as the work reporter here. While our survey would not be considered a "siteless" survey (Alcock and Cherry 2004; Caraher *et al.* 2006; Dunnell and Dancey 1983), our methodology was certainly influenced by the work of these intensive survey projects. In addition, the full-coverage methodologies developed in the New World (Fish and Kowalewski 2009; Kowalewski 2008; Sanders *et al.* 1979; Willey 1953) informed a great deal of our survey planning.

We conducted an intensive pedestrian survey of 10 sq km in the steppe and foothills of Wadi al-Feidh. The survey zone was divided into 10 grid squares, each 1 sq km in size (Figure 2.4). Depending on the density of sites, we spent approximately 4-5 days in each 1 sq km grid square. Our team consisted of 4-5 surveyors who were spaced at approximately 10-25 m intervals. After some experimentation with the space between surveyors, it seemed best not to insist on rigid intervals, but to vary the spacing between us based on common sense concerns such as topography, vegetation, modern occupation, and the complexity of archaeological remains. Sites were recorded on both satellite photographs and using an Epoch 10 L1 differential GPS, which allowed for quick and accurate recording of spatial data.

Site boundaries were determined either by artifact fall-off patterns or by the natural geography. In many cases, these coincided. At most sites we encountered low-density artifact scatters, which were not clearly associated with architectural features. Depending on the complexity of cultural remains at a site, we would further subdivide each site into smaller units to maintain better control over the spatial variation of artifacts. Overall, our collection strategy was to carefully document artifacts and physical landscape features separately, as the relationship between the two was not often straightforward. The intensity of coverage was much higher within a collection unit, with surveyors spaced at 5-10 meter intervals, collecting 100% of the artifacts. Small finds included pottery, lithics, glass, and metal. Pottery has been the basis for dating sites, as most of the other materials are not particularly diagnostic.

Our use of the term 'intensive' may need clarification, as definitions of survey intensity – usually measured by the space between surveyors walking transects (Schiffer *et al.* 1978: 13-14) – vary by region and the goals of the project, the nature of the physical landscape, and other factors. Extremely high-intensity surveys, such as siteless surveys employed in parts of the northern Mediterranean (Bevan and Conolly 2002; Bintliff *et al.* 2002; Caraher *et al.* 2006), place surveyors at 5-10 m intervals. This level of intensity is necessary to document the complexity of continuous artifact distributions in contexts such as ploughsoil assemblages (see chapters in Francovich *et al.* 2000; Schofield 1991). Many Levantine surveys, by comparison, can be characterized as low-intensity, in that they are often vehicular, cover hundreds of square kilometers in one or two field seasons, and seldom have a focus on off-site areas. Wadi al-Feidh does not have the continuous artifact distributions of ploughsoil assemblages, so we did not opt for the close spacing and recording strategy of siteless surveys (Dunnell and Dancey 1983; Gallant 1986). The goal was to strike a balance between the ability to detect small sites while still managing to survey the entire 10 sq km area within the two months allotted. Therefore, our use of the term intensive must be considered within the context of southern Levantine surveys.

We also recorded the presence of terracing on satellite photos of the area. Extensive terracing in the eastern survey region was to be expected because modern villages have been farming on the steppe for at least the last hundred years. However, the terraces we observed much farther west, where agriculture would have been difficult due to the extreme topography, were more surprising. Due to time constraints we were unable to conduct systematic surface collections from the entirety of the terracing features. However, our sample of pottery from sites within the terracing features provides a basic foundation for interpreting the duration of agricultural activities, and future fieldwork will address the history of the terraces directly.

Results of the Survey

In total, we recorded 123 sites ranging in size from 1.2 ha to as small as a few square meters (Figure 2.4A). Out of these 123, we identified 11 sites dating to the Iron Age and 27 sites dating to the Roman period (Table 2.2). Three of these sites contained ceramics from both periods. Due to the low-density ceramic scatters that dot the landscape, the dates given for many of the sites described below are based on a small number of chronologically identifiable artifacts. Furthermore, we must recognize that many of the features recorded during the survey (i.e., cairns, roads, rock walls, and small structures) may not be contemporaneous with the ceramics that were collected.

Iron Age Settlements

During the late Iron Age, two settlements sites were occupied in the Wadi al-Feidh: Site 116 and Site 103 (Figure 2.4B). We designated these as settlement sites based on the high frequency of surface ceramics, the dense clustering of rooms visible on the surface, and the clear association between the two. Both of these settlement sites appear to have no occupation earlier than the Iron Age, and both were reoccupied later in the Middle Islamic period between 1000-1400 CE (Whitcomb 1992). The remainder of the Iron Age sites are composed of the artifact scatters and features described above.

The first settlement site, Site 116 (also known as Qurayat Mansur), has been known to archaeologists for some time (Hübner 2004). The site, which is approximately 1.2 ha, was built on a hilltop in the westernmost part of the survey area, on the edge of the foothills described above, and resembles a mesa overlooking the Wadi Arabah (Figure 2.5). Geologically, the site is situated at the eastern boundary of the Ahaymir Volcanic Suite, which is composed of quartz porphyry and granite. This geological formation is characterized by narrow wadis and aggressive relief (Rabb'a 1994: 12). Due to this paleo-topography, when Site 116 was established in the Iron Age natural cliffs surrounded the site on more than 75% of its circumference. These features restricted access to the site and provided a natural defensibility for the site's inhabitants.

Adjacent to Site 116, Wadi al-Feidh descends westward into the Arabah Valley via a series of 12 waterfalls, some 50-60 m high (Figure 2.6). This landscape is impassible without rock climbing gear. Pools of fresh water, fed by the Wadi al-Feidh spring, accumulate below the waterfalls year round. Our survey of the area, which included rappelling, showed that it is possible to access some of these pools from the northern slope of Site 116.

Approximately 100 m northeast of Site 116, we recorded terracing in the valley bottom. These small plots provided land for irrigated agricultural production. In addition, we recorded terracing on many of the hillsides surrounding Site 116. Figure 2.4B shows the relationship between these terracing features and the Iron Age settlement.

Systematic surface collections at Site 116 showed that late Iron Age ceramics represent a significant majority of the total ceramic assemblage. The late Iron Age assemblage is composed of undecorated coarse-ware vessels for cooking and storage, including various open-form bowls, rilled-rim kraters, and jars (Figure 2.7). These utilitarian vessel types are typical of late Iron Age ceramic assemblages from sites throughout southern Jordan (Bienkowski 2011b).

Architecturally, Site 116 is composed of clusters of rectilinear rooms. Two small clusters are found at the northern and eastern portions of the site, while the largest cluster of rooms is located in the southern part of the site. Much of the site plan follows the natural topography of the hilltop, which is quite uneven in some places. All of the architecture is dry-stone construction using locally available stones. The site's entrance is through a small cluster of rooms in the northeast. Access to the site is limited to this one entrance. A long wall runs along the eastern edge of the site, above a cliff that, to the southeast, is well over 100 meters in height; the wall may have served as a wind break or a retaining wall (Bienkowski 2011a).

The second Iron Age settlement site was recorded as Site 103 (locally known as Khirbat Gleah, after the local toponym for the area). This previously unknown site is located on a high plateau above the Wadi al-Feidh spring, and measures just under 1 ha. Similarly to Site 116, access to the site is limited by topography. The only entrance is along a winding path from the south. Many small valleys with remnants of ancient terracing surround Site 103 (Figure 2.8).

While most of the ceramics we recovered from Site 103 date to the Middle Islamic period (ca. 1000-1400 CE), we also found strong evidence for Iron Age II occupation in the northern and eastern portions of the site. The Iron Age ceramic assemblage is composed of cooking and storage vessels, resembling the ceramics at Site 116.

The architectural features in the northern and eastern areas of Site 103 are distinct from other areas of the site that date to a later occupation phase. Similarly to Site 116, a long wall was built above the cliffs along the site's northern edge. Additional poorly preserved structures were recorded in this part of the site. Architecturally, the structures are distinct from the later-phase rooms, and they may be associated with Iron Age occupation of Site 103.

At the northwest tip of the settlement we recorded a number of pictographs carved into the exposed bedrock (Figure 2.9). The imagery includes animal figures, such as ibex and camels, and human figures. Pictographs are difficult to date with certainty, but many of the motifs have parallels with other ancient southern Levantine sites ranging from the 3rd millennium BCE to the 7th century CE (Eisenberg-Degen and Rosen 2013).

Roman Period Agricultural Processing Sites

By the Roman period the major Iron Age settlement sites in the survey area were abandoned. In fact, no Roman settlement sites were recorded within the survey boundaries. However, Sites 104 and 114 have evidence of Roman period agricultural production (Figure 2.4C). Other than this, the majority of Roman period sites we recorded are composed of artifact scatters and off-site features.

Site 104 is located adjacent to the Wadi al-Feidh spring in the valley bottom (Figure 2.10). Fig, oleander, and tamarisk are abundant around the spring, and may have been in antiquity as well. The processing site is small, less than a quarter hectare, and while the remaining architecture is badly disturbed, we observed many ground stones (including one milling stone) on the surface. The ceramic assemblage is composed of a variety of undecorated coarse- and fine-ware vessels, including plain Nabataean fine-ware bowls, plain jars and jugs, and cooking pots (Figure 2.7). These ceramics date to the late 1st through late 2nd century CE Based on these artifacts, and the small size of the site, it seems likely that the site was used for processing agricultural crops.

Perhaps the most interesting feature of the site is two rock cut canals that begin immediately to the west of Site 104 (Figure 2.11). These canals are cut into the sandstone 1-2 m above the current stream bed. They are approximately 20 cm wide by 20-30 cm deep, and are quite regular in their construction. The canals continue along the valley for approximately 1 km and end at Site 114, where we also found evidence of early Roman ceramics.

Site 114 (also known as Khirbat Feidh) was surveyed unsystematically in the past (Hübner 2004). Based on our systematic surface collections, the Roman period is most abundantly represented here. The architectural features of the site are badly preserved, making it difficult to say more about the spatial organization or the function of the site. A number of wall lines are visible on the surface (Figure 2.12), and the valley bottom adjacent to the site contains the remains of terrace walls, suggesting that this may be an agricultural installation.

Non-Settlement Sites

The remainder of the Iron Age and Roman period sites consist of what we describe as non-settlement sites. This category of sites includes features such as small structures, cairns, walls and terraces, campsites, rock shelters, and bedrock mortars. Determining the function of these features is difficult, but often such places reflect functions related to agriculture and pastoralism, such as very short lived settlements (as in the case of campsites and rock shelters), penning for animals, tool storage, and structures for trapping water and soil. While these features are often physically associated with the small finds we collected, it was often difficult to determine whether they are chronologically associated. Many of the features appeared rather old, due to the presence of lichen, the accumulation of sediment around them, and collapse and deterioration. The passage of time indicated by these observations is impossible to infer at this time, however.

We recorded nine non-settlement sites with Iron Age ceramics (Figure 2.4B). Spatially, these Iron Age sites are spread throughout the entire survey area, and are small compared to the size of Roman period non-settlement sites. In most cases, they are also located in close proximity to the terraces we recorded during the survey. The features most commonly recorded at these sites were small structures and cairns, but also included bedrock mortars, campsites and rock shelters, and isolated walls and terraces. These ephemeral structures are a common landscape feature in southern Jordan, and often reflect the use of the terrain by agro-pastoralists.

Roman period non-settlement sites were far more numerous in the survey; we recorded 27 with Roman period ceramics (Figure 2.4C). These sites tend to be concentrated in the eastern half of the survey area, where the land is better for agricultural production, and their size increased in comparison with earlier Iron Age sites. Overall, the sites are also found in close proximity to terraces, especially those recorded within the steppe landscape described above. Small structures and cairns were the most commonly recorded features at these sites, in addition to a small number of bedrock mortars, campsites and rock shelters, and isolated walls and terraces.

Small round and rectilinear structures (Sites 6, 24, 25, 27, 35, 63, 77, 82, and 91) were the most common features associated with both Iron Age and Roman period sites (Figure 2.13). These features are no more than a few courses in height, and range in size from 2 m in diameter to as large as 8 x 15 m. Most appear to have been unroofed, serving as some type of enclosure. In some cases, they are associated with isolated walls or terracing. These features are found throughout the survey area, but are the most concentrated in the eastern region, on the steppe, where site densities are highest overall. Though it is difficult to identify their function specifically, these features may have been used as animal enclosures or temporary shelter, for processing crops, or for storing agricultural supplies and products.

The second most common features recorded during the survey were cairns (Sites 7, 12, 13, 14, 17, 21, 24, 25, 27, 34, 35, 49, 50, and 53). Cairns ranged in size from 1-5 m in diameter, and some were as high as 2 m (Figure 2.14). As is the case with the small structures, cairns were concentrated in the steppe zone of the eastern survey area, where they likely represent the clearing of rocks from agricultural fields, many of which show signs of recent plowing. Although some of the cairn sites we recorded appeared to be fairly recent, others appear to be heavily lichen coated and very eroded, perhaps hinting at a much older age. The ceramic assemblages associated with some of the cairn features hint at possible Iron Age origins. Throughout antiquity cairns have served a variety of purposes that are hard to identify without excavation. Some of the cairns we recorded were clearly related to the clearance of agricultural fields, while others served less obvious purposes. At sites 38 and 50 we were able to identify the function of the cairns as graves. These features had been looted, leaving the interior of the cairn exposed and some of its contents scattered nearby. We observed an interior cist that had been exposed by the looting, and human remains around the cairn.

Roads and trails were also a common feature in the landscape. Modern Bedouin goat herders use many of these roads, although their antiquity is evident from the ancient sites they connect. The dating of roads is difficult, and not something we attempted for this project. However, other projects have been successful in mapping Iron Age and Roman period roads and trails from nearby regions from archaeological and historical data (Kloner and Ben-David 2003; Roll 2007). One of the major roads we explored begins near Site 114 and runs westward over the mountains and down into the Arabah Valley. Due to the extreme topography of the foothills mentioned previously, this is a unique feature in southern Jordan, and only a small number of routes connecting the Arabah Valley with the Jordanian plateau are known to have been used during antiquity (Ben-Yosef *et al.* 2014a).

Discussion of the Survey Results

The results above demonstrate the ability of intensive, systematic survey to recover a significant amount of data from even the most environmentally marginal areas. The small and ephemeral sites we recorded are unlikely to be discovered using extensive surveying methods. Systematic survey of marginal regions such as Wadi al-Feidh are also important for recovering data on agro-pastoralism and other forms of semi-sedentary lifestyles because these areas are frequently inhabited for this purpose. Limited agricultural productivity, difficult terrain, and semi-arid conditions placed a number of restrictions on the settlement patterns we observed through time, and over the span of a millennium these patterns changed dramatically in relation to broader regional-scale phenomena as well. These data provide the foundation for a more thorough and complex understanding of settlement systems from two of the peak periods of cultural development in the southern Levant – the Iron Age and Roman periods.

The Iron Age Settlement Pattern and Social Organization

Survey of the Wadi al-Feidh has generated new lines of evidence for understanding late Iron Age settlement patterns. Whereas settlements on the plateau were structured around a loosely organized agricultural state, the settlements below (i.e., west of) the plateau do not share this practice. The results from Sites 116 and 103 are rather more suggestive of the practice of a mixed subsistence economy, and the limited amount of arable land surrounding these sites suggests that agricultural production was not a major subsistence focus. Land for small-scale farming, grazing, as well as wild plant and animal resources around the perennial spring, on the other hand, are all within close proximity to these sites. Given these factors, it is unlikely that Iron Age communities living in the Wadi al-Feidh procured their subsistence from agricultural production alone. Instead, the locations of these small settlements in areas that provided access to multiple resources may reflect a subsistence strategy of resource diversification and mixed agro-pastoralism, a common practice amongst groups inhabiting environmentally marginal areas (Marston 2011; Spielmann *et al.* 2011), and in line with the community based model described in chapter one of this dissertation.

While we do not have any excavation data from these 8th century BCE settlements in Edom to present a detailed reconstruction of their subsistence strategies, published excavations from early Iron Age (ca. 1200-1000 BCE) settlements on the central Jordanian plateau are an excellent analogy. The excavators of Khirbat al-Mudayna al-Aliya (KMA) carried out a detailed study of the settlements' paleobotanical and archaeozoological remains. As expected, domesticated grains and livestock were abundant. But in addition to these staples, a significant amount of wild resources, such as wild grasses and wetland weed species, were recovered alongside domesticated barley. The excavators suggest that cultivated crops were planted near the water source, rather than near the settlement (Lev-Tov *et al.* 2011). In mountainous or broken landscapes it is common for farmers to travel long distances to reach their crops for a variety of reasons (Forbes 2007: 190-195), so this should not come as a surprise. Furthermore, this could be an indication that wild plants were gathered alongside domesticated crops. In the case of Wadi al-Feidh, Iron Age communities would have travelled a few hundred meters to as much a few kilometers to reach the closest agricultural terraces mapped by our survey.

The archaeozoological remains from KMA further suggest that — in addition to domestic cattle, goat, pig, and sheep — wild animals were also exploited (Lev-Tov *et al.* 2011). Among the faunal remains collected at the settlement were red deer, small and large bird species, small fish, and freshwater crab (species also available around Wadi al-Feidh). Local communities may have obtained these resources through hunting or gathering. In any case, the data attest to the diversity of subsistence practices in place at KMA, and the extent to which the ancient inhabitants of the site took advantage of the local environment to procure their food.

The two Iron Age settlements in Wadi al-Feidh were built at locations with easy access to the spring microenvironment, where fresh water, wild resources, and agricultural land were readily available. The off-site data further imply that Iron Age groups built terraces and other water management features for water and soil retention. These features need not have been solely for the production of food for human consumption, as animal fodder may have also been an important agricultural crop (Forbes 1998; Palmer 1998).

While we are unable identify the exact function of each of the off-site features we recorded, taken as a whole, they appear to reflect the use of the landscape for activities such as agricultural production and animal grazing. Numerous small structures, terraces and other walls, cairns and other features are commonly associated with the practice of mixed agro-pastoralism, including check dams for soil and water retention, small plots of land for growing food or animal fodder, temporary shelter, animal penning, and food and tool storage. Altogether, the results suggest that ancient communities took advantage of the many subsistence options available to them, and practiced a strategy of low-intensity agriculture, combined with the utilization of locally available resources. This is a common risk-buffering technique often observed for small-scale societies (Butzer 1996; Marston 2011; Zori and Brant 2012).

Site 116 has been compared to other hilltop sites known throughout Edom. These sites are seen as places of refuge, as their locations are easily defensible, and sometimes even seem secretive (Lindner and Farajat 1987; Lindner *et al.* 1996b). Such sites, the argument goes, would have been occupied temporarily during times of political turmoil — perhaps during skirmishes with neighboring polities such as Moab or Judah, or with an Assyrian army collecting tribute. However, this hypothesis is problematic. Despite their defensible characteristics, Sites 116 and 103, along with many of the other hilltop settlements, were much more than temporary refuges. As the data from Wadi al-Feidh suggest, the labor invested in construction, and the density of surface ceramics, point to at least a semi-regular occupation. Systematic survey of the settlement and off-site features leads to a very different interpretation of how these two

Iron Age settlements functioned. Microenvironments like the one provided by the Wadi al-Feidh spring are not a common landscape feature in southern Jordan. Extensive areas for pasturing, small plots of arable land, perennial water, and wild resources were readily available within a distance of a kilometer or less. In this light, we argue that the ancient Iron Age communities of Wadi al-Feidh practiced small-scale agro-pastoralism and exploited the unique ecological resources provided by the landscape. This environmental diversity was neither available, nor necessary, to the large agricultural villages on the plateau, but was essential for the survival of the inhabitants of Wadi al-Feidh.

The Roman Period Settlement Pattern and Social Organization

During the Roman period, the traditional model of hinterland settlement pattern expansion is supported by our results. The data we collected in the Wadi al-Feidh support the idea of an expansion of agriculture, with a peak near the beginning of the late Roman period (i.e., the end of the 1st century CE). The survey data suggest that Wadi al-Feidh was exploited primarily for agricultural production and animal grazing, as no settlement sites were recorded in the survey boundaries and most of the artifact scatters and features were recorded in close proximity to agricultural terraces. This settlement pattern resembles the political centralization model from chapter one, as the state plays a strong role in the agricultural landscape and production seems to have been driven by top-down strategies. A vast majority of the Roman period ceramics were collected in the eastern half of the survey area, in the Mediterranean and Steppe climate zones, which would have been the most productive for expanding agricultural activities.

Nabatean agricultural production is well attested throughout southern Jordan. Recent excavations and dating of terraces near Petra confirm their Nabataean origin (Beckers *et al.* 2013). Common crops produced by the Nabataeans included domesticated grapes, olives, and wheat and barley. In addition, they cultivated local plants used in the production of unguents, such as rock rose, terebinth, and balanos (Johnson 1987). While our results are consistent with existing models of agricultural production, they add to our understanding of the significant investments the Nabataeans made in the agricultural hinterlands. Specifically, though evidence of agriculture is usually found in valleys higher up on the plateau, finding it in marginal zones such as the western half of Wadi al-Feidh is unusual. Thus, the terracing of many high relief areas deeper into the Wadi al-Feidh, along with the evidence of processing that went on there, suggests a substantial investment in the construction, maintenance, and labor output in this area.

As the survey results demonstrate, Roman period agricultural production extended farther down the valley at processing sites 104 and 114. Abundant ground stone artifacts and a single milling stone recovered from Site 104 suggest that this site was used for processing agricultural crops. This processing may have required a source of water, which was in abundance here due to the proximity to the spring.

An interesting feature of Site 104 is the rock cut canals, which follow the length of the wadi until they reach Site 114. Such features are typical of Nabataean hydraulic engineering, the most famous examples of which are found throughout the ancient city Petra. The Site 104 canals, which were hand carved into the bedrock for a length of approximately 1 km, imply that Sites 104 and 114 were related in their functions. Furthermore, the canals reflect the substantial labor investment made by the Nabataeans at the two processing sites. Unfortunately, the sites are poorly preserved, so any interpretation beyond this basic characterization is impossible.

Although no Roman period settlements were recorded in the valley itself, villas and farmsteads have been recorded from regions nearby. For example, in the nearby area of Jabal as-Sufaha, Lindner (1998) reported settlement sites dating to the early and late Roman period. Based on the results of the our survey and other surveys from this region, the settlements on Jabal as-Sufaha were probably related to the management of agricultural exploitation in Wadi al-Feidh by wealthy sub-elite members of Nabataean society. The extension of this system into the Wadi al-Feidh reflects the effort to which ancient cities, such as Petra, went to exploit their agricultural hinterland.

Conclusions

The research design for the Wadi al-Feidh survey was aimed at providing a detailed examination of the marginal environmental zone that connects the Mediterranean highland plateau and lowland desert zone of southern Jordan's Edom region. The research is particularly unique for the region because it targeted a valley in an ecologically marginal location with rough topography. We have shown that intensive and systematic survey is a feasible survey method in this rough environment, and made it possible for us to detect very local-scale and ephemeral activities that have often eluded traditional survey work in the southern Levant. These activities included small-scale agro-pastoralism, extensive farming and cultivation, and animal grazing.

More specifically, we have found that late Iron Age communities in the Wadi al-Feidh took advantage of local microenvironments to practice small-scale agro-pastoralism. The perennial spring, in particular, must have played a key role in the choice of settlement location for these groups. Although settlement sites such as 116 and 103 have been interpreted as hilltop refuges, through our survey we have shown that the locally available resources could have supported the probable semi-permanent occupation at those sites. Indeed, the survey results suggest a more permanent occupation and use of local landscape resources than has been previously recognized. The locations of these settlements provided ancient communities with easy access to agricultural and pasture land, as well as wild plant and animal resources. Overall, the late Iron Age data correspond best with the community based model described in Chapter 1.

We have also shown that by the Roman period these settlements were abandoned. The survey results suggest that agricultural production, and perhaps animal husbandry, was the primary reason for the exploitation of Wadi al-Feidh during this time. Expanding agricultural production under the Nabataean kingdom targeted the Mediterranean and steppe woodland climate zones most heavily, as these were the areas with the most agricultural potential. While agricultural production is well attested during this time in other regions, the presence of terraces in the deeply incised portions of the Wadi al-Feidh suggest much more investment in agriculture than previously recognized, and perhaps reflects the western extent of agricultural production on the plateau. The wadi also appears to have been used for the processing of crops, as attested at processing sites 104 and 114. Furthermore, rock cut canals are a characteristic feature of Nabataean hydraulic engineering, and attest to the amount of labor invested in resource extraction. These data for the Roman period support the political centralization model described in Chapter 1. From the perspective of the rural hinterland, the Nabataean kingdom had little trouble extending its influence into this marginal zone.

Rugged terrain is often avoided or given less attention due to the costs associated with conducting a survey project there. However, pastoral landscapes and traces of small-scale agricultural production will often be transformed or erased by large-scale cultivation. Difficult to reach places were often home to groups who sought to maintain an alternative lifestyle, and because of this are some of the few places where archaeologists can get a clear picture of aspects of the local economy, such as substance practices and land use. While many questions remain, we believe our systematic survey results offer important insights for a diachronic study of subsistence economies and social organization. Though the survey was focused on a very specific 10 sq km region, our ability to interpret the results was aided by existing large-scale regional surveys. Thus, our project also demonstrates the importance of a multi-scalar approach to surveying, echoed in many recent survey publications (Honeychurch *et al.* 2007; Ur and Hammer 2009). For archaeology in the southern Levant to move beyond the study of cities and tells to include a more robust understanding of alternative forms of settlement, we must extend our research into less hospitable locations.

In the general context of the aims of this dissertation, the Wadi al-Feidh survey addresses how fluctuations in subsistence practices are driven by a number of factors, including the local ecology, regional political economics, and micro-regional social organization. The new data for agro-pastoral subsistence practices, especially, force us to consider the common assumption that pastoralism is the go-to subsistence mode during periods of low social complexity and in marginal physical environments. Of course, it is known that even pastoralists will engage in agriculture or some form of cultivation from time-to-time, but the results from Wadi al-Feidh present a scenario that involves much more agriculture than previously recognized. This complicates the general dichotomy of the desert and the sown so common in archaeological narratives.

Chapter 2, in full, is a reprint of the material as it was submitted for publication in "Characterizing the Rural Landscape during the Iron Age and Roman period (ca. 1200 B.C.–A.D. 400): An Intensive Survey of Wadi al-Feidh, southern Jordan" Knabb, Kyle A., Najjar, Mohammad, Levy, Thomas E. (In press) *Journal of Field Archaeology.* The dissertation author was the primary investigator and author of this paper.

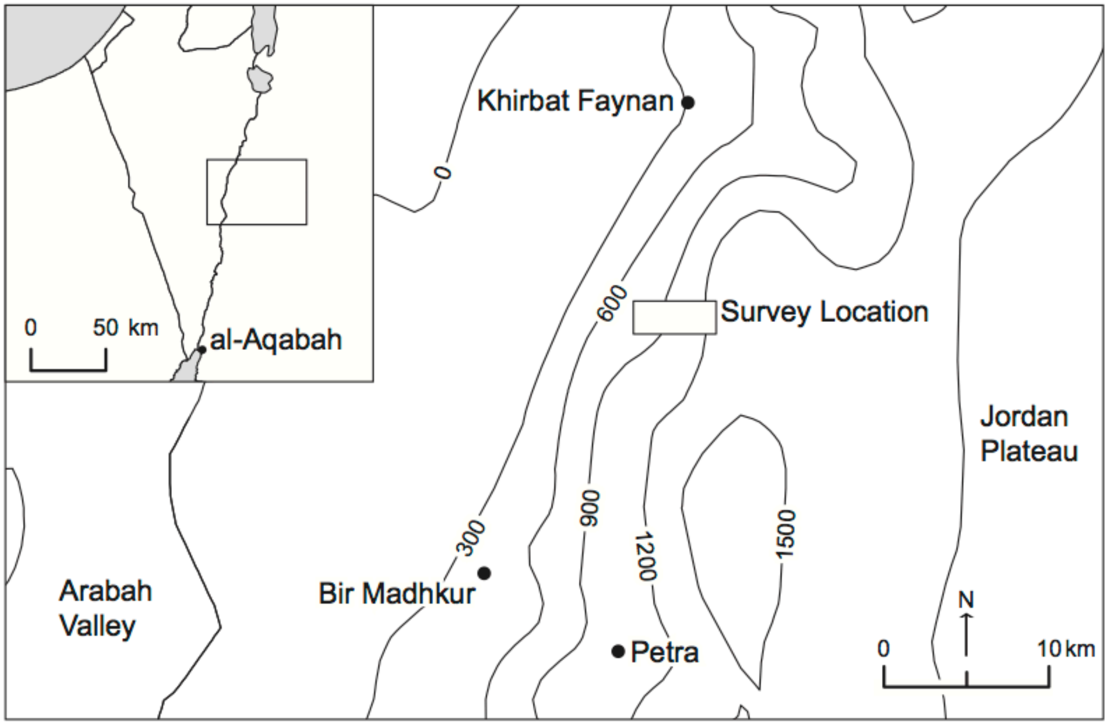


Figure 2.1: Wadi al-Feidh survey area shown between the Jordanian Plateau and the Arabah Valley. Inset shows location of survey area within the southern Levant.

Figure 2.2: View of steppe landscape. Flat areas have been plowed for agricultural purposes while steeper slopes have been terraced to expand agricultural land. Photo orientation is to the north.

Figure 2.3: View of the foothills, which are west of the steppe and slightly lower in elevation. The terrain becomes much more jagged and uneven in this area, resulting in many small valleys, steep hills and cliffs. Lush vegetation from the spring microenvironment is visible in the valley bottom. Photo orientation is to the west.

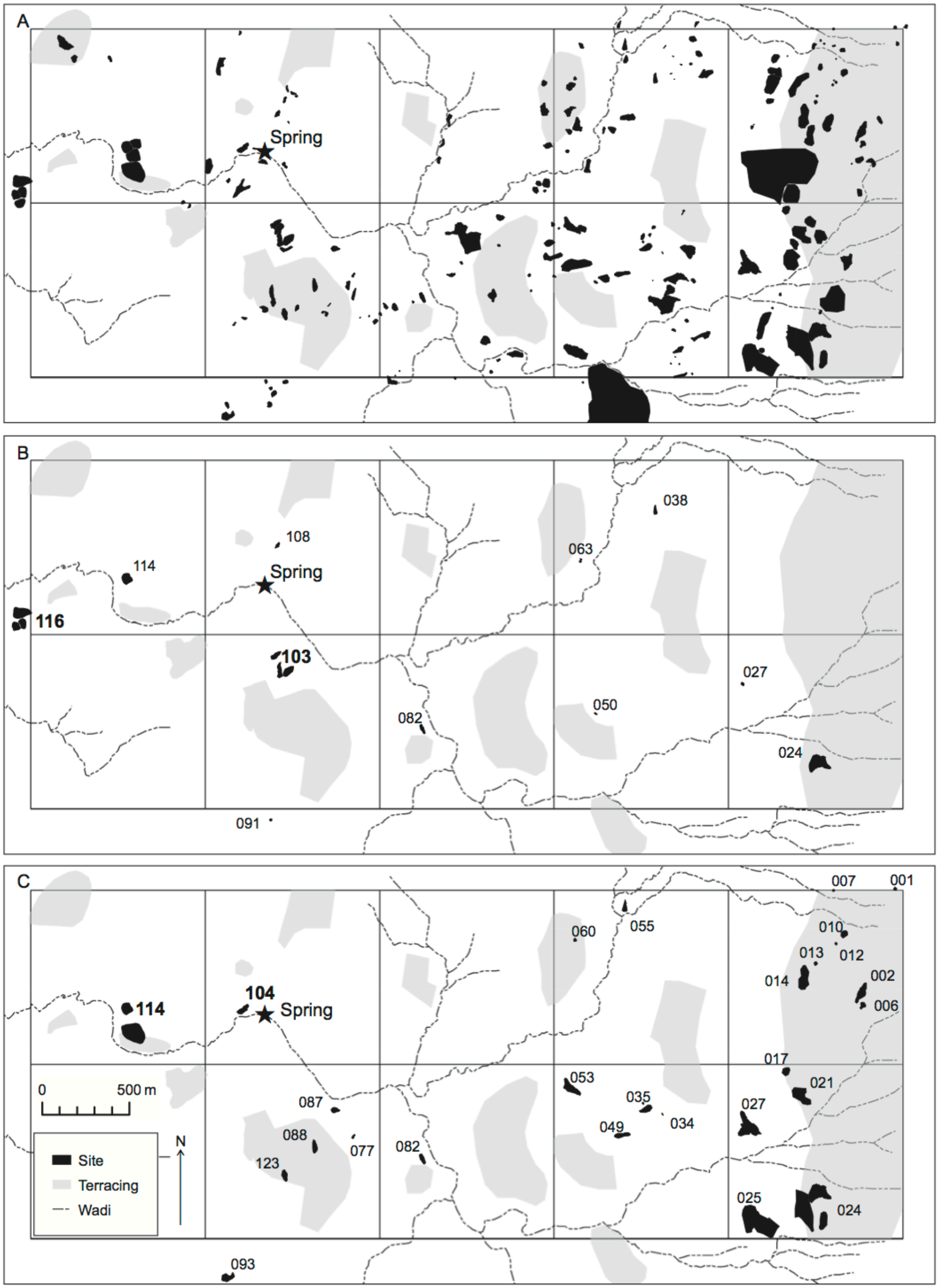


Figure 2.4: Map showing all recorded sites: A) Iron Age; B) and Roman period; C) sites mapped during the Wadi al-Feidh Survey. Sites specifically mentioned in the text are labeled in bold.

Figure 2.5: Site 116 (Qurayat Mansur) in the foreground (lower left). The site is constructed on a mesa on the boundary between the foothills and the rugged cliffs above the Arabah Valley, which is visible in the background. Photo orientation is to the west.

Figure 2.6: Pools of water accumulate below the waterfalls adjacent to site 116. These waterfalls are fed by the Wadi al-Feidh spring. Our survey, which included rappelling to explore the waterfalls, demonstrated that these pools are accessible from the north slope of Site 116.

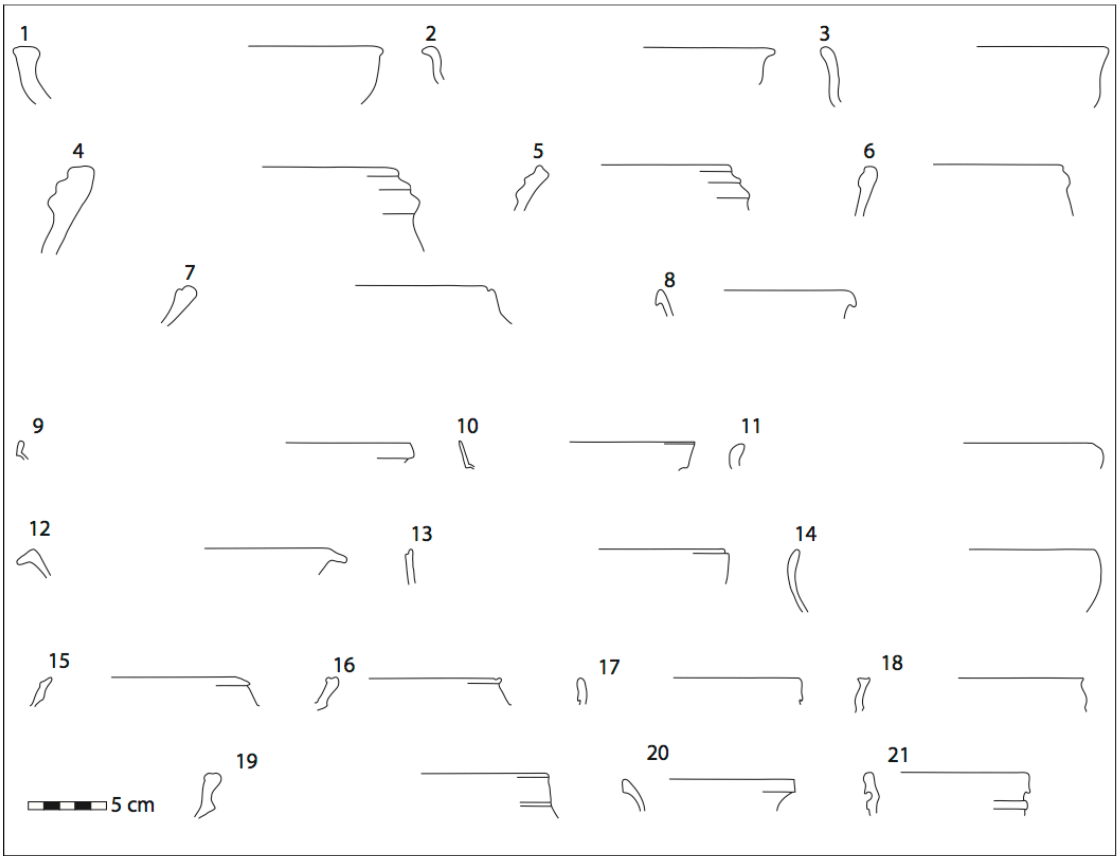


Figure 2.7: Diagnostic ceramics: 1–3) Iron II bowls; 4–6) Iron II Jars; 7) Iron II Cooking pot; 8) Iron II Jug; 9–14) Early Roman Bowls; 15–17) Early-Late Roman Jars; 18–19) Late Roman/Early Byzantine transition Jars; 20–21) Early-Late Roman Jugs.

Figure 2.8: A small valley with remnants of ancient terracing adjacent to Site 103, which is located atop the hill in the rightmost frame of the picture. View is to the north.

Figure 2.9: Petroglyphs from Site 103 pecked into the bedrock outcrop at the north point of the site, overlooking the valley bottom and the spring.

Figure 2.10: Site 104 - a small processing site in the valley bottom adjacent to the Wadi al-Feidh spring. Fig, oleander, tamarisk, and other hydrophilic plants are abundant here, and may have been in antiquity as well.

Figure 2.11: One of the rock-cut canals connecting Site 104 and 114. These canals are typical of Nabataean hydraulic engineering, and are cut directly into the sandstone bedrock a few meters above the valley bottom. For reference, the author is standing in the canal.

Figure 2.12: Site 114 (Khirbat Feidh) a Roman period site that is very poorly preserved. Many terrace walls and other derelict structures were recorded here, suggesting its use for agriculture. New structures have also been built by modern inhabitants of the valley for shelter and for animal penning.

Figure 2.13: An example of a small structure recorded by the Wadi al-Feidh survey. Site 107b is a small rectilinear structure recorded in a sheltered tributary valley of the foothills region of Wadi al-Feidh.

Figure 2.14: An example of a cairn recorded by the Wadi al-Feidh survey. This cairn, like most recorded during the survey, was located along the steppe region of Wadi al-Feidh.

Table 2.1: Local and regional southern Levantine chronologies.

B.C./A.D.	Period	Local	Regional
1200			
1100 1000	Iron Age I	Non-sedentary settlement, copper production in Faynan	Formation of local polities (Ammon, Moab, Israel, Judah)
900 800 700	Iron Age IIA/B	Formation of Edomite polity	Continuation of local complex polities
600 500	Iron Age IIC	Edomite polity becomes tributary state under Assyria	Assyrian imperial expansion
400 300	Iron Age III	Sparse and small-scale settlement (influence of eastern empires)	Neo-Babylonian and Persian imperialism
200 100	Hellenistic	Formation of Nabatean kingdom, expansion of agricultural and trade	Seleucids and Ptolemies contest southern Levant
0 100	Early Roman	Independent Nabatean kingdom, Annexed by Rome in 106 A.D.	Romans and Parthians contest southern Levant
200 300	Late Roman	Continuity of Nabatean material culture under Roman empire	Romans and Parthians/Sassanians contest southern Levant
400 500 600	Byzantine	Decline of trade economy, shift to local agricultural production	Political and economic crisis in Roman Empire

*Compiled from (Bienkowski and van der Steen 2001; Graf 1990; Herr and Najjar 2001; Kouki 2009; LaBianca and Younker 1998; Schmid 2001)

Table 2.2: List of Iron Age and Roman Period sites recorded during the survey.

Site	Feature types	Possible functions	Time periods *	Area (sq m)
		--Iron Age sites--		
024	Mortar, rectilinear/round structures, terraces, wall	Agriculture, processing, temporary shelter	IA, ER, B	8006
027	Round structure	Agriculture, animal penning, temporary shelter	IA, ER, R+	399
038	Cairns	Field clearance, graves, territorial markers	IA	961
050	Cairns	Field clearance, graves, territorial markers	IA	240
063	Rectilinear structure	Animal penning, temporary shelter	IA, IA+	341
082	Campsite, mortars, round structure	Animal penning, processing, temporary shelter	IA, ER, R+, MI+	1095
091	Round structure	Possible cistern, storage	IA, MI-LI	265
103	Petroglyphs, rectilinear structures, walls	Settlement	IA, MI	6387
108	Rock shelter, walls	Animal penning, check dams, storage, temporary shelter	IA	638
114	Rectilinear structure, terraces, walls	Agriculture, animal penning, storage, temporary shelter	IA, ER, R, MI, MI-LI	3122
116	Rectilinear structures, walls	Settlement	IA, MI, MI-LI	9475
		--Roman Period Sites--		
001	Abandoned 20th century rock built house	Unknown, prior remains likely destroyed	ER, R+	261
002	Terracing	Agriculture	R, R+, MI, MI-LI	3504
006	Round structures	Agriculture, storage, temporary shelter	R, R+, MI, MI-LI	823
007	Cairn	Field clearance	ER, R+, MI-LI	129
010	Mortar, rectilinear structure, terracing	Agriculture, processing	ER	1195
012	Cairn	Field clearance	ER	167
013	Cairn	Field clearance	R	302
014	Cairn field	Field clearance	R	5942
017	Cairns	Field clearance	ER	1516
021	Campsite, cairns, walls	Agriculture, animal penning, field clearance, storage, temporary shelter	ER, R+, LR-B, MI-LI	6372
024	Cairns, mortar, rectilinear/ round structures, wall	Agriculture, field clearance, processing	IA, IA+, ER, R+, B, MI	27012
025	Cairns, round structure, wall	Agriculture, animal penning, field clearance	ER, R+, MI, MI+	21694

Table 2.2: List of Iron Age and Roman Period sites (continued)

Site	Feature types	Possible functions	Time periods *	Area (sq m)
027	Cairns, round structure	Animal penning, field clearance	IA, ER, R+	9095
034	Cairns	Field clearance, storage, territorial markers	ER	62
035	Campsite, round structures	Animal penning, temporary shelter	R, MI-LI	1958
049	Cairns	Field clearance, processing	R	1792
053	Cairns	Field clearance	ER, R, MI-LI	3855
055	Rectilinear/round structures, walls	Animal penning, check dams, temporary shelter	ER, B+	1102
060	Rectilinear structure	Animal penning, temporary shelter	ER, B	252
077	Rock shelter, round structure	Animal penning, temporary shelter	ER, MI, MI+	257
082	Campsite, mortars, round structure	Animal penning, processing, temporary shelter	IA, ER, R+, MI+	1095
087	Walls	Agriculture, check dams	ER	1044
088	Rectilinear structure	Animal penning, temporary shelter	R, R+, MI-LI	1531
093	Wall	Agriculture, check dam	ER, MI	2289
104	Rectilinear structure, rockshelter	Processing, storage, temporary shelter	ER, R+, B, MI	1774
114	Rectilinear structure, terraces, walls	Agriculture, animal penning, storage, temporary shelter	IA, ER, R, MI, MI-LI	14459
123	Cairns, round structure	Agriculture, animal penning, field clearance, temporary shelter	ER, R, R+	1464

*B=Byzantine, ER=Early Roman, IA=Iron Age, LI=Late Islamic (A.D. 1400-1950), LR=Late Roman, R=Roman (early-late), MI=Middle Islamic (A.D. 1000-1400), +=listed period or later

Chapter 3: Settlement Patterns and the Metallurgical Landscape – New Archaeological Surveys in the Lowlands of southern Jordan's Faynan Region

Introduction

This chapter presents the cumulative results of five seasons of archaeological surveys conducted by the Jabal Hamrat Fidan (JHF)/Edom Lowlands Regional Archaeological Project (ELRAP) from 1998 to 2011 (Figure 3.1) focusing primarily 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 three additional seasons of archaeological survey. The first, conducted in 2004, was a small survey of Wadi Fidan that focused on an area south of the 1998 survey boundaries; the second, conducted in 2007, was a continuation of the 2002 survey of the Wadi al-Jariya, and completed the systematic survey of that wadi system; and the third, conducted in 2011, was a small survey of the Buweirda Springs in the northern Arabah valley southwest of Wadi Faynan (Figure 3.2).

Methodological Considerations

Most archaeological survey projects in southern Jordan have had as their main objective to record and describe settlements in the region's desert setting (Hart 1986, 1989; Hart and Falkner 1985; Lindner 1992; MacDonald 1988, 1992; MacDonald *et al.* 2004). The surveys conducted have been purposive or extensive, relating to either one time period or to prominent sites on the landscape. As 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 frequency (McQuitty 2005). These surveys are also 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 and the density of sites within a survey area. This project employs methodologies developed elsewhere in the Mediterranean that deal with these issues (Alcock 1993; Bintliff and Sbonias 1999). Intensity refers to the degree of detail inspected within the survey boundaries. Survey intensity is one of the most important factors affecting the recovery of archaeological materials. 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 3.3). Surveyors were spaced no more than 25-50 meters 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 non-sedentary 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, features, structures, and ecofacts remains (Table 3.1).

Theoretical Considerations

One of the key theoretical issues investigated by ELRAP is the role of technology in social evolution. Copper production is a technology that has a strong archaeological signature, easily detectable through both survey and excavation methods. 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 thorough an emphasis on specialization and its connection to the rise of complex societies (Brumfiel 1998; Brumfiel 1987; Costin 2004; Peregrine 1991; Sinopoli 1998). A more detailed description of the production systems in place during the Iron Age in Faynan and their implications for historical ecology will be discussed in Chapter 3 of this dissertation, while Ben-Yosef and Levy (2014) have described the technological changes and material culture of Iron Age metallurgy in detail elsewhere.

Research Background

As noted above, this chapter focuses on previous surveys conducted by the UCSD Edom Lowlands Regional Archaeological Project (ELRAP), including the 2007 survey of the Wadi al-Jariya and 2011 survey of the Buweirda springs that were conducted for this dissertation. 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.* 2007b). Three wadi channels have been surveyed since 1998 in addition to the Buweirda springs oasis: Wadi Fidan, Wadi al-Ghwuyab, and Wadi al-Jariya. Wadi Fidan and Wadi Faynan are part of the same catchment system, as are Wadi al-Jariya and Wadi al-Ghuwayb. While the recording methods have varied from season to season as we purchased new equipment, the survey methodology and research design has remained consistent.

Description of the Survey Areas

Wadi Fidan begins near the modern Bedouin village Qurayqira, where the Wadi Faynan cuts through Jabal Hamrat Fidan Monzogranite range forming a narrow gorge. The wadi then flows north-northwest for four kilometers, bounded by flat, relatively even terraces of fluvial gravels and aeolian sands. As the wadi narrows to the north, it intersects a complex formation of Lisan Marl, Finan Granitic, Minshar Monzogranite, and Hunayk Monzogranite (Rabb'a 1994). At this narrowing point there is a perennial spring which gently flows along the rest of the wadi called ‘Ain Fidan. Eventually, the wadi turns westward and passes through the Minshar Monzogranite. In addition, there are patches of Pleistocene Conglomerate which make up terraces along the wadi where a number of sites were discovered in 1998. After two kilometers the wadi opens into a wide alluvial plain composed of Aeolian sand and dunes and other wadi sediments that is the eastern edge of the Arabah valley (Figure 3.4).

Approximately five kilometers northeast of Wadi Fidan, Wadi al-Ghuwayb was most likely part of the same settlement system during the Iron Age. It flows for 14 kilometers to the west, around the Jabal al-Minshar (the northern extremity of the Jabal Hamrat Fidan), eventually reaching the Wadi Arabah. To the east the wadi splits into two smaller drainages. The northern drainage cuts through 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-Ghuwayb. Here, the Wadi al-Ghuwayb 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 3.5). Just before the wadi empties into the Wadi Arabah 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-Dahl for 6.5 kilometers until it empties into Wadi al-Ghuwayb approximately one kilometer east of Khirbat an-Nahas. 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. Two and a half kilometers to the north the wadi cuts through layers of Burj Dolomite-Shale. This area is also where the Iron Age copper smelting site Khirbat al-Jariya was established (Ben-Yosef *et al.* 2010). As the wadi continues to the northeast 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. Three kilometers northeast of Khirbat al-Jariya the wadi cuts through the Umm Ishrin Sandstone, and in its northernmost reaches the wadi flows through the Muwaqqar Chalk Marl, the Wadi Umm Ghudran Chalk, and other chalky limestone formations. 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 (Figure 3.6).

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. A spring at the north end of the wadi produces little more than a trickle, so the wadi is usually dry. A few secondary 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 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.

The Buweirda Springs, located approximately 80 km south of the Dead Sea, are a lush, riparian oasis within the arid desert of the north Arabah Valley (Figure 3.7). A portion of these springs, of which there are at least 6 currently known, were surveyed as a part of the Edom Lowlands Regional Archaeology Project's 2011 season of fieldwork and supervised by the author. The results of this survey demonstrate the long-term exploitation of the springs for ancient human settlement. Furthermore, they raise questions regarding the archaeological and ecological preservation of the springs, which are threatened by modern farming and sand dune encroachment.

Perhaps one of the first references to the Buweirda springs comes from a report made by Major Kitchener to the Palestine Exploration Fund in 1884 (Kitchener 1884). Kitchener took part in a survey of the Wadi Arabah and eastern Sinai on behalf of the fund from October 1883 through the spring of 1884 as part of the PEF's survey of Palestine. According to his report, after descending into the Arabah valley from Petra, the team camped in the Buweirda springs before heading north to Faynan, and then to the Dead Sea. Kitchener writes of the springs: "A good deal of blown sand from sand dunes in the valley lead up to the springs which break out in several places from some soft loamy soil in the valley, and form several small streams full of reeds, tamarisk, bushes, and palms, etc.; the water is slightly brackish," (1884: 213). Following his report, very little has been written or explored about this intriguing group of springs, an oasis in the arid desert of the Arabah valley. While most of the material for this chapter was published in Knabb *et al.* (2014), this is the first presentation of the Buweirda springs data collected in 2011.

Survey Design, Recording Methodology, and Results from Previous Surveys

Overall, the same basic survey methods were used in all the seasons of ELRAP work, with the exception of the introduction of GPS recording technologies in 2007. The main goal of the 1998 survey 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 PPNB site (Levy *et al.* 2001; Twiss 2007, 2008); Wadi Fidan 4, an EBA I village (Adams and Genz 1995); Khirbat Hamrat Ifdan, an EBA III-IV copper smelting site ; Wadi Fidan 40 (Levy *et al.* 1999; Levy *et al.* 2005a), an Iron Age cemetery; and Khirbat an-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 km2 segment of Wadi Fidan in 10 days. During this time, seven surveyors walked transects at 50 meter intervals. The survey boundaries included the area around Khirbat Hamrat Ifdan and followed the wadi northwest to where it empties into the Wadi Arabah (Figure 3.8). In the small area, the surveyors recorded 125 sites (Appendix 1), which were defined as "a distinct spatial clustering of artifacts, features, structures, and ecofacts remains" (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. The survey began where the 1998 survey left off, to the southeast of Khirbet Hamrat Ifdan and continued for 250 meters south of the Wadi

Fidan Spring. The objective of this survey was full coverage of 350 meters 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. 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 (i.e. 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 collections 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 12.62 hectare surveyed area (Figure 3.9; Appendix 1). 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 multi-period use.

The 2002 survey of Wadi al-Ghwuyab and Wadi al-Jariya covered 12 km2 in three weeks and was primarily aimed at contextualizing the Iron Age landscape around Khirbat en-Nahas prior to the first large-scale excavation (Levy *et al.* 2014a). The survey team walked transects spaced up to 50 meters apart. The survey boundaries included all areas within 250 meters of the wadi channels. In total, the surveyors recorded 118 sites: 64 in Wadi al-Ghuwayb and 54 in Wadi al-Jariya (Figure 3.10, Appendix 2).

The most prominent of these sites are Khirbat en-Nahas, Khirbat al-Jariya and Naqeb Aseimer. 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). Naqeb Aseimer is a Middle Islamic copper smelting site. Similar to the Fidan smelting sites, copper mines were found in close association with each of these sites (Appendix 2). 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. The total area surveyed was approximately ten square kilometers. A total of 96 new sites were recorded in Wadi al-Jariya and two secondary drainages (Figure 3.11; Appendix 2). Surface architecture and artifacts were used to identify sites. Diagnostic artifacts (lithics, pottery, glass) were collected in order 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. 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.

For the Buweirda springs, two factors complicate surveying in the area: Recent and ongoing farming, and the spread of aeolian sands and sand dunes. Presently, much of this area is being used for farmland. Water from the springs is pumped into above ground cisterns for irrigation, and some of the springs have been bulldozed to create reservoirs. If this continues, much of the archaeological traces of ancient human settlement will be destroyed. However, the possibility of future dune movement or new remote sensing methods from the ground or the air may reveal more sites in the future.

Our survey focused on an area extending from the southern-most spring, and then north to the second major spring, which you can see in this satellite photo (Figure 3.12). The survey methodology consisted of systematic, intensive surveying using handheld GPS, and systematic 10% surface collection and mapping at sites and agricultural features. As Kitchener had noted, sands and sand dunes surround the Buweirda springs. During our survey we frequently encountered large dunes and sand beds throughout the springs. Between the expansion of modern irrigation farming, and the spread of sand dunes through the Arabah valley, we must consider the possibility that what sites still exist are being lost to natural and anthropogenic processes.

A poignant example of this trend is the ancient site of Khirbet Buweirda - an ancient settlement recorded by Kitchener's colleague George Armstrong. Kitchener writes, "Near the springs Armstrong observed terraces of an old town of considerable extent. There are numerous little mounds of artificial appearance; fragments of coloured pottery abound. The foundation of a building is seen, the stones having a very old and time-worn look, and portions of an aqueduct, level with the ground, are traceable from one of the springs leading to the site," (1884: 213). From Armstrong's observations, this would appear to be a fairly significant site. However, when we interviewed some of the locals about it, none of them were familiar with it, and others recalled some pottery scatters nearby their farms, but nothing to the extent described by Kitchener. Unfortunately, this site wasn't within the boundaries of our survey, at least according to Kitchener's maps. So it's hard to say what an intensive survey would have turned up. Needless to say, significant portions of the ruins seem to have been either destroyed or buried.

With these two issues in mind, we make the case here that the Buweirda springs were a location of significant human occupation spanning the Pre-Pottery Neolithic through the late Islamic periods, that modern farming and sand dune migration are ongoing threats to the material culture there, but, in spite of these issues, we can still learn a great deal about the archaeology of the Buweirda Springs from intensive survey.

Iron Age Metallurgical Sites from Other Surveys

Umm ez-Zuhur Mines – Umm ez-Zuhur is a mining area located between Wadi Fidan and Wadi al-Ghuwayb (Figure 3.13). This complex was first reported by the Deutches Bergbau Museum 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 el-Hetiye – Barqa el-Hetiye is a small Early Bronze Age and Iron Age smelting site located ca. 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 9th 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 (Adams *et al.* 2010; Hauptmann 2007: 142).

Jabal al-Jariya Pit Mines, Khirbat al-Ghuwayba, Ras al-Miyah Mines – These sites were visited during the 2007 Faynan-Busayra Regional Survey (FBRS), and are presented in detail in the chapter by Ben-Yosef et al. (2014a). 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.* 2009a). Preliminary optically stimulated luminescence (OSL) dating of one of the pit mines sampled in 2009 confirms an Iron Age date (Ben-Yosef *et al.* 2014b).

Ras an-Naqb – Ras an-Naqb is a primarily Early Bronze Age II/III site ca. 4 km southeast of Khirbat en-Nahas. One slag mound at the site, containing ca. 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 EB II/III slag to extract the remaining metal.

Khirbat Faynan – Although the surface of Khirbat Faynan is dominated by Byzantine period architectural remains, there are many Iron Age slag mounds around the site in addition to smelting debris from other periods (Hauptmann 2007: 94-109; Levy *et al.* 2012; Musil 1907). Previous surveys by the DBM (Hauptmann 2007) and CBRL (Barker *et al.* 2007b), 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 non-agricultural buildings and evidence of smelting activities, which dates to the Iron Age (Mattingly *et al.* 2007: 278-279). There are also several agricultural field systems which 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*. (2014b) 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-Ghuwayb and Wadi al-Jariya is not clear. These are problems ELRAP plans to investigate in the future.

Wadi Abiad Mines – The Wadi Abiad mining district contains two sets of mines. There are ten 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 (Ben-Yosef and Levy 2014).

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 (Ben-Yosef and Levy 2014).

Wadi Dana Mines – Wadi Dana contains 14 mines which 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 (Ben-Yosef and Levy 2014). The following discussion presents definitions of the range of site types encountered in the ELRAP surveys discussed here.

Results of the ELRAP Surveys 1998-2011

Agricultural Sites

Only two Iron Age agricultural sites were recorded by ELRAP team members, both in Wadi Faynan. The category is defined as sites that only exhibit evidence 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 7 is composed of two small dams in the wadi separating clusters of possible structures or field walls. The measured size of this site is 1700 m2. Two circular features were also recorded close to the site. Eleven out of the 13 ceramic sherds collected from the site date to the Iron Age.

WFD 19 is located in a small wadi that branches off of Wadi Fidan, about 70 meters south of WFD 7. The site consists of several walls varying from one to three preserved courses, which extend over an area of 1725 m2. 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 meters, forming a rectangle in the valley. The walls may have been used as part of an ancient terrace system. 31 sherds were collected at the site, all of which date to the Iron Age.

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 600m of the west side of Wadi al-Jariya, was the only architecture fragment site from which we collected Iron Age ceramics. Each feature is located on a low, sandy plateau above the wadi, and is separated by small drainages that run perpendicular to Wadi Jariya. The site is composed of poorly preserved architecture fragments (Figure 3.14-15) that may have been part of a campsite. A number of cairns and circular features (Figure 3.16-3.17) 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 10 is a group of 5 cairns spread over several hilltops north of Wadi Fidan. The cairns and associated were recorded within an area of 300 m2. Four Iron Age body sherds were collected from this site.

WFD 14 is a single small cairn, roughly 400 meters southeast of WFD 10, surrounded by many lithic flakes and debitage. A single Iron Age sherd was collected near the cairn.

WFD 15 is a small site consisting of two cairns (15a and 15b) on a hilltop, one with standing stones. Each cairn is about 4 meters in diameter. Though no ceramics were collected at WFD 15, but the site was dated to the Iron Age based on its proximity to WFD 7, an Iron Age agricultural site (Figure 3.18-3.19). Located on near the mouth of the Wadi Fidan overlooking the Wadi Arabah, these standing stone feature may have been a territorial marker near one of the main western entrances to Faynan.

WFD 67 consists of three cairns on the northern slope of the drainage, constructed within an area of 986 m2. The cairns are constructed 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 89 is a group of four cairns associated with a relatively dense Iron Age pottery scatter within an area of 25 m2. 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 prominent circular feature near the center of the site, around which was found a concentration of Iron Age pottery (Figure 3.20). 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 6800 m2.

WFD 630, a cluster of four oval-shaped cairns that range in size from 2-4 meters, 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 155 m2 within which four sherds of Negebite Ware were collected.

WFD 631 (210 m2) is a group of cairns and stone circles located ca. 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.

WAG 59 is situated on the eastern end of the plateau bounding Wadi Nqeib Aseimer to the north. Clear views of Khirbat en-Nahas and Wadi al-Ghuwayb are afforded from all features at this site (4257 m2) , which consists of one cairn approximately 1.5 m x 1 m, 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 5888 m2 to the west of Wadi al-Jariya, and is bounded by gullies to the north and south and a cliff face to the west. A number of cairns are present throughout the site (Figure 3.21-22), 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.

WAJ 522 is a cluster (272 m2) 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.

WAJ 523 (1456 m2) consists of nine cairns of varying sizes, most of which are concentrated at the central part of the site. Some of the larger cairns were built of larger-than-average rocks. (Figure 3.23-3.24)

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 5466 m2, and consists of several cairns and crude stone circles found in a thin scatter throughout the site. (Figure 3.25-3.26)

WAJ 590 is a small site that consists of three small cairns on a rocky plateau 70 m east of Wadi al-Jariya. Though a small amount of Iron Age ceramics were collected from the site, 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 two meters to the north. WAJ 596 (12,682 m2) also includes a tent clearance and a large rock circle, five meters in diameter, constructed of large rocks placed on their side. Iron Age, Roman/Byzantine and Islamic period pottery was collected at the site. (Figure 3.27-3.30)

WAJ 641 (4662 m2) 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 tumuli were still visible during the 2007 season. Pottery collected at the site dated to the Iron Age and Roman/Byzantine periods. (Figure 3.31)

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-Ghuwayb surveys; campsites were only recorded in Wadi al-Jariya.

WAJ 516 is and ancient campsite located approximately 250 meters west of Wadi al-Jariya on small and relative flat terrain, which is covered with eroded shale. The site encompasses and area of 3088 m2. A large structure was found at the center of the site. This structure has been divided into two uneven spaces. The largest measures 14 x 10 meters, and the small space measures 7 x 5 meters. The structure is surrounded by 12 cairns. Considerable amounts of ceramics and some flint artifacts were found in and around the structure. (Figure 3.32-33)

WAJ 521 is located on a topographic saddle ca. 250 m to the west of Wadi al-Jariya. The large rectilinear structure (Figure 3.34) is similar to other campsites recorded in Wadi al-Jariya and by the FBRS (Ben-Yosef *et al.* 2014a). In addition, there are more than 10 cairns at this site (3208 m2). At the highest point of the saddle there is a stone circle measuring 4.5 m in diameter (Figure 3.35). A large amount of Iron Age pottery was collected 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. None of the features at the site are more than 80 cm in diameter. Iron Age pottery and some slag was collected at the site, as well as some lithic artifacts. (Figure 3.36)

WAJ 562 (1923 m2) 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 wall 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 3.37)

WAJ 565 is (174 m2) 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 meters and a stone circle approximately two meters in diameter. A groundstone mortar was also recorded in close proximity to the site. (Figure 3.38)

WAJ 586 (1141 m2) is located on a hill 50 meters 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 which possibly served as a tent clearing. On the northern side of the hill is a tall cairn. A road built in the mid-20th 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 3.39)

WAJ 588 is located on a rocky hill and plateau above Wadi al-Jariya. The site (21,798 m2) extends to both sides of the wadi, though 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, one rectangular and one circular. 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 of them 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. (Figure 3.40-41)

WAJ 591 (993 m2) 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 (1951 m2) is located on a plateau on the western side of Wadi al-Jariya consists of several square rooms, ca. 5 m 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. (Figure 3.42-43)

WAJ 595 sits on a high plateau to the northwest of Khirbat al-Jariya. The site (8762 m2) provides spectacular views of Wadi al-Jariya, Wadi al-Ghuwayb, Khirbat al-Jariya, and even as far as the Wadi ‘Arabah. 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 to the Early Bronze Age. (Figure 3.44-48)

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, example of an Iron Age cemetery is WFD 40 (Beherec *et al.* 2014). WFD 40 is a large Iron Age cemetery located to the north of Wadi Fidan, and was excavated as part of the JHF and ELRAP projects during the 1997, 2003, 2004 and 2009 field seasons. See Beherec et al. (2014) for a detailed presentation of the Iron Age cemetery.

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 13 (657 m2) 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 one meter in height.

WFD 604 (1365 m2) consists of two circular features (Figure 3.49-50), between one and three meters in diameter, on the northeast bank of the Wadi Fidan. In addition, surveyors recorded a large wall fragment (Figure 3.51) that is six meters long and two courses wide, and an architectural fragment that may be rectangular in shape, but no more than a few meters wide.

WAG 24 is situated on terrace north of Wadi al-Ghuwayb, near the junction of Wadi Ghuwayb al-Ghani and Wadi Ghuwayb al-'Atshana. The site (4538 m2) is bounded in the north by a smaller drainage, which runs east-west. Numerous extensively eroded circular features (Figure 3.52-53) 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 60 (137 m2) is located on a hillock surrounded by drainages at the mouth of Wadi Nqeib Aseimer. 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 3.54), which has been robbed. In the eastern portion of the site, another possible tumulus, this one undisturbed, was noted.

WAG 61 (2749 m2) is located on the western end of the plateau bounding Wadi Nqeib Aseimer to the south. The site follows the cliff line and has a clear view of Khirbat en-Nahas and Wadi al-Ghuwayb to the northwest. 11 circular features were identified (Figure 3.55), along with four possible tumuli, and 27 irregular heaps of shale slabs.

Located along the western bank of Wadi al-Jariya, WAJ 514 is 1218 m2 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 stone circles, a cairn and various poorly preserved installations. For example, one large stone circle measures 1.4m in diameter, small ca. 60cm in diameter (Figure 3.56).

WAJ 520 is an impressive site that may be a cemetery. The site (ca. 33,639 m2) is located on a plateau ca. 50 m west of Wadi al-Jariya. Dozens of tumuli are scattered through the landscape, 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 which 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 (ca. 60cm diameter) stone circles 1.2m apart. Fragmentary wall adjacent.

WAJ 537 (4277 m2) sits on a flat, sandy plateau above and to the southwest of Wadi al-Jariya. It consists of several relatively well-preserved stone features, scattered throughout the plateau, including circular features (Figure 3.57-58), cairns, and wall lines. Although well-preserved, none of the features is complete. Several hearths and other installations whose usage could not be identified were also found. Some lithic artifacts, copper ore, slag and a copper object were found, as well as a small quantity of pottery which dates to the Iron Age and possible the Early Bronze Age.

WAJ 561 (61 m2) 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.

WAJ 564 sits on a low sandstone shelf above small wadi, sheltered to the west by sandstone cliffs. Approximately eight stone circles were recorded , varying from 1-3 meters in diameter. The site extends over an area of 158 m2.

WAJ 574 (661 m2) is located on a rocky plateau south of Site 560, a mine. This site takes advantage of a natural rock outcrop to form one side of a wall. Two rock walls are perpendicular to the outcrop and the south side is open (Figure 3.59). The surveyors recorded a stone circle at the southern end of the structure, and nearby there is a hearth and 2 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 2.4 x 4 meter. We observed two additional small circular features (Figure 3.60) near the rock circle, and a single post hole near wadi channel.

WAJ 582 (82 m2) 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 (Ben-Yosef *et al.* 2014b). Two rock ovals: one partial and one complete were identified. Each one measures about 2 x 1 meters. The features may have been used as a road marker of some kind. The area has been damaged by heavy bulldozing and erosion (Figure 3.61).

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 2 is one of the smallest metallurgical sites found on 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 52 is a small but complex site, composed of numerous walls (Figure 3.62) in association with a small drainage (Figure 3.63) alongside a Pleistocene conglomerate outcropping. The site extends westward, where the surveyors recorded three large rectilinear structures. The dimensions of the structures are approximately 10 x 20 meters. Pieces of slag are scattered uniformly across site. Five cairns mark the southern extent of the recorded site boundaries. 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. As with WFD 52, ceramics collected from WFD 52a date to the Early Bronze Age, Iron Age, and Roman/Byzantine periods. The four Iron Age sherds make up about 1/3 of the ceramics collected from the site.

WFD 58 is a relatively large (5000 m2) area littered with large quantities of slag. 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 77a, 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). The excavations at RHI are discussed by Smith and Levy (Smith *et al.* 2014b).

WFD 120 refers to Khirbat Hamra Ifdan, a large copper production and settlement site that dates primarily to the Early Bronze Age III-IV, but also has important Iron Age smelting evidence. 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 62 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 *et al.* 2008; Levy *et al.* 2005b). Detailed discussion of various aspects of the JHF and ELRAP excavations at KEN can be found in Levy et al. (2014a), Smith and Levy (2014), Muniz and Levy (2014), and Ben-Yosef and Levy (2014).

WAJ 511 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 meters. The remains of several badly preserved walls or installations (Figure 3.64) 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 on Iron Age metallurgy, have been published previously (Ben-Yosef 2010; Ben-Yosef *et al.* 2010). For further discussion, see Ben-Yosef and Levy (Ben-Yosef and Levy 2014).

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 ca. 657 m2.

Mines from Wadi al-Jariya and Wadi al-Ghuwayb

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 has 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. 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 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-Ghuwayb. 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 Nqeib Aseimer. Three mine shafts are visible on the surface, and these are surrounded by tailing piles (Figure 3.65). 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 Khirbat Nqeib Aseimer, 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 only collected at 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 site 551, where they collected Roman/Byzantine ceramics. In addition, one quartzite hammer stone of unknown date was collected from site 544, and four mining hammers - similar in style to those collected from Wadi Fidan 4 - were collected from site 548.

The third cluster of mines [WAJ 560, 572, 577, and 578; Figure 3.66-72)] was recorded during the 2007 season in a tributary wadi connected to Wadi al-Jariya, just 100 meters north of Khirbat al-Jariya. The tributary is bounded by sandstone cliffs, and ascends gradually in elevation. There is an NRA road, and past the road there is a path that can be followed to the Rass al-Maya fortresses. The surveyors recorded three mines in this area. WAJ 560 is a mineshaft and mine tailings covering an area of about 3130 meters square (Figure 3.66-68). 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 which date to the Iron Age. WAJ 572 is a mineshaft that has been filled in with sediment and collapse (Figure 3.69-70). The shaft is about 1.5 meters 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 3.71). 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 3.72).

At the fourth cluster of mines, surveyed during the 2007 season, nineteen distinct mining sites were recorded (WAJ 587; 600-615; 617-618; Figure 3.73-3.86). 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 kilometers 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 15580 square meters and the smallest is a little more than 200 square meters. Iron Age ceramics were collected from the surface of 14 sites, while ceramics from other periods were collected from nine sites. Early Bronze Age style mining hammers were collected from five of the tailing piles. Only one mine shaft (Figure 3.84) was recorded at the second cluster of mines, at site WAJ 614. The shaft appeared to be approximately 7-10 meters deep, and was surrounded by tailings.

Sixteen mine sites were recorded in the fifth cluster (Figure 3.87-95): 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 two kilometers of Khirbat al-Jariya. The tributary wadi is bounded by sandstone cliffs that cover the dolomite shale that contains copper mineralization. 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 square meters to 7750 square meters. 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.

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 62 contains a rectilinear structure on hilltop above WFD 4, which appears to be much too large to be a tumuli. One Iron Age pot sherd was collected from this site (ca. 16 m2), which can only tentatively be dated to the Iron Age.

WFD 112 consists of a rectangular building 22 x 8 meters. 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 one meter 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 ten meters to the south of the rectangular feature. 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 (1724 m2) is approximately one kilometer south of the Wadi al-Jariya spring. The main feature at this site is a rectangular structure (Figure 3.96) 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 north-east 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 (Ben-Yosef *et al.* 2014a).

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 (4363 m2) is located 250 meters to the west of Wadi al-Jariya at the base of a small cliff. The sites' 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 3.97) 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.

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 81 is a very small scatter of pottery sherds (ca. 1 m2). 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 87 is a dense scatter of Iron Age pottery, located near possible grave features on the eastern edge of the feature. WFD 96 is a small scatter of four Iron Age ceramic sherds.

WFD 628 is located on the western bank of the Fidan spring. No architectural features were observed. The main feature at this site was a large lithic scatter, but there was also a smaller pottery scatter. The pottery dated to the Early Bronze Age, Iron Age, and Roman/Byzantine periods.

WAG 26 is located on a low terrace east of Wadi al-Jariya and north of Wadi al-Ghuwayb. Wadi al-Jariya forms the western boundary of the terrace. The find spot (ca. 369 m2) is cleared of the cobbles that would seem to be normally covering the surface. Finds included lithics, copper ore and many Iron Age sherds.

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. The scatter extends across an area of ca. 20 m2.

Tumuli

Tumuli refer to cairns or rock piles that were used as graves. This is usually evidenced 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 ca. 69 m2.

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 3.98) in the eastern portion of the site (covering an area of ca. 3328 m2). In addition to there, 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.

Buweirda Springs Survey

Surveyors recorded 18 sites during the survey of Buweirda springs (Table 3.2). Because the area is extensively covered by sand dunes, the sites consisted of artifact scatters located at sand dune margins. Poor visibility and site preservation seems to have been the most influential variable in our ability to locate sites. Thus, it is quite possible that many more sites are covered by the Buweirda sand dunes, some of which are upwards of 10-15 meters high, or have been destroyed by modern farming. The following is a short description of three sites recorded during the survey.

Site 07 was recorded in the northern reaches of the survey area, about 200 meters from one of the springs (Figure 3.99). The site, which measures 1300 square meters, is situated at a margin between many large sand dunes. Again, the site boundaries were measured by a decline in artifact density. Because of obstruction by sand dunes, it is possible that the true site boundaries are quite different from the ones we measured.

The major artifact type found at this site were lithic artifacts. Some of the most impressive finds included blades, end scrapers, and points. In addition to the lithic artifacts, ceramics (mostly from later time periods) and ground stone were collected from the site.

Site 10 is located in the southeast portion of the survey, near the bank of one of the springs. The site is located near the margin of gently sloping sand dunes. Site 10 is one of the largest sites we recorded during the survey, measuring 7500 square meters. The boundaries were measured by a decline in artifact density. However, as with the other sites we recorded, this may be a result of poor visibility because of sand dunes. No architectural features were observed at the site.

The most common type of artifact we collected at site 10 was ceramics. The assemblage appears to be primarily Early Bronze and late Islamic in date, based on our preliminary analysis of the field data. In addition, we collected lithic artifacts and eggshell bead fragments. The most diagnostic lithic artifacts are tabular scrapers, of which we recovered 5 distinct fragments. Many ground stone artifacts were observed in the field, but not collected, suggesting that some kind of processing was taking place at this site.

Based on the artifacts discussed above, Site 10 appears to date initially to the Early Bronze Age. The surrounding environment would have provided many of the natural resources for subsistence. Because no architectural features were observed, it's difficult to say more about the sites' function.

Site 1 dates almost entirely to the Nabatean/Early Roman period, and was recorded in the western portion of the survey area. The size of the artifact scatter, measured by a decline in artifact density, is 1.8 ha. The most striking aspect of this site is the density of pot sherds. The ceramic assemblage is composed of many fragments of Nabataean Fine Painted Ware, jugs and juglets, jars, unguentaria and generally vessels associated with the overland trade of goods.

Conclusions

The intensive pedestrian surveys carried out by the ELRAP team along the Wadi Fidan, Wadi Ghuwayb 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. As shown here, our surveys discovered more than mines. A total of 27 Iron Age sites were recorded in Wadi Fidan during the 1998 and 2004 survey seasons. The three wadis discussed were part of a settlement system that focused on the extraction, processing and distribution copper. A comparison of the results for each wadi catchment is discussed below and presented in Table 1.

Summary of Wadi Fidan

As seen in the distribution of Iron Age sites along the Wadi Fidan (Figure 3.100, Appendix 1), Iron Age settlement function varied significantly compared to the WAJ/WAG catchment. As one of the main western gateways to the Faynan district was the Wadi Fidan, it is interesting that Iron Age settlement in this area was not as intense as it was in early periods. Although many of the sites were dated using small samples of Iron Age sherds, 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). With the exception of the immediate area around Khirbat Faynan, 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. The presence of these sites suggest that small-scale agriculture may have been used to supplement a mostly pastoralist lifestyle. Unlike Wadi al-Jariya and Wadi al-Ghuwayb, the soils of the wadi beds in Wadi Fidan and Wadi Faynan are conducive to agricultural production. Annual flooding and the perennial spring at ‘Ain Fidan would have made seasonal crop production possible.

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. Much of this scant evidence may be a result of the reprocessing of Early Bronze Age slag by Iron Age copper producers at sites like Khirbat Hamrat Ifdan. However, the site of Rujim Hamrat Ifdan, where ELRAP excavations revealed Iron Age copper production, are an important exception (Smith *et al.* 2014b).

Summary of Wadi al-Jariya and Wadi al-Ghuwayb

Seventy-five Iron Age sites were recorded in Wadi al-Jariya and Wadi al-Ghuwayb (Figure 3.101, Appendix 2). Unlike the wadis to the south and southeast, there was no agricultural production in Wadi al-Jariya or Wadi al-Ghuwayb; 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 (Ben-Yosef *et al.* 2014a). Though there is little evidence of permanent settlements in Wadi al-Ghuwayb and Wadi al-Jariya, where the large sites of Khirbat en-Nahas and Khirbat al-Jariya served as major centers of mining, smelting and production, but no evidence of permanent settlement has been uncovered.

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 five kilometers 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 seven kilometers 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 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. That said, mining hammers like those found at Wadi Fidan 004 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 available in Wadi al-Jariya or Wadi al-Ghuwayb, miners would have made them near the source so as to minimize the amount they had to carry.

A total of 36 mine sites with evidence of Iron Age occupation 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.

Another interesting discovery from the Wadi al-Jariya surveys was the presence of eight Iron Age campsites. These sites are some of the only campsites from the Iron Age recorded in Edom. In addition, the numerous architecture features, circular features, rectangular structures, and rock shelters evidence 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.

Summary of Buweirda Springs

The survey results demonstrate that over the last 6000 years the Buweirda springs have been witness to a number of occupation phases (Table 3.2). In particular, early prehistoric sites, represented by lithic scatters at dune margins, were relatively common. Many of the lithics at these sites are high quality flints, and have evidence of heat treatment. There are some indications that many of these sites date to the Pre-Pottery Neolithic, but there were surprisingly few diagnostic artifacts at the sites. Unfortunately, at this point it hasn’t been possible to identify more specific occupation phases at most of these early sites. This may be because these sites were places for the initial processing of lithics, which would explain the high numbers of flakes and debitage. Alternatively, much of the sites could be buried under layers of aeolian sands, and what were finding on the surface is a small sample of something more significant.

During the Early Bronze Age we have evidence for at least one or two sites. However, these occupation phases are clouded, so to speak, by the high frequency of late Islamic ceramics because some Early Bronze ceramics closely resemble, in form, fabric, and color, the ceramics from the late Islamic periods, most likely early Ottoman to be specific. One must consider the possibility that many of these previously recorded sites could actually date to much later periods. Only recently, as archaeologists are putting more of a focus on Middle and Late Islamic ceramic assemblages throughout Jordan, are we beginning to recognize the complex, and often times hyper-regional diversity of Islamic ceramic distributions.

Site 10 is a case in point. A majority of the pottery assemblage from this site is late Islamic in date, with some EB pottery as well. In addition to this EB pottery there were at least 5 tabular scrapers recovered from the site, and a large number of indeterminate lithics. Tabular scrapers are found at sites from the Chalcolithic through the Middle Bronze age, but given their co-occurrence with EB ceramics suggests that there was a definite Early Bronze occupation at the site.

Sites dating to the Early Roman period and later are also well represented in our survey. Based on the high frequency of vessel forms recovered from Site 1, it is probably safe to say that the site was used as a campsite or caravan stop frequented by merchants coming to and from Petra, on their way across the Arabah valley or down to the Red Sea. The spice trade, along with other goods traveling through the Red Sea and through Petra, was an important part of the Nabataean and Roman political economy. Because of the perennial springs and lush plant resources, this would have been an excellent locale for a caravan stop on the north-south route through the Arabah Valley.

Aside from Site 1 described earlier, most of the remaining classical period sites are represented by relatively small pottery scatters at dune margins, with very few other artifact types. These sites, which may be campsites given the sparsity of other features or artifacts, seem to be much later in date, ranging from the late Roman/Byzantine transition and later. Given the sparsity of materials from these sites, it's hard to say much more at this point.

With regards to the sand dunes, since the primary deposition of aeolian terrain during the late Pleistocene/early Holocene, the local terrain has been modified significantly as shifting climate systems have effected the stability of these features. In particular, the redistribution of sands over short, medium, and occasionally long distances would have particular bearing on our ability to find archaeological sites, which, like vegetation, are excellent traps for aeolian sediments. This research has bearing on our understanding of the impact of natural and human induced environmental degradation. Based on our observations of sand dunes and modern farming, these factors pose real and immediate threats to the archaeology of the Buweirda springs.

In the general context of the aims of this dissertation, the survey data described above address how measured changes in settlement patterns and subsistence practices are driven by a number of factors, including the local ecology, regional political economics, and micro-regional social organization. The new data for agro-pastoral subsistence practices and small, ephemeral settlement related to extractive metallurgy shed light on the processes of social change in the marginal physical environments of southern Jordan. In Chapter 4, the environmental impacts of these practices are examined in more detail, focusing on the question of whether mining and smelting resulted in lead and other heavy metal contamination in Wadi Faynan.

Chapter 3 is an edited manuscript (with the exception of the Buweirda springs data) of the material as it appears in Knabb, Kyle A., Jones, Ian W. N., Najjar, Mohammad, Levy, Thomas E. (2014) "Patterns of Iron Age Mining and Settlement in Jordan's Faynan District: The Wadi al-Jariya Survey in Context" in New Insights into the Iron Age Archaeology of Edom, Southern Jordan, Volume 2. Eds. Thomas E. Levy, Mohammad Najjar, Erez Ben-Yosef. Pp. 577-625. The dissertation author was the primary author of this manuscript.

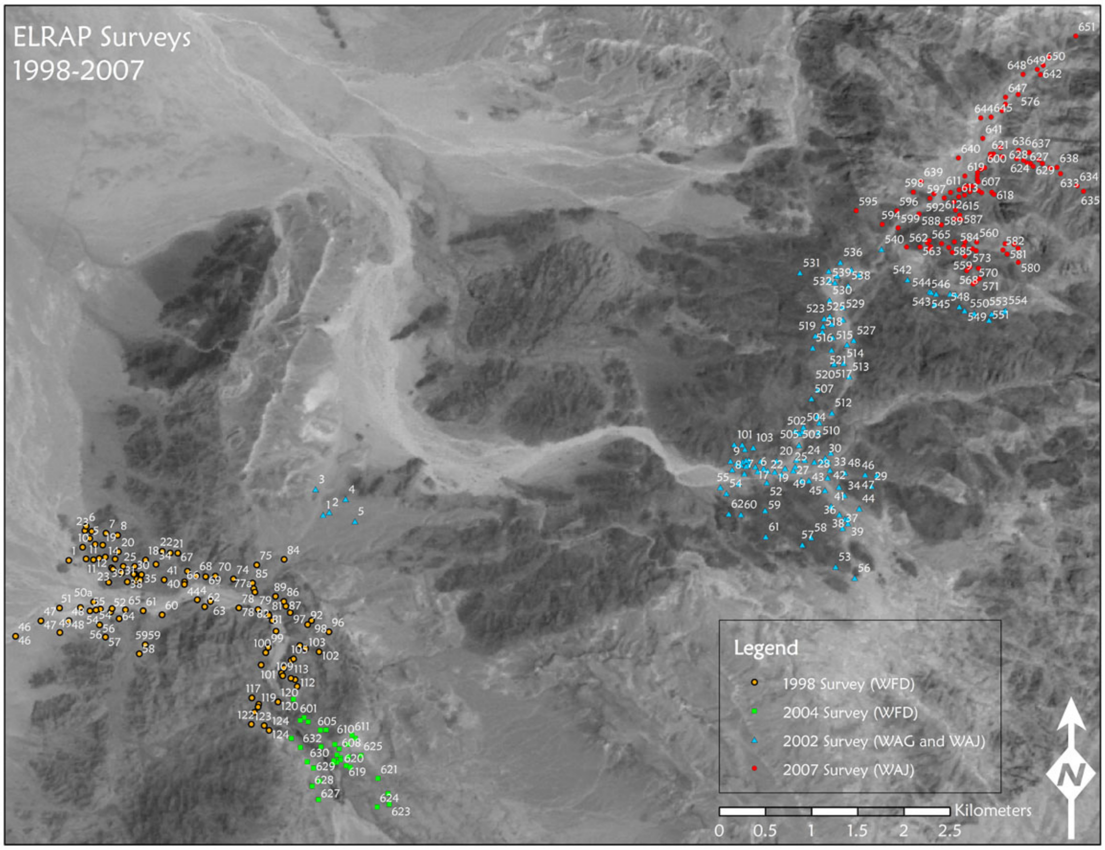


Figure 3.1: Map of all sites recorded during JHF and ELRAP surveys conducted from 1998-2007 (Background image: (C) CNES/SPOT Image 1992-1994).

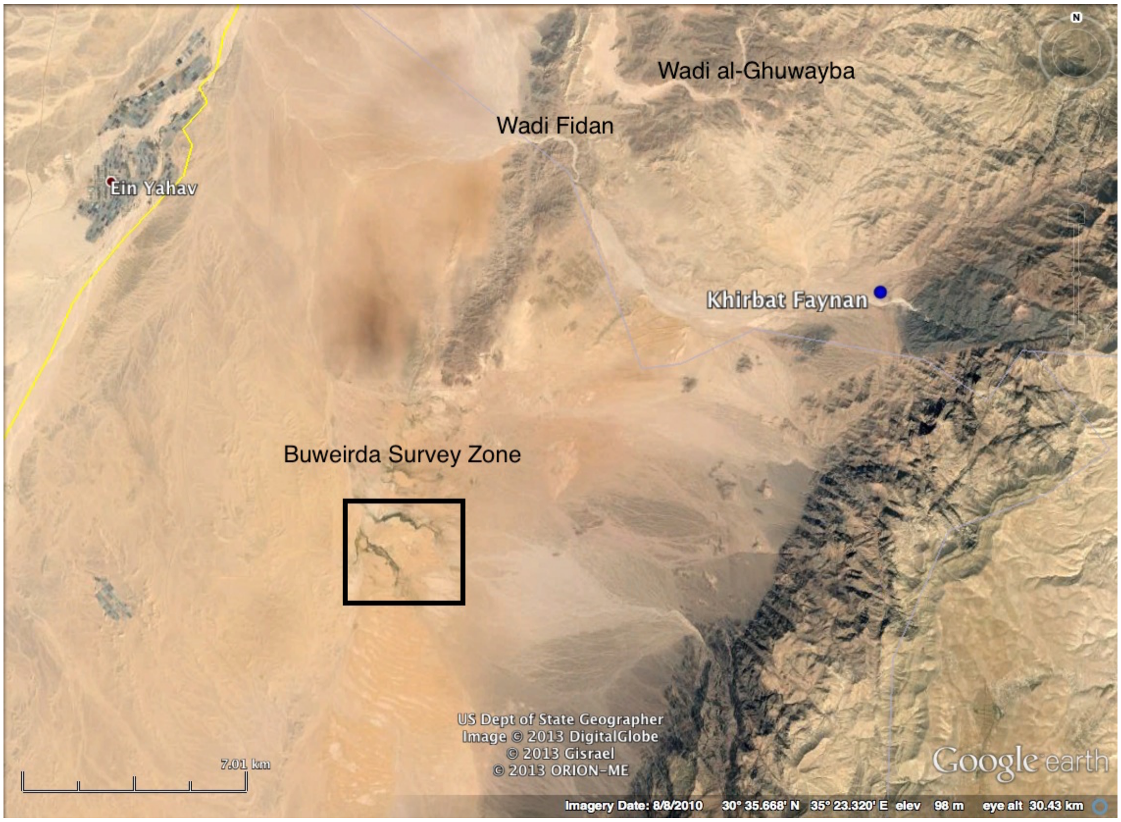


Figure 3.2: Map of Faynan region and Wadi Arabah showing location of Buweirda Springs survey zone.

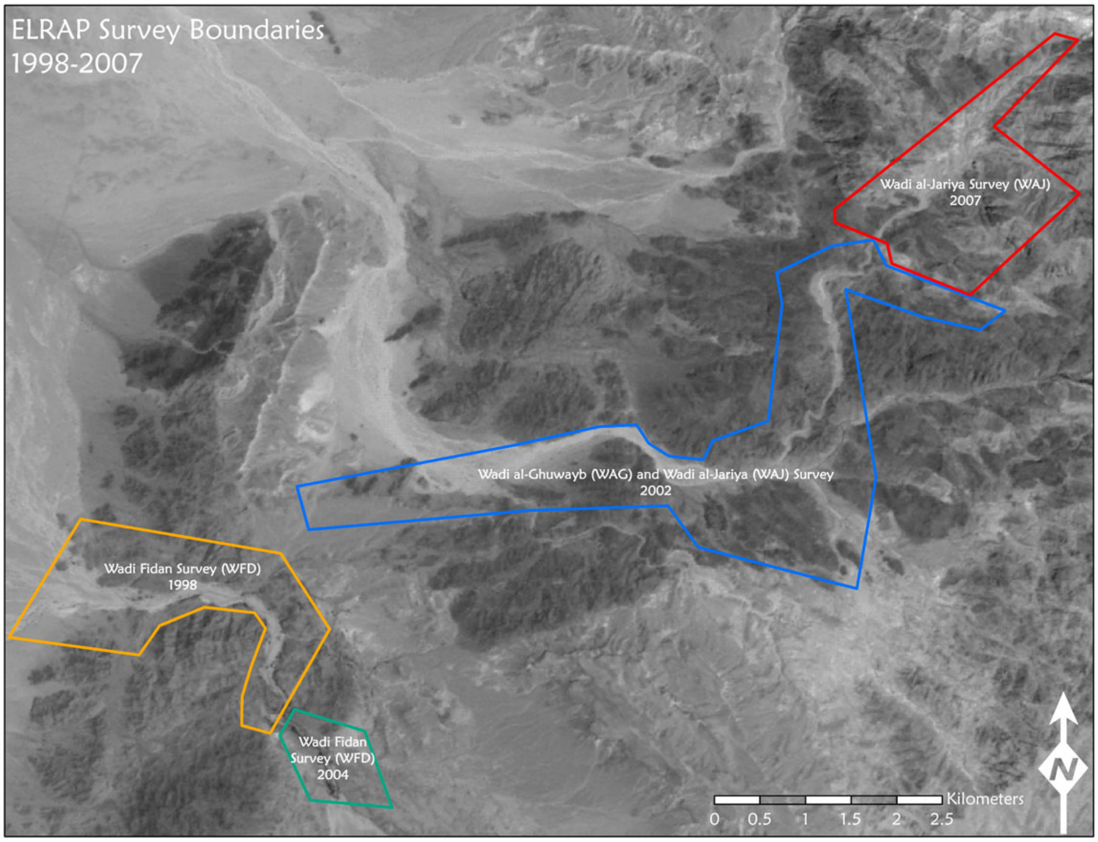


Figure 3.3: Map of the boundaries of all ELRAP surveys conducted from 1998-2007 (Background image: (C) CNES/SPOT Image 1992-1994).

Figure 3.4: Overview of Wadi Fidan. Wadi Arabah in the background.

Figure 3.5: Figure 6.4: Overview of Wadi al-Ghuwayb.

Figure 3.6: Wadi al-Jariya north of Khirbat al-Jariya. The wadi ascends in elevation to the north (left in the picture), bounded by tall sandstone cliffs.

Figure 3.7: Overview of the mixed sand dune – oasis landscape of Buweirda spring zone.

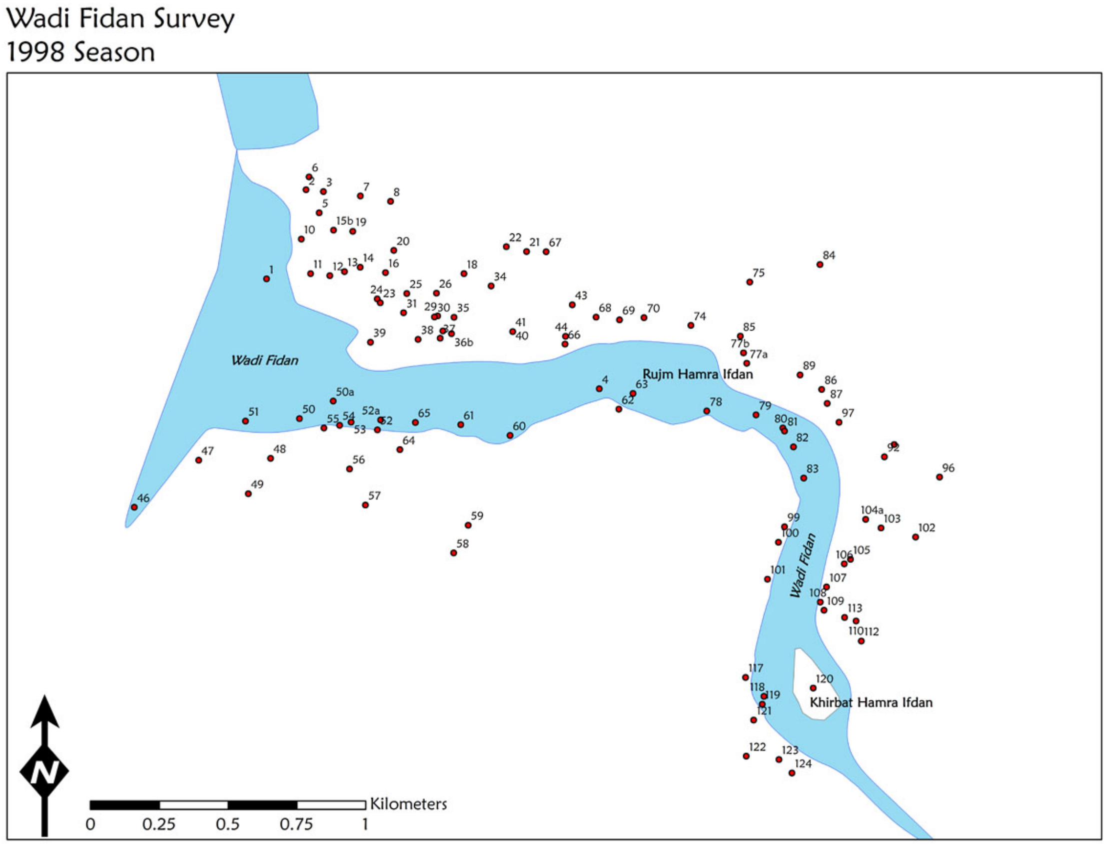


Figure 3.8: Map of all sites recorded during the 1998 Wadi Fidan Survey.

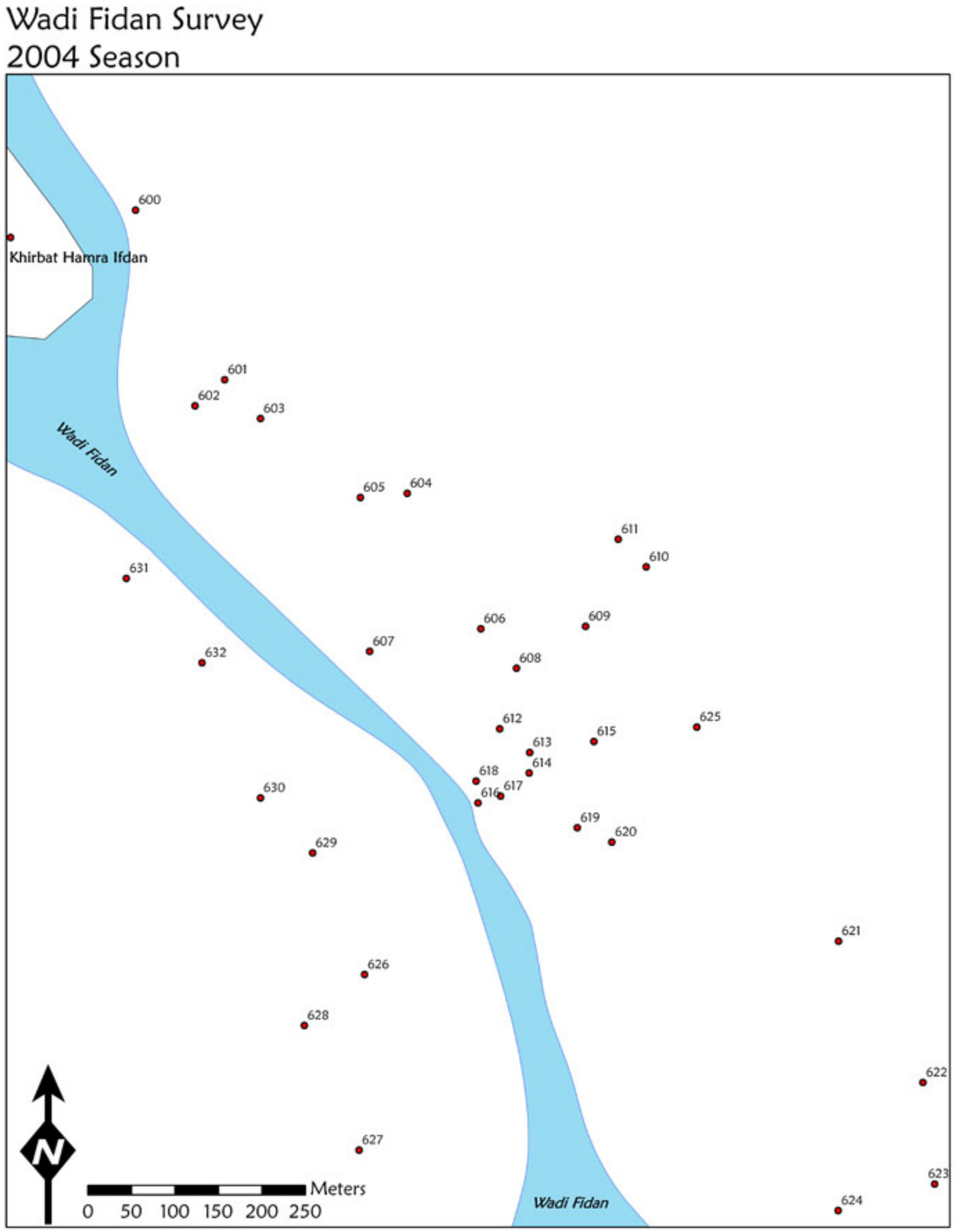


Figure 3.9: Map of all sites recorded during the 2004 Wadi Fidan Survey. The 2004 survey area is located to the southeast of Khirbat Hamra Ifdan.

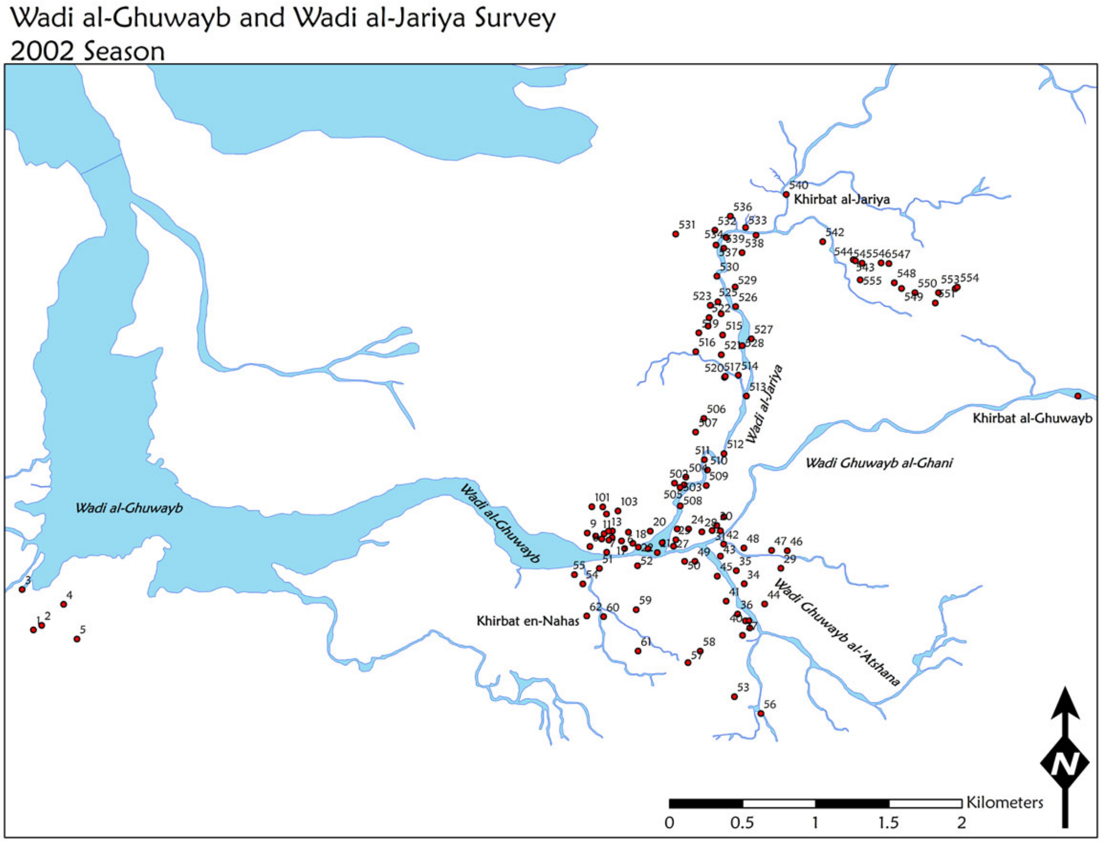


Figure 3.10: Map of all sites recorded during the 2002 Wadi al-Ghuwayb and Wadi al-Jariya Survey.

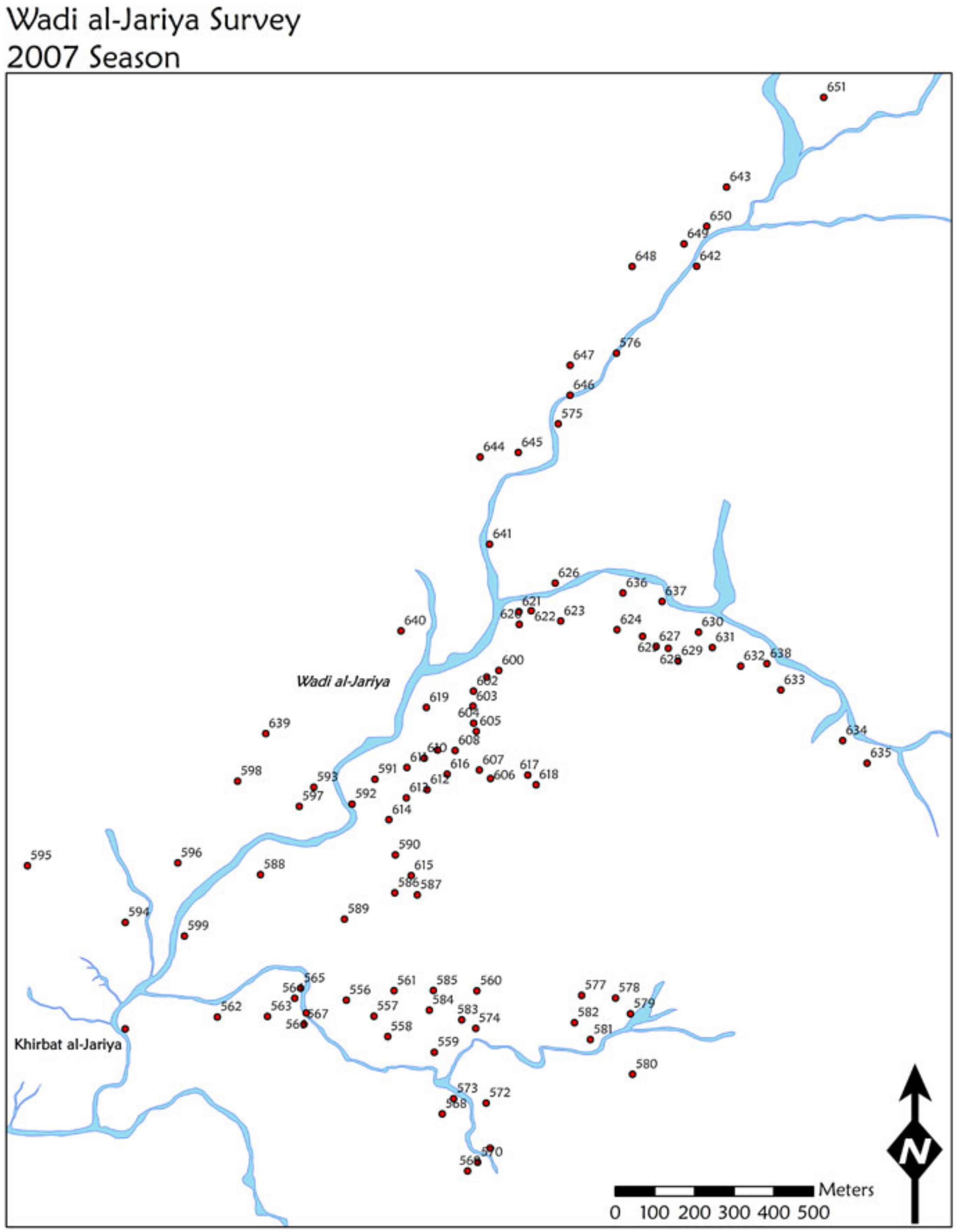


Figure 3.11: Map of all sites recorded during the 2007 Wadi al-Jariya Survey.

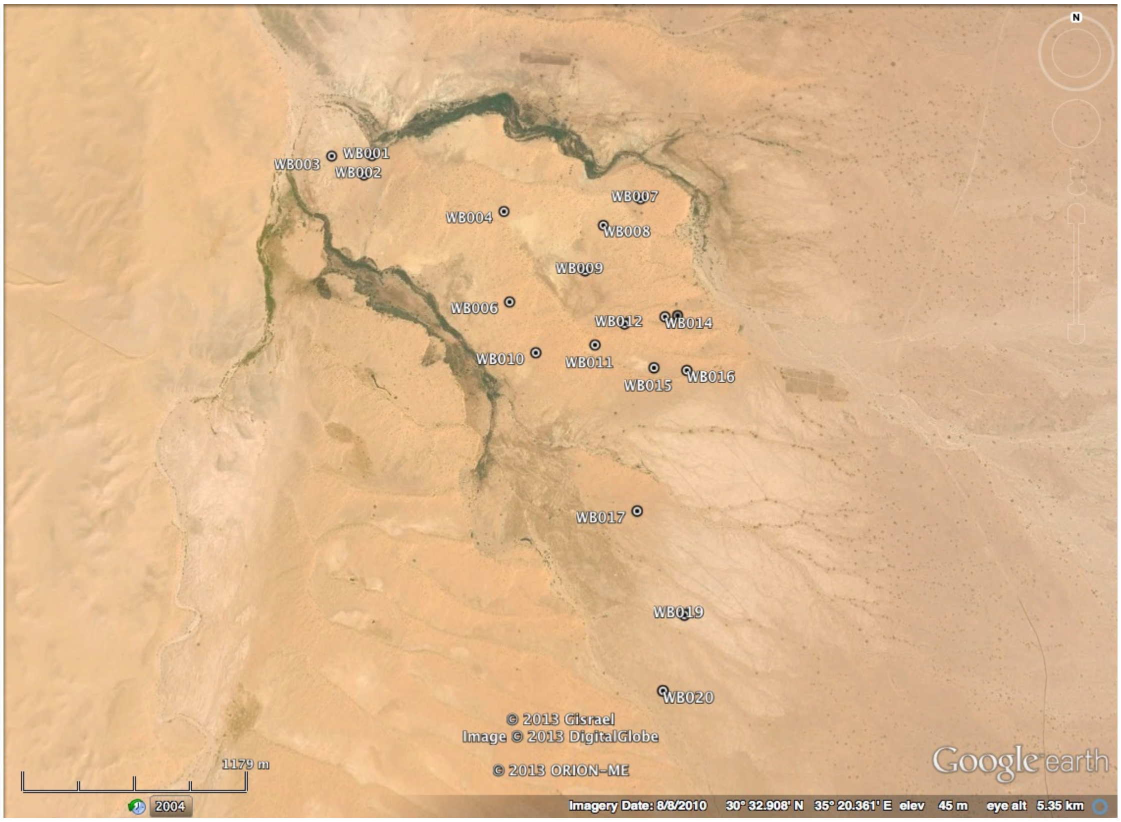


Figure 3.12: Map of all sites recorded during the 2011 Buweirda springs survey.

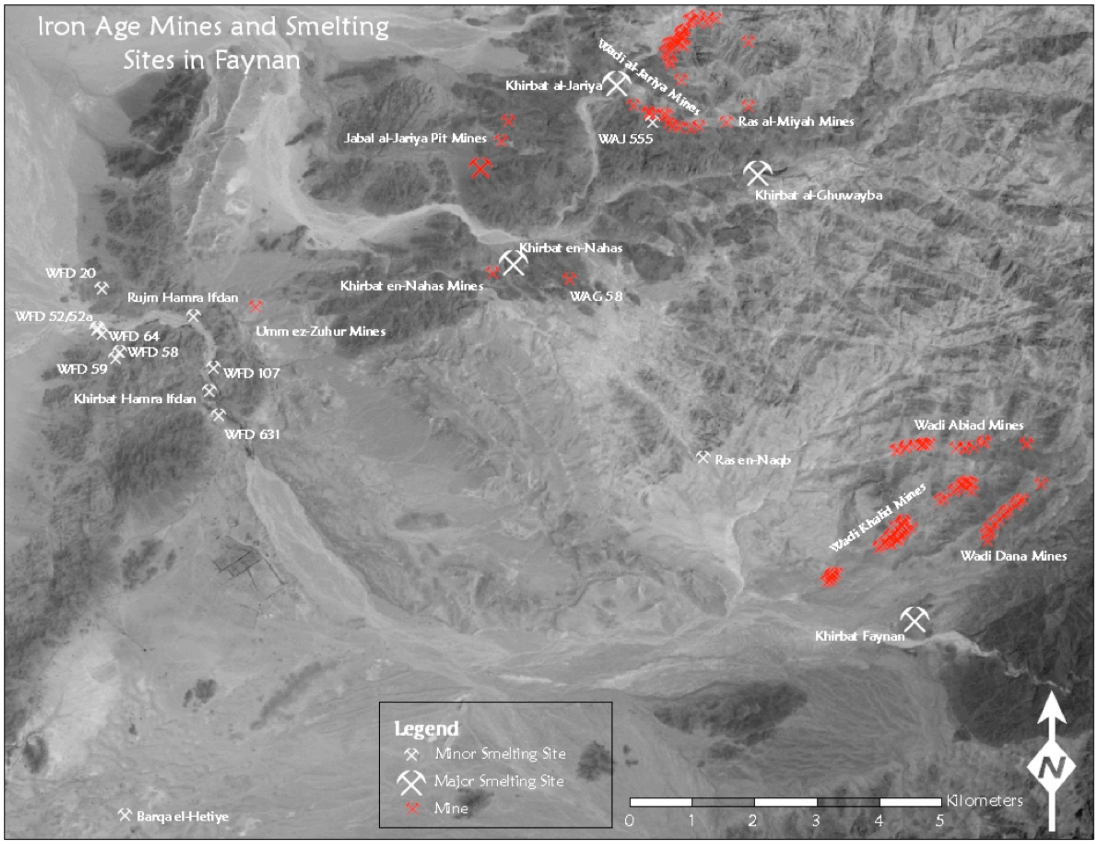


Figure 3.13: Map of all major mining and smelting sites located in the Faynan District (Background image: (C) CNES/SPOT Image 1992-1994).

Figure 3.14: View south at several eroded architecture fragments built of stone against a hillside at WAJ 640.

Figure 3.15: 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 3.16: Circular depression at WAJ 640, now overgrown with Anabasis shrubs.

Figure 3.17: A circular feature incorporating a larger standing stone at WAJ 640.

Figure 3.18: Feature A at WFD 15, a small cairn incorporating a standing stone.

Figure 3.19: Looking north from feature B at WFD 15, a small cairn.


Figure 3.20: The prominent circular feature at the center of WFD 602. A dense concentration of Iron Age pottery was found around this feature.


Figure 3.21: One of several cairns concentrated in the western portion of WAJ 515.

Figure 3.22: One of two short wall lines present in the western part of WAJ 515.

Figure 3.23: A cairn built in a relatively cleared area at WAJ 523.

Figure 3.24: One of the small cairns recorded at WAJ 523.

Figure 3.25: One of the small stone circles found at WAJ 527.

Figure 3.26: 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 3.27: Two of the cairns at WAJ 596, which sits atop a rocky plateau above Wadi al-Jariya.

Figure 3.28: The tent clearing recorded in a field of stones at WAJ 596.

Figure 3.29: The largest of the four cairns found at WAJ 596.

Figure 3.30: The large (ca. 5 m in diameter) circular feature at WAJ 596, constructed primarily of standing stones.

Figure 3.31: The robbed cairns which were found at WAJ 641.

Figure 3.32: The large rectangular feature at the center of WAJ 516, probably a tent clearing.

Figure 3.33: One of the 12 cairns surrounding the large rectangular feature at WAJ 516.

Figure 3.34: 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 3.35: A view of the topography of WAJ 521, also showing one of the eroded cairns found at the site.

Figure 3.36: A view looking south across WAJ 530, highlighting the heavily eroded and ephemeral nature of most of the 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 3.37: A heavily-eroded tent clearing found at WAJ 562.

Figure 3.38: A view of WAJ 565, looking west toward the sandstone cliffs, which 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 3.39: 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-20th century is visible.

Figure 3.40: One of two tent clearings (rectangular) identified at WAJ 588, with its accompanying hearth clearing (circular). In the top of the image, Wadi al-Jariya to the southeast is visible.

Figure 3.41: Two small cairns recorded at WAJ 588.

Figure 3.42: One of the rectangular features at WAJ 593, which was identified as a tent clearing.

Figure 3.43: Several wall lines at WAJ 593, arranged around the central cleared area.


Figure 3.44: Four circular features found at WAJ 595.


Figure 3.45: The tent clearing found in the southeastern part of WAJ 595.

Figure 3.46: The large robbed tumulus near the center of WAJ 595.

Figure 3.47: Looking west over the Wadi ʻArabah from WAJ 595. The site commands views of Wadi al-Ghuwayb, Wadi al-Jariya, and west as far as the ʻArabah.

Figure 3.48: Looking southeast over Wadi al-Jariya from WAJ 595. Khirbat al-Jariya is visible in the center of the photo.

Figure 3.49: Site 604 - small circular fragment recorded during the 2004 survey of the Wadi Fidan, on the northeast bank above the wadi channel.

Figure 3.50: A larger circular feature, pictured here, was also recorded at site 604, on a flat, rock terrace above Wadi Fidan. View is to the east.

Figure 3.51: A single course, partially buried wall line makes up one of the features at site 604. Wadi Fidan can be seen in the background, below the Jabal Hamrat Fidan mountains.

Figure 3.52: One of the circular features recorded at WAG 24, on a terrace above the Wadi al-Ghuwayb, which is visible in the background. Orientation to the north.

Figure 3.53: Another circular feature at WAG 24, in Wadi al-Ghuwayb. Like the previous feature, this one was constructed on a terrace just above the wadi.

Figure 3.54: This circular feature at site WAG 60 has been heavily disturbed by looters. Similar to WAG 24, this feature was constructed on the bank above Wadi al-Ghuwayb.

Figure 3.55: Site WAJ 61, a series of circular features and cairns on a hill above Khirbat an-Nahas. From the terrace the site commands an excellent view of Wadi al-Ghuwayb, Wadi Nqeib Aseimer, and Khirbat an-Nahas.

Figure 3.56: Stone circle at site 514. In the background there is a possible circular feature.

Figure 3.57: One of the circular features recorded at site WAJ 537. Wadi al-Jariya can be seen in the background.

Figure 3.58: Another well-preserved stone circular feature recorded at site WAJ 537.

Figure 3.59: Site 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 three meters perpendicular to the wall, forming a horseshoe shaped feature.

Figure 3.60: A small rock circle feature with a standing stone that is part of site WAJ 575.

Figure 3.61: Overview of site WAJ 582, which is composed of circular features that have been disturbed by bulldozing and erosion.

Figure 3.62: One of the walls recorded at site 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 3.63: Overview of site 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 3.64: One of the installations recorded at site 511. Because of the high amount of copper slag found at the site, it has been classified as serving a metallurgical function.

Figure 3.65: A possible infilled mineshaft at site WAG 58. The site is composed of three infilled mineshafts that are surrounded by tailing piles.

Figure 3.66: Site 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 Resource Authority. For scale, note person standing above the tailing.

Figure 3.67: A close-up of a section of the tailing pile at site WAJ 560 that was exposed during bulldozing by the NRA.

Figure 3.68: A wall at the top of the tailing pile, which may have surrounded a shaft entrance that is now covered with collapse.

Figure 3.69: Site 572 – a light scatter of copper ore and Iron Age ceramics below a collapsed mineshaft opening (see below).

Figure 3.70: Collapsed mineshaft opening at site WAJ 572.

Figure 3.71: Site 577 – a possible mineshaft opening (above the north arrow) that has been filled with rock collapse and sediment.

Figure 3.72: A mine opening at site 578. The opening has been enlarged by a bulldozer. The modern digging stops after about ten meters, after which the mine may open into a gallery or a shaft.

Figure 3.73: Site 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 3.74: A small circular feature in the tailings of site WAJ 587.

Figure 3.75: 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 site WAJ 602. Tailing piles were recorded individually in order to measure their size and have better control over the surface artifacts collected during the survey.

Figure 3.76: 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 3.77: A typical tailing pile at site WAJ 607, in a small tributary on the east side of Wadi al-Jariya. The view is to the west.

Figure 3.78: Small, approximately one meter diameter, circular features found adjacent to the tailing pile at site WAJ 607.

Figure 3.79: Site 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 3.80: A cross-section of the mine tailings at site WAJ 608. The cut (perhaps by the NRA) shows that the tailings are over a meter deep in some areas.

Figure 3.81: A possible mine adit at site WAJ 608. The small feature was eroded from weathering. Note the pencil placed for scale.

Figure 3.82: 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.

Figure 3.83: A large scatter of copper ore at site 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.

Figure 3.84: An open mineshaft at Site WAJ 614. The shaft measured about 1.5 meters in diameter and extended to a depth of ten meters.

Figure 3.85: Site 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 3.86: Copper ore mineralization at site WAJ 615. The ore was easily accessible near the surface of the site, and along the floor of the channel (see previous image).

Figure 3.87: Site 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).

Figure 3.88: The entrance to site WAJ 621. The opening would have been quite large before it was in filled with collapse and sediment.

Figure 3.89: Site 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 3.90: One of the features at site 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 the wadi al-Jariya.

Figure 3.91: This tailing pile at site 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.

Figure 3.92: A small tailing pile at site 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 3.93: A small architecture fragment at site WAJ 626. Late Islamic 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 3.94: Site WAJ 628, a large tailing pile is visible in the background, across the wadi. Construction and bulldozing by the NRA is visible in the foreground, and a modern road runs from the left to the right of the frame.

Figure 3.95: Site WAJ 629 – a large pile of tailings covers the surface of the hill slope. A large, approximately one meter wide, trench has been dug through the tailings. The modern wadi channel of the tributary wadi is visible in the background.

Figure 3.96: Site WAJ 643, view to the south. This rectangular feature is approximately one kilometer north of Ayn 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.

Figure 3.97: 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 meters. They may be related to the campsites the survey team found in the same wadi system.

Figure 3.98: Site WAJ 639 – these tumuli have been robbed. They were built on a terrace on the eastern side of the wadi Jariya. A group of mines can be seeing in the background, below the cliffs which bound the eastern side of the Wadi Jariya.

Figure 3.99: Overview of Buweirda Site 7 showing the site (foreground) at the margin of large sand dunes.

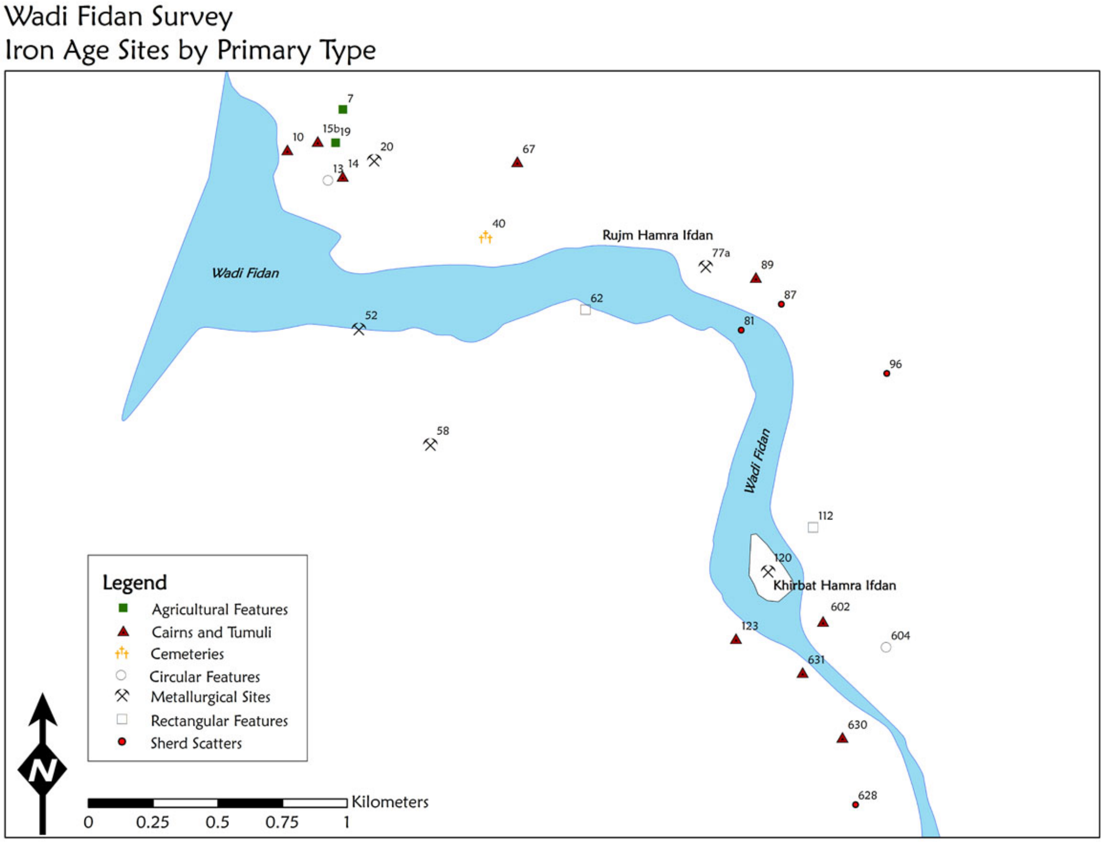


Figure 3.100: Map of Iron Age sites recorded in Wadi Fidan during the 1998 and 2004 surveys.

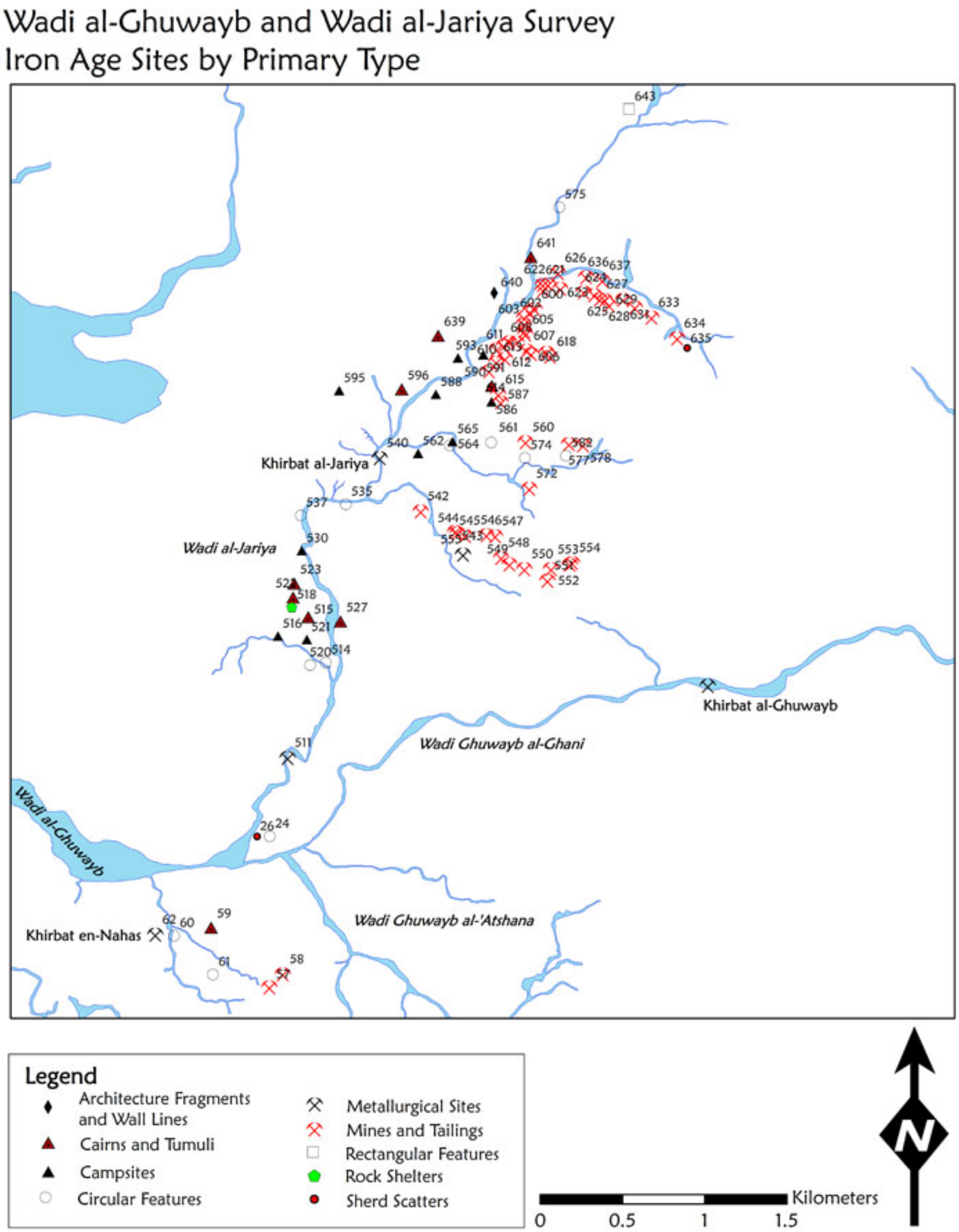


Figure 3.101: Map of Iron Age sites recorded in Wadi al-Ghuwayba and Wadi al-Jariya during the 2002 and 2007 surveys.

Table 3.1: Site frequencies based on site type and location.

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 Feature	2	1
Rock Shelters	-	1
Sherd Scatter	4	2
Tumuli	1	1
Total	26	94

Table 3.2: Buweirda Springs survey sites from 2011 season.

Site no.	North UTM	East UTM	Site Size (m^2)	Periods represented	Site Type
WB001	723267	3383372	18000	Early Roman, Islamic	Artifact scatter, Campsite
WB002	723226	3383253	11000	Neolithic, Roman, Islamic	Lithic scatter (production site?)
WB003	723031	3383365	3100	Prehistoric, Roman/Byzantine	Artifact scatter (pottery and flint tools, debitage)
WB004	724051	3383048	175	Early Bronze	Artifact scatter, possible hearth
WB006	724099	3382509	900	Roman/Byzantine +	Pot Drop
WB007	724843	3383140	1300	Neolithic	Artifact scatter, small settlement
WB008	724629	3382976	1100	unknown	artifact scatter
WB009	724528	3382702	1900	Early Prehistoric	lithic scatter
WB010	724257	3382217	7500	Early Bronze	Artifact scatter, small settlement
WB011	724592	3382269	500	Classical	Sherd scatter
WB012	724758	3382395	600	Classical	Artifact scatter (ceramics and groundstone)
WB013	725060	3382450	1700	Classical	Artifact scatter (ceramics, glass, groundstone)
WB014	724988	3382441	2500	Classical	Artifact scatter (ceramics, glass, groundstone)
WB015	724927	3382144	3500	unknown	Artifact scatter (lithics, ceramics, groundstone)
WB016	725113	3382133	2600	Classical	Artifact scatter (ceramics, lithics, groundstone)
WB017	724839	3381340	2	late Classical +	Pot Drop
WB019	725100	3380786	350	Early Prehistoric	lithic scatter
WB020	724985	3380387	2400	unknown	sherd scatter

Chapter 4: Resource Production and Landscapes of Environmental Change – Investigating Agricultural Systems, Geomorphology and OSL Dating

Introduction

As shown in the previous chapter, settlement patterns in the Faynan region changed significantly in response to the changing political economy of the region. This raises a number of important questions regarding resource production and landscape change in the southern Jordanian research area. In particular, has ancient copper mining and smelting resulted in the spread of significant quantities of heavy metal particles throughout the Faynan valley? This question may seem like one with a straightforward answer, but as discussed in the introductory chapter, understanding environmental change is complicated and requires multidimensional explanations of social and natural phenomena. Specifically, this chapter deals with the issues of how archaeological and geochemical evidence can be misunderstood – or even misused – without proper implementation and interpretation. The implications of whether or not mining and smelting led to the spread of heavy metals include issues of ancient and modern pollution, the consequences for human health and ecosystem stability, and societal collapse and abandonment of the Faynan valley through time.

As Faynan was the center of intensive farming and industrial-scale copper production for over 1600 years, the region is an excellent case study for the evolution of socio-political complexity and environmental degradation. Through time, communities in this marginal zone responded to changing political, economic, and environmental shifts in a number of ways. Their strategies ranged from participation in the 'boom and bust' economics of copper mining (Barker *et al.* 2007b; Knauf 1992; Levy 2009; Levy *et al.* 2008; Levy *et al.* 2014b), to creating small-scale subsistence economies that were based on risk-management, flexibility, and commensalism (Hill 2006; Lev-Tov *et al.* 2011; Porter 2011). In all these cases, human actions, decisions, and choices in the realms of politics, economy, and social life had both intentional and unintentional consequences for the world they inhabited.

The results of previous ancient pollution studies in Faynan (Grattan *et al.* 2002; Grattan *et al.* 2007; Grattan *et al.* 2013; Pyatt *et al.* 2002a; Pyatt *et al.* 1999; Pyatt *et al.* 2000; Pyatt and Grattan 2001; Pyatt *et al.* 2002b; Pyatt *et al.* 2005) have shown that certain areas contain elevated levels of heavy metals, such as lead, copper and manganese. In the amounts reported serious damage to plant and animal life would be expected in the valley's current state. This has also been used as an explanation for the decline of population in the valley during certain historical periods. In the following chapter a critical examination of ancient lead contamination and environmental change is presented that paints a very different picture. Using new data collected from the very same valley, our analysis shows that heavy metals are far less concentrated in areas outside of mining and smelting waste piles, and that by selectively sampling only from these trash heaps the environmental impact of ancient copper production has been greatly exaggerated. The consequences of these premature judgments effect not only how we conceive of the past, in their contribution to the idea that human nature is naturally destructive to the non-human, natural environment, but also may have an impact on the autonomy and treatment of communities currently living in Faynan.

The implications of this research engage theoretical issues of culture-nature relationships, including human responses to environmental change, human impact on the environment, the role of landscapes in structuring and reproducing political economic systems, perceptions of crisis and degradation, and ancient and modern human health. Whereas for the Faynan valley environmental change has often been treated separately from political and economic issues, this chapter will consider the cultural dimensions of environmental change in response to a growing body of literature on the recursive nature of socio-natural systems.

Ancient Environments: Human Adaptations and Human Impacts

The study of human impacts on the environment has become one of the most important areas of study in archaeology, driven by perhaps the most fundamental question in this field – is the evolution of human culture maladaptive? This question has been taken on recently by those in the field of socio-natural studies (Butzer and Endfield 2012; Fisher *et al.* 2009a; Hill 2004; Kohler and Leeuw 2007; van der Leeuw and Redman 2002), whose research has centered on topics of deforestation, erosion, climate change, mass extinction, saltation, and pollution.

Within the broad framework of socio-natural studies, and particularly within the field of archaeology, is the question of the relationship between increasing socio-political complexity and human impacts on the environment (Adams 1965; Butzer 1982; Redman 1999; Sanders *et al.* 1979; Steward 1968; van der Leeuw 1998).

Because human societies require physical resources to develop, subside, and expand, the local ecology is an important factor in understanding how societies changed, and how they changed their environment. Such has been the purview of historical ecology, an approach that seek to understand the changing relationship among human societies, economic pressure, cultural context, and the environment (Balée 1998b; Crumley 1994b). One of the most important developments to come out of this discipline is the way in which the human-environment connection is perceived: that society and nature exist in a state of flux, of non-equilibrium dynamics, and long-term change (Botkin 1990; Turner *et al.* 2003; Vayda and McCay 1975; Zimmerer 1994); and that this relationship is recursive – as human society adapts to the local surroundings, it modifies its environment in the process (Blaikie and Brookfield 1987; Cronon 1995; Descola and Pálsson 1996b; Scoones 1999; van der Leeuw and Redman 2002; Zimmerer 1994). Environmental change cannot be explained in simple cause-and-effect relationships, but must take into account a variety of interrelated socio-natural factors.

One such socio-natural factor is the common form of landscape modification known as "landesque capital," a term originally coined by Brookfield (1984) and later taken up by ecologists and archaeologists (Blaikie and Brookfield 1987; Brookfield 1984, 2001; Fisher 2009; Kirch 1994). Landesque capital is a concept used to identify the manipulation of a landscape for long-term gains in productivity, and can include terraces, irrigation, and other infrastructures that involve labor-saving and other inputs for future production. It allows for further infrastructural improvements from continued occupation of the land, and innovations that lead to further improvements in production (Brookfield 1984). The concept has mostly been applied to agricultural intensification, but could easily be applied to any production system that requires the construction of and maintenance of infrastructural features on the landscape.

An implicit part of most landesque capital landscapes is a degradation time clock that starts ticking once labor is pulled from the system; the stability of the landscapes requires that it is maintained. Thus, abandonment has profound and negative consequences for the landscape. Societal factors causing maintenance to be postponed or withdrawn relate to the perceived value of the landscape and its productivity (Fisher 2009). These factors are culturally contingent and variable through time and place, as are the strategies and techniques for the development of capital infrastructure. As a result, environmental stability may become increasingly reliant on labor, which in turn, may actually promote population growth. In these instances, "population pressure on resources is something that can operate on both sides, contributing to degradation, and aiding management and repair," (Blaikie and Brookfield 1987: 34). Now, rather than understanding degradation as a purely environmental phenomenon, degradation becomes as much a matter of human perception and cognition as it is an unavoidable natural process. Thus, when degradation occurs it is usually the result of neglect of these systems over time. Episodes of degradation can also occur under conditions of colonialism, changes in land tenure or political economic organization, and epidemics (Butzer 1996; Denevan 2001; Dunning *et al.* 2002; Fisher *et al.* 2003; van der Leeuw 1998; Whitmore and

Turner 2001). Consequently, an explanation of the causes of environmental degradation must include the consideration of both political and economic processes as well as purely environmental ones.

A particularly useful concept for understanding the organization of the economy and its relation to environmental change is the economic logic of labortaksing and technotasking, terms coined by Scarborough (2003b) in comparing economic organization and environmental change in the Maya lowlands and highland Mexico. These economic orientations represent unique practices adopted by archaic and modern societies, and explicitly relate how economic practices shaped the natural environment (Scarborough 2003b). At the heart of the distinction between these practices is economic systems that emphasize increasing the productivity of land (labortasking) versus those that attempt to increase the productivity of labor (technotasking) (Bray 1986: 113). Labortasking was originally applied to distinguish small-scale economies in east and southeast Asia from western, technotasking economies, and more recently, Scarborough (2003b, 2009) applied the concept to the economic orientation he observed in Mesoamerica.

Labortasking societies invest in a highly differentiated, highly-skilled workforce, often assigned to members of an extended family or kin group. This specialized workforce may also develop distinctions between manual labor skills and managerial skills. Increases in production are achieved through intensification of productivity and the application of skilled labor (Bray 1986: 134). These economic strategies tend to develop less-centralized economic institutions for organizing the economy than technologically-oriented economic strategies (Scarborough 2009). Overall, labortasking societies tend to develop in contexts where skilled labor is abundant and capital is limited. The investment in skilled labor and the slow, cumulative production of landscape infrastructure is more likely to lead to a more sustainable built environment and a slower rate of landscape change. This of course, depends on the ability of individuals to pass on their knowledge to the next generation of skilled laborers, and if this process is interrupted degradation may occur (Scarborough 2003b: 14).

Technotasking societies substitute technological buffers for skilled labor, and is more common in cases where capital is more abundant than labor (Scarborough 2003b: 14). These societies employ labor-saving technologies requiring less specialized knowledge to produce economies of scale. Increases in production are achieved through expansion of productivity and investment in technological capital, oftentimes with the goal of rapidly exploiting resources necessary for the practice of statecraft (Scarborough 2003b: 13). The capital-intensive nature of this organization promotes economic inequalities (Bray 1986: 115), but not necessarily along kinship lines, as in the case of labortasking societies. Because new technologies are often introduced that require new skills and the reallocation of resources, the built environment is less stable and the landscape experiences a much more rapid rate of change (Scarborough 2003b: 14). Technotasking is the principle economic logic of most modern Western economies and tends to be associated with centralized economic institutions (Bray 1986; Scarborough 2009).

These two models provide new ways for assessing the relationship between economic organization and environmental change in archaic societies. Of course, these economic organizations are not mutually exclusive or static categories, but ends of a spectrum that is constantly changing through time and location. So, for example, labortasking societies may become more exploitative under certain conditions, such as regional political change or under rapid environmental change. And while both modes are likely to construct landesque capital, the process by which this comes about and the knowledge required to create and maintain it is variable, as is the effect on the environment. The economic logic of a society may also affect its resilience and susceptibility to collapse.

Resiliency theory offers a robust way to evaluate the complex mix of data we acquire for environmental change in socio-natural systems (Gunderson and Holling 2002; Redman 2005). It facilitates interdisciplinary analysis by considering the relationship between nature, economies, and institutions at different spatial and temporal scales of operation. Unlike processual-style systems theory, resiliency theory predicts the inevitability of stability and transformation (Redman *et al.* 2009). Resiliency theory and adaptive cycles have been applied in a number of archaeological and other interdisciplinary contexts (Dearing 2008; Holling 2001; Nelson *et al.* 2006; Redman *et al.* 2009; Redman 2005; Redman and Kinzig 2003; Rosen and Rivera-Collazo 2012; Thompson and Turck 2009). This relationship is expressed through the model of adaptive cycles, which reflects changes in three properties of a socio-natural system: the potential available for change, the degree of connectedness between internal controlling variables, and the resilience of the systems. Connectedness can be seen as a measure reflecting the degree of flexibility or rigidity of internal controlling variables and their sensitivity to external variation. Resilience represents a measure of a system's vulnerability to unexpected or unpredictable change.

Adaptive cycles are constituted by four phases (Figure 4.1): the release (Ω) phase, the reorganization (α) phase, the exploitation (r) phase, and the conservation (K) phase (Holling and Gunderson 2002; Redman 2005). In the release phase (Ω), the system of resource accumulation becomes increasingly fragile and is released, or collapses, as a result of external agents such as drought, fire, etc. This leads to the reorganization phase (α), in which resources are reorganized into a new system. Reorganization creates potential for growth, resource accumulation, and storage. Resilience and potential are high in this phase, while low connectedness fosters innovation and experimentation. Reorganization also incorporates residual biocultural structures from previous cycles – solutions to unpredictable shock derived from social memory and past on through mechanisms of cultural transmission. Successful innovations may enter into future reorganization phases if they become a part of the cultural repertoire. Following the reorganization phase is the exploitation phase (r), defined as a period of growth and exploitation, and conditions of increasing potential under which resilience remains relatively high. Because connectedness is low, the system is highly influenced by external variability, as both opportunity for exploitation as well as potential constraints. This leads to the conservation (K) phase, a period of low flexibility and decreasing resilience. As the system becomes increasingly connected, it is less susceptible to outside influences and increasingly rigid and internally predictable. As such, innovation is low and the system becomes increasingly vulnerable to surprises. Eventually, something triggers the end of the K phase and the system experiences crisis and transformation because resilience is so low.

It is well established that the landscapes – both the natural and the built environments – play a significant role in the structuring and reproduction of human cultures. Resiliency theory allows us to make inferences and develop new hypotheses about the patchy and fragmentary archaeological and environmental records. The approach employed here is novel in that it focuses on the political and economic dimensions of environmental change, rather than overly simplified notions of the cause-and-effect relationship between people and their environment. These links are essential to understanding the interconnected relationship we all share with our environment. For the southern Jordan data presented here, resiliency theory provides a model for understanding these relationships without making *a priori* assumptions about environmental degradation, and instead predict both stabilizing and destabilizing effects across spatio-temporal scales of analysis.

Research Background - Environmental Considerations and Previous Research

Environmental Background

Wadi Faynan is located in the Arabah valley, approximately 50 km southeast of the Dead Sea (Figure 4.2, see also Chapter 3). To the east, the foothills rise to the eastern Plateau, which reaches elevations of up to 1600 masl. The Faynan region is dominated by the large, Wadi Faynan alluvial drain age system that is fed by a number of tributary wadis, including Wadi Dana, Wadi Ghuwayr, Wadi Shayqar, Wadi Abiad, and Wadi Khalid. These drainages combine after descending from the mountains to the east and then flow westward through a wide expanse of alluvial and colluvial floodplains that comprise Wadi Faynan. After turning north the drainage becomes Wadi Fidan (see Chapter 3), and then empties into the Wadi Arabah. In ancient times, seasonal rainfall in the eastern mountains eventually drained into the Wadi Faynan catchment to the west. These floodwaters were harvested by ancient farmers who constructed the agricultural terraces that are standing to this day. The Faynan area is also a natural resource zone rich in copper ore (Rabb'a 1994), and for this reason hundreds of copper mines were exploited in the tributary wadis leading to Wadi Faynan. The most prominent settlement feature in this arid region is Khirbat Faynan (Figure 4.3), one of only a few tell sites (i.e. ancient occupation mound) in southern Jordan, where settlement density at this site peaked during the Iron Age and Roman period (Levy *et al.* 2014b). This geography – the combination of floodplains suitable for agriculture and copper ores – provides a unique case study in which to study diachronically the relationship between social complexity and environmental degradation.

Paleoclimates

Paleoclimatic data are particularly important for understanding the geomorphological history of the Faynan region. This is particularly necessary for interpreting the OSL dates, as well as the transport mechanisms behind the spread of ancient pollutants. For the Faynan region, a detailed report of the environmental and geomorphological history was recently published by the Wadi Faynan Landscape Survey (Barker *et al.* 2007b). The relevant climate and environmental data for the late 2nd millennium BCE to the 4th century CE for southern Jordan and neighboring areas are described below.

Today, Wadi Faynan receives less than 100 mm of annual precipitation, so farming is only possible through floodwater and spring water irrigation along wadi basins. Beginning approximately 15km to the east rainfall averages change rapidly as the elevation rises some 1500m – one travels through four environmental zones as the plateau is reached (cf. Levy *et al.* 2014a: 25, Figure 1.14). At these elevations annual rainfall reaches an average of ~350mm, suitable for rain-fed agriculture. However, for farmers working in the modern day Wadi Faynan, perennial springs are the primary source of water for the agricultural crops grown today. This water is transported using plastic pipes and stored in above-ground cisterns lined with plastic. Modern technology and government subsidies have allowed the current residents to grow crops year round without the need to maintain the ancient fields and harvest annual floodwaters. The ancient paleoclimatic records for the Iron Age and Roman period have been reconstructed based on a variety of local and regional case studies, and are described below.

The climate of the southern Levant became increasingly arid at the start of the late Holocene (c. 2000 BCE - present). Rainfall levels, on average, were similar to or less than what they are today. Based on data from the Dead Sea, Migowski et al.

(2006) interpret an arid episode signified by relatively low dead sea levels from c. 1450 – 200 BCE. This is consistent with low lake levels measured at Lake Kinneret (i.e. Sea of Galilee) from c. 2050 – 50 BCE (Hazan *et al.* 2005). However, these data conflict somewhat with the relatively high Dead Sea levels measured between 1500 – 1200 BCE (Frumkin 1997; 1994; Frumkin and Elitzur 2002; 2001; Frumkin *et al.* 1991; Klinger *et al.* 2003). Schilman et al. (2001) also interpret a humid interval between 1550 – 1050 BCE based on marine sediment cores from off the coast of Israel. Other evidence for a wet period around this time has been found at the Nahal Qanah cave in Israel, dating to c. 1250 BCE (Frumkin *et al.* 1999), and in fluvial sequences of northern Jordan, dating to c. 850 BCE (Cordova 2008). So, while the data are somewhat contradictory, it is likely that relatively wetter conditions prevailed around the beginning of the Iron Age.

Following the start of the Iron Age, there seems to have been a long span of relatively arid conditions. Low Dead Sea levels are generally agreed upon from c. 1150 – 350 BCE (Frumkin 1997; 1994; Frumkin and Elitzur 2002; 2001; Frumkin *et al.* 1991; Klinger *et al.* 2003; Migowski *et al.* 2006). Schilman et al. (2001) also suggest an arid period from c. 1050 – 50 BCE based on marine sediments, and Dobowski et al. (2003) interpret arid conditions between c. 1050 – 600 BCE based on the isotopic evidence from Lake Kinneret.

A number of studies have found evidence for a wet period during the start of the Roman period in the southern Levant, sometimes known as the "Roman wet period." Such evidence has been found at the Dead Sea from c. 150 BCE - 150 CE

(Frumkin and Elitzur 2002; Klinger *et al.* 2003; Migowski *et al.* 2006). Dubowski et al. (2003) suggest a humid period at Lake Kinneret from c. 600 BCE - 350 CE, with a peak at c. 50 BCE. Hazan et al. (2005) concur with a rise in lake levels during this time. This wet period seems to have been followed by a long period of aridification and occasional drought (Bar-Matthews and Ayalon 2004; Frumkin *et al.* 2009). By most accounts, these wetter conditions persisted for the rest of the Roman period. These paleoclimate provide an important baseline for understanding the paleoenvironmental background of agricultural and metallurgical production and the environmental effects of these human activities. However, the implications of these highly variable, and sometimes contradictory, climate studies for ancient agricultural production will be an important topic for further study, but are beyond the scope of this dissertation.

Geomorphological History

Sedimentary deposits in the Faynan valley were formed through alluvial, colluvial, and aeolian processes, most originating from within the Faynan escarpment (el-Rishi *et al.* 2007; Hunt *et al.* 2007; McLaren 2004; McLaren *et al.* 2004). Most of the archaeological sites, as well as the agricultural fields, were constructed on the Faynan (late Pleistocene - early Holocene), Dana Wadi (late Holocene), and Tell Loam (late Holocene) members (el-Rishi *et al.* 2007). These deposits are composed of low-energy alluvial and aeolian sediments, including epsilon cross-bedded silts and sandy gravels, well-sorted fine sands, and braided fluvial or wind-blown deposits (Hunt *et al.* 2007).

For the geological context of ancient metallurgy in Faynan, refer to Chapter 3 and Levy *et al.* (Levy *et al.* 2014a).

For the new geoarchaeological analyses presented below, these data provide an important background for understanding the sedimentological history of Wadi Faynan in the context of the analytical techniques described below. This type of sedimentary deposition is ideal for the OSL dating and geochemical analysis described in this chapter because there is a greater likelihood that the sediments were sufficiently exposed to sunlight (required for OSL) and that there has not been significant mixing or turbation of strata (necessary for both techniques). The implications of this research for ancient agriculture and copper production have been described previously (cf. el-Rishi *et al.* 2007; Hunt *et al.* 2007; McLaren 2004; McLaren *et al.* 2004), and beyond the background information they provide for interpreting the analytical techniques described below, are outside the scope of this dissertation.

Previous Fieldwork - Wadi Faynan Field Systems

To date, the most intensive study of the Faynan field systems was conducted by the Wadi Faynan Landscape Survey (WFLS) project (Barker *et al.* 2007b). While the project's broad goals intertwined issues of aridification, landscape, settlement, and pollution (Barker *et al.* 2007c: 18-19), one of the most important outcomes was the systematic investigation of the field systems. The survey was the first systematic work on the ancient Faynan field systems to record and identify their function, development, and relation to other settlements in the Faynan valley (Newson *et al.* 2007: 141). The WFLS project conducted systematic, intensive surface survey at a total of eight field systems (Figure 4.4). In each of these field systems, the surveyors recorded various types of wall features and artifact densities, and collected a sample of pottery from each field for dating. However, in a region like Faynan, where continuous occupation has left behind hundreds of thousands of pottery sherds from mixed time periods, relying on surface ceramics for dating can be problematic. The original research presented here is aimed at addressing this problem.

While many of the field systems may date to as early as the Early Bronze Age, a vast majority of the surface artifacts suggest that the fields were used most intensively during the period of time between the Iron Age and the late Roman period. The largest field system, WF4, contained the largest number of sherds dating to the classical periods. This dating is verified by the presence of many sluices and spillways that are comparable to other classical period sites (e.g. Barker *et al.* 1996; Oleson 2010). Some of these fields have been sampled for the purpose of palynological analysis and to assess stratigraphy (Hunt and El-Rishi 2010). For these reasons, and due to the fact that as of 2011 the Bedouin of Faynan have begun farming in many of the fields in WF4, we decided to conduct excavations of field systems WF442 and WF443.

The field systems on the north bank of Wadi Faynan are structurally different from the large WF4 field system located along the south bank. They tend to be much simpler, and lack sluices, spillways and other complicated water management structures. WF442 and WF443, in particular, seem to be the most likely candidates for Iron Age agricultural fields (Mattingly *et al.* 2007: 283). The wall lines are constructed as simple cross wadi and irregular-shaped fields for catching and distributing floodwaters (Figure 4.5). Due to the presence of many classical period sherds, the surveyors concluded that the Iron Age walls served as terraces for low-intensity runoff farming during the Nabatean and Roman periods (Mattingly *et al.* 2007: 285). Because these fields represent the most likely case of continuous use from the Iron Age through Roman period, we selected them for further study. In addition to having served as agricultural systems, the previous researchers have hypothesized that the terrace systems inadvertently served as traps for ancient lead pollution. Thus, before describing the sampling strategy and results of the original excavations in these field systems carried out for this dissertation, it is important to review the history of pollution research in Faynan.

The History of Pollution Research in Faynan

A prominent theme throughout the much of the previously published research in Wadi Faynan has been related to the issue of ancient pollution. The idea that industrial copper mining and metallurgy has resulted in the spread of pollutants; that pollution led to diminished agricultural yields; that livestock, and even ancient people, were poisoned, have far reaching consequences for understanding ancient and modern populations living in Wadi Faynan. As will be shown in the following analysis, and contrary to the results of previous pollution studies described below, our research has shown that outside of some very specific loci of metallurgical waste the concentrations of heavy metals are far lower than those reported previously, suggesting that we must rethink how we understand environmental degradation and its consequences in southern Jordan.

Various studies performed by Grattan *et al.* (2002; 2007; 2013) and Pyatt *et al.* *(2002a; 1999; 2000; 2001; 2002b; 2005)* have demonstrated elevated levels of heavy metal concentrations in many of the samples they tested. Samples for measuring the heavy metal content of ancient and modern contexts were collected from sedimentary deposits, plant and animal tissues, and osteological remains found throughout the Faynan valley (Table 4.1). Based on these results, they propose a model of metal pollution with significant consequences for the environment and human health: that lead and copper concentrations in many archaeological deposits resulted in an overall reduction in agricultural potential and livestock fertility, as well as human sickness and disease. The biocultural pathways to living organisms have been illustrated for this dissertation in Figure 4.6.

Sedimentary deposits from metallurgical, anthropogenic, and natural contexts have revealed Pb concentrations ranging from expected background levels to upwards of 50,000 ppm. Grattan *et al.* (2007) present the most comprehensive study of sedimentary deposits in the Faynan valley. Sampling from a number of locations in the valley, they demonstrate that there are elevated heavy metal concentrations at sites of metallurgical debris accumulation. These include: the ancient barrage wall (WF5512) – a semi-continuous accumulation of metallurgical debris beginning 1866-1535 BCE; metallurgical debris piles and associated field walls located adjacent to Khirbat Faynan; an ancient mine located in Wadi Khaled; a stratigraphic sequence from the site Tell Wadi Faynan, dating back to 5290-5040 BCE and as recent as the Roman/Byzantine period; and a transect of surface samples along Wadi Faynan, sampling from the wadi bed, from agricultural fields, and from metallurgical debris piles. Cu and Pb concentrations were highest from the metallurgical debris contexts, and lowest from contexts without any trace of smelting or mining. Additional data on heavy metal concentrations in sedimentary deposits were presented by Pyatt *et al.* (1999; 2000) from metallurgical debris deposits adjacent to Khirbat Faynan. The dating of these deposits is uncertain because the authors do not specify their exact location, and Khirbat Faynan is surrounded by debris piles of various ages. Nevertheless, the Cu and Pb concentrations of the metallurgical debris near Khirbat Faynan indicate substantially elevated levels of these elements.

Plant and animal remains were also tested for their heavy metal concentrations. Pb concentrations for these samples reach as high as 1,000 ppm. These samples were collected from a number of locations throughout the valley, and included invertebrates (Pyatt *et al.* 2002a), modern sheep and goat tissue and excrement (Pyatt *et al.* 1999; Pyatt *et al.* 2000; Pyatt *et al.* 2005), and vegetation (Pyatt *et al.* 2000). Invertebrate samples were collected from sites throughout the Faynan valley, in both metallurgical debris contexts, agricultural fields, and control sites away from mining and smelting. Sheep and goat samples were collected from animals that were known to have grazed in the vicinity of Khirbat Faynan. Of course, these animals only spent a part of their lives around metallurgical waste, as they are highly mobile and travel in and out of the valley frequently as a part of their grazing patterns. Vegetation was likewise collected from both metallurgical waste and control contexts. The types of vegetation sampled included short- and long-living species, those that are preferentially grazed, seed producing plants, trees, shrubs, roots, and bulbs.

Osteological remains were examined to test the effects of previously measured heavy metal concentrations on the human inhabitants of Wadi Faynan (Grattan *et al.* 2002; Pyatt *et al.* 2005). The Pb concentrations of human remains are reported to reach nearly 300 ppm. These remains were collected from cemeteries in the Faynan valley adjacent to Khirbat Faynan. Pyatt *et al.* (2005) obtained skeletons dating primarily to the Byzantine period, with one dating to the Bronze Age (specific sub-period unspecified). The remains examined include human femur, cranium, and rib; except for the rib sample, both the outer and inner bone were tested. Grattan *et al.* (2002) analyzed 36 human skeletons from the Byzantine cemetery adjacent to Khirbat Faynan, originally excavated in 1999 (cf. Findlater *et al.* 1998). The specific bones from each skeleton used in the analysis are not stated.

Critique: Issues with the Previous Pollution Data and their Interpretation

As would be expected, it is clear from the work of Grattan, Pyatt, and others that mining and smelting in the Faynan valley resulted in metallurgical deposits with high concentrations of lead and other heavy metals. What is less clear is the extent to which this has spread to the environment beyond the loci of metallurgical production. As Grattan's and Pyatt's studies sampled almost exclusively from contexts where metallurgical waste was discarded, the most accurate conclusion one can draw from these data is that metallurgical debris piles have elevated concentrations of lead and other heavy metals. Data from production contexts are, unfortunately, poorly suited for extrapolating to the rest of the valley, and this inevitably calls into question some of the conclusions that have been drawn regarding the environmental and human health consequences of ancient copper mining and smelting. For the purposes of the new pollution data presented below, two important methodological issues in the previous research must be addressed: first, the discrepancy between Pb concentrations in metallurgical and non-metallurgical contexts; and second, the methodological treatment of ancient bone and metal concentrations.

Regarding the first methodological issue, any sample reported to have an elevated lead concentration is from a locus of metallurgical waste (Table 4.1). Site WF5512 (the barrage wall adjacent to Khirbat Faynan) and the area immediately surrounding it (Sites WF5017, WF1491/5741, WF1491/5741b, and WF5738) are one of the main deposits of mining and smelting debris in the valley. The barrage wall, constructed during the Roman occupation of Faynan, acted as a barrier behind which smelting waste was deposited directly and through erosional processes. The wall was also part of a barrage-pool system created to presumably store water for metallurgical activity (Grattan *et al.* 2013). The other sites in the area are part of a complex of buildings and metallurgical debris that represent large-scale metal production during the Iron Age (Mattingly *et al.* 2007). Basal layers of sites WF5021 and WF5022, approximately 1.5 km west of Khirbat Faynan, date to the late Neolithic period and have been interpreted as locations where the early smelting of copper ores occurred. Thus it is not surprising that elevated lead concentrations were observed from contexts with ash and charcoal, where smelting was likely carried out, while high lead concentrations measured in samples from the upper layers are associated with evidence of Roman period smelting at the site (Grattan *et al.* 2007). Similarly, the primary evidence for high concentrations of lead in Pyatt's investigations comes from samples collected from metallurgical debris piles adjacent to Khirbat Faynan, but without further specification of their location.

What about evidence away from these obvious sources of pollution? In a study conducted by Pyatt *et al.* (2002a), modern-day invertebrates collected from the agricultural fields had similar concentrations of lead as the control samples collected from a site two kilometers away from Khirbat Faynan, while invertebrates collected from the waste piles had twice the concentration of lead. Essentially what this study shows is that the lead concentration of agricultural fields in the Faynan valley do not seem to be more polluted than the control samples where no contamination has occurred. Two additional studies on modern vegetation in Faynan are similarly unclear, as samples were only collected from plants growing amongst waste piles and from 'control' contexts outside of the valley (Pyatt *et al.* 1999; Pyatt *et al.* 2000). Logically, what these studies show is that plants growing on metallurgical waste will take up lead and other heavy metal ions as a part of their regular biological processes, because no samples were collected from vegetation in growing in the Faynan valley away from the metallurgical waste. The data cannot, however, be used to extrapolate beyond this narrow context with much certainty, and given the results of the invertebrate study it seems likely that plants growing under normal circumstances would not display higher lead concentrations than what was measured in the control. Unfortunately we simply do not have this information.

Regarding the second methodological issue, the evidence from previously analyzed human and animal remains appears to indicate that lead and other heavy metals made their way up to higher trophic levels (Grattan *et al.* 2002; Pyatt *et al.* 1999; Pyatt *et al.* 2000; Pyatt *et al.* 2005). The results indicate significantly elevated levels of lead and copper in ancient human bones, and in the bones and teeth of ancient and modern sheep and goat. Furthermore, to demonstrate that these metal concentrations did not come from the surrounding sediment, Pyatt *et al.* (2005) measured both the bones and surrounding sediments (Table 4.1). However, even with this added element of control there are some issues with these data – namely, that the authors did not account for processes of diagenetic uptake, i.e. the process of post-depositional accumulation of elements in the environment. What this means for the previous analyses described above is that to demonstrate bioaccumulation one must eliminate the possibility of diagenetic processes, which requires more than comparisons of bone concentration to soil concentration (Pike and Richards 2002). A complete understanding of the geochemistry of the element, how it interacts with the soil and bone, and transport mechanisms (such as water) are required before preliminary conclusions can be made. For a complete description of the issue of diagenetic uptake in human skeletons see Pike and Richards (2002), as further discussion would be beyond the scope of this dissertation.

To sum up, our understanding of the history of environmental pollution in the Faynan valley is partial at best. Previous studies have primarily targeted contexts from which pollution is known to have occurred: mine tailings and smelting debris piles. The locus of human activity extends far beyond these small areas, and a complete understanding of the pollution history requires that we examine more. Environmental crises cannot be explained by simple cause-and-effect relationships. The work described below attempts to build on previous work in Faynan to extend our knowledge about the causes of environmental change and the relationship between human decision-making and its material effects in the local biosphere.

New Research and Analytical Methods for the Study of Ancient Pollution in Faynan

Field Methods

WF442 and WF443 are neither the largest nor the densest field systems in Wadi Faynan. They were selected for investigation because of the high probability that they might date to the Iron Age and Roman periods, the most intensive periods of agricultural production and copper metallurgy. Their construction is more irregular and open than the field walls of WF4, which is believed to have been used most intensively during Roman period and later. The WF442 and WF443 field systems were constructed on a layer of mixed alluvial and aeolian sediment that sits on an ancient wadi bed. For this doctoral dissertation research, ten soundings were conducted in the WF442 and WF443 fields systems on the north bank of Wadi Faynan during the fall of 2011: five units in WF442 and five units in WF443 (Figure 4.7).

Excavations revealed that the mixed aeolian/alluvial sediments mostly rest on ancient alluvial layers that probably represent the ancient wadi beds on which agricultural fields were built. The soundings are the first systematic excavations of ancient agricultural fields in the Faynan region.

Each of the ten excavation units were 2x1 m with the exception of Unit 7, which was extended to 3.5x1 m to accommodate the depth of the excavation. Units were spread across the two field systems under investigation, and placed either bisecting or adjacent to a field wall visible on the surface, or in the middle of a field and not near a wall. The purpose of this was to determine the depth of walls visible on the surface, and if there were any noticeable differences between sediments upstream or downstream of the terrace walls. All units were excavated until sterile soil was reached. Sterile soil was indicated by sandy, reddish brown conglomerate with numerous clasts that predates farming in the region. These are fluvial deposits and may reflect ancient wadi beds. In general, the deposits above the sterile layers were fairly homogenous - light yellowish brown sandy silts with moderate to high compaction. During the excavations we recorded soil characteristics, such as composition, color, and compactness. One hundred percent of all sediment excavated from these test trenches was screened using a 1/4 inch sieve, and all artifacts were recorded and collected. As there was a paucity of material culture found in these test excavations, one of the biggest challenges was to date the ancient agricultural terrace systems.

Luminescence Dating of Ancient Agricultural Fields

Dating ancient terrace systems is extremely difficult because, as noted above, most have not been sampled with excavation. Furthermore, the complex history of deposition, erosion, and uncertainty inherent in dating techniques makes it nearly impossible to precisely date the actual use of agricultural fields. Techniques such as radiocarbon dating, luminescence dating, etc. are not "magic bullets," and should never be treated as such. That said, the application of Optically Stimulated Luminescence (OSL) dating (Avni *et al.* 2012; Davidovich *et al.* 2012; Porat *et al.* 2006) outlined here reflect the age of the sedimentary layers that have been analyzed for pollution. While it is unlikely that the data will allow us to identify periods when the fields were being used, the dates allow us to estimate the time of deposition. This dating also contributes to our understanding of the developmental history of the agricultural systems and their link to ancient mining. When there is an absence of material culture and datable organic remains associated with terrace walls, OSL is perhaps the best solution for dating these ancient farming systems.

Luminescence dating is the only way to directly date minerals like quartz and feldspar, which are found in abundance in the Wadi Faynan sediments. OSL measures the last time sediments containing these minerals were exposed to sunlight. This technique relies on the physical principle that many minerals on earth exhibit luminescence properties that directly relate to the amount of time since the minerals were heated or exposed to sunlight (Aitken 1989). For OSL dating of archaeological sediments, quartz is generally preferred over feldspar (Feathers 1996; Wintle 2008b). OSL dating has been successfully applied to a variety of archaeological contexts (Avni *et al.* 2012; Bishop *et al.* 2004; Davidovich *et al.* 2012; Rittenour 2008; Vafiadou *et al.* 2007). Recently, OSL dating has been used to measure samples as young as 100 years, and as far back as many hundreds of thousands of years (Duller 2004; Wintle 2008a). This wide range has made it an important dating method for understanding the chronology of the spread of modern humans (Cochrane et al. 2013), and for paleoclimate and geology research of the quaternary (Rittenour 2008; Singhvi and Porat 2008; Stone 2013). Additionally, breakthroughs in LED light sources and equipment for measuring multiple samples at once have significantly reduced the price of OSL dating. Unlike radiocarbon dating, luminescence dating does not require complex calibrations to be converted to calendar years and uses materials that are relatively more ubiquitous.

The samples collected from Wadi Faynan for this study are aeolian and low-energy fluvial deposits, and like sediments associated with wadi systems in Israel that have been the subject of OSL investigation (cf. Avni *et al.* 2012), are ideal because these deposits are most likely to have been bleached completely prior to their deposition. We collected OSL samples from each excavated unit. Because OSL samples are light sensitive, they were collected in the early morning before direct sunlight hit the excavation surface (Figure 4.8). A thin layer of sediment was excavated from the sidewall to remove potentially contaminated particles. The samples were collected by hammering opaque PVC pipe horizontally into the sidewall of the unit within each stratigraphic layer. Each end of the pipe was packed with newspaper, wrapped in tin foil and then duct tape to prevent the sediment from shifting and to keep out light. In total, nine samples were submitted to the University of Utah for OSL dating from four excavation units. These OSL dates provide important chronological constraints for the analysis of ancient pollution that would not otherwise be possible through the analysis of surface artifacts.

Geochemical Investigations

Geochemical analysis was carried out to determine the degree of pollution from nearby copper smelting activities. To address the problem of sampling from known ancient copper production contexts that characterizes the earlier ancient pollution studies in Faynan, this study focused on sampling agricultural field systems located at some distance from the production contexts. The geochemical analysis was done in collaboration with Prof. Yigal Erel of the Earth Sciences Institute at the Hebrew University in Jerusalem, where I spent approximately two months working closely with Prof. Erel and his laboratory staff learning the required procedures and completing the geochemical analysis. An important consideration in the proposed pollution tests is to know when and under what conditions the samples were deposited. Two methods will be applied to the samples prior to geochemical testing - granulometry and particle size analysis. These physical analyses are good indicators of the local depositional environment.

To determine the degree of pollution in the agricultural fields, we analyzed the chemical composition and isotopic concentration of the sediments using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) for trace and major metal analysis (Erel and Torrent 2010). As mentioned in the previous section, two of the primary indicators of pollution from copper smelting in Faynan are lead and copper (Grattan *et al.* 2007; Grattan *et al.* 2013). Our new pollution study also tested for other known pollutants (e.g. arsenic, bromine, mercury).

Soil samples were prepared for ICP-MS following standard protocol. Samples were sieved through a 125μm screen using the wet-screen method and double distilled water (DDW), lightly crushed, and homogenized. An aliquot of 0.1g of each of the soil samples was completely dissolved (total digestion) in Teflon beakers in a mixture of ultra pure concentrated HF, HNO3, and HClO4. One ml HNO3 was added to the sample and diluted 1:50 in DDW and stored in 50ml plastic tubes. Sample aliquots were prepared for ICP analysis at a dilution of 1:1000. By processing the samples in this way we were able to measure the elemental concentration of the most mobile (i.e. most likely to spread pollution) fraction of sediments in the Wadi Faynan agricultural fields. These results are presented below.

Results of the Study

Excavation and Geochemical Results

Few subsurface artifacts were found during the excavation of the ancient agricultural fields, and most came from the upper 20 cm or were collected from the surface (cf. Newson *et al.* 2007). This is surprising given the relatively high density of artifacts collected from the surface by previous projects. Soil samples were also poor in macro-botanical remains, though future phytolith analysis may reveal more evidence of the crops being grown in antiquity.

ICP-MS analysis of fully digested sediment samples revealed that few samples exhibited any significant levels of heavy metal pollution, and those that did reflect only a small amount of lead enrichment. These results are contrary to what is predicted by the previous model of environmental pollution described above (cf. Table 4.1). Instead, our new data reflect sporadic indications of elevated heavy metals in certain locations and depths below the surface (Table 4.2), and do not bare relation to distance from source (Figure 4.9), suggesting that a new model for the spread of heavy metals is required – one that incorporates natural and cultural, as well as pre- and post-abandonment variables to understand how copper and lead were released into the environment.

The results presented in Table 4.2 show that elevated concentrations of Pb and Cu were measured in most of the samples. However, elevated concentrations alone are not an indication of an anthropogenic origin, and therefore not very meaningful. As natural variations in the abundance of minerals have an important effect on the concentrations of elements in the deposit, we must normalize the total Pb concentration to an element without an anthropogenic contribution, most commonly Al. Generally an enrichment factor (EF) greater than five is an indication of anthropogenic origin, while any value below five may be of natural origin. All samples contain excess Ca, which reflect the higher proportions of carbonates in the sediments. When correcting for that (by normalizing to Ca, instead of Al), most EF values converge to ~ 1. In general it seems that trenches 6 and 7 are slightly polluted with Pb, and the rest are not (Table 4.3). The rest (with the exception of 9 and 10) are polluted only with Cu. The majority of the samples are not polluted by any other metal.

Trench 2 is the closest to the Khirbat Faynan slag piles and the Wadi Dana (Figure 4.7). Based on our excavations, it appears that the terrace has been mostly eroded out by Wadi Dana. Excavations here were entirely sterile, and the sediment is characteristic of other sterile soils from the sterile, basal layers of other excavation units – poorly sorted, light reddish brown medium and coarse sand. As such, these data can only inform us on the spread of metals in the relatively modern water courses following the abandonment of the fields for agricultural purposes, and in this case they indicate that only minimal anthropogenic pollution is found in this part of Wadi Dana, despite its close proximity to the slag piles. Though copper and lead concentrations are high (Cu 81 ppm, Pb 57 ppm), the EF for both elements is low (Cu=3.6, Pb=2.1, see Table 4.2 and Table 4.3).

Trench 3 is located in the center of the WF443 field system (Figure 4.7). The unit abuts a terrace wall visible on the surface, whose foundation was found approximately 30 cm below the surface. A small quantity of pot sherds, slag, and lithics were recovered in the first 20cm of excavation. Sterile soil was reached at a depth of approximately 70cm. The sediments above the sterile layer, light yellowish brown silty sands, appear to be fill from agricultural terracing. The top two layers of Trench 3, from 0-40cm below the surface, are enriched in Cu only, with an EF of 11 at the top layer (0-20cm) and 8.3 below (Table 4.2 and Table 4.3). These values may reflect the recent accumulation of metals from weathering, or it may also be the case that these layers were originally buried sometime in antiquity, and since then erosion and deflation have worn away the original top soils. We found evidence for deflation in the adjacent WF442 field system, in the form of plow marks on partially buried surface rocks (Figure 4.10), and similar weathering may have occurred at WF443.

Trench 4 was located in the center of the WF443 field system (Figure 4.7), abutting a field wall visible on the surface that appears to be collapsed, as large rocks likely used in the construction are strewn about below the upper-most course. In addition, numerous smaller rocks up to 25cm in size have accumulated behind the wall, and may be related to collapse or wall support. Sterile soil was reached at a depth of approximately 70cm. The soils above this appear to be fill related to agricultural terracing. The sediments are light yellowish brown silty sands, and very compact. Only the uppermost layer, 0-20cm, is enriched with Cu, with an EF of 3 (Table 4.2 and Table 4.3). As with trench 3, these values may reflect recent accumulations of enriched windblown sediments, but this is difficult to determine with certainty.

Trench 5 is the westernmost excavation unit in WF443 (Figure 4.7). The unit abuts a field wall visible on the surface, which does not appear to extend below one course. The upper 40cm of this unit were very rocky, with stones up to 25cm in size, possibly reflecting the remains of a collapsed wall. Sterile soil was reached at a depth of approximately 40cm. The agricultural fills above the sterile layer are similar to those excavated in other units: light brown silty sands. Unlike the other units in this field system, however, buried sediments in this trench are enriched with Cu at the 20-40 cm level (EF = 12). Pb enrichment at this level is negligible (EF = 1.7). It is possible that this unit is located within a part of the fields that experienced less deflation/erosion than other units further east. Additionally, this unit is much farther from the metallurgical debris piles, a likely source of recent windblown sediments enriched with Cu and Pb.

Trench 6 is located in the eastern portion of the WF442 field system, in the middle of a field and not adjacent to a wall (Figure 4.7). Sediments here were quite deep, reaching approximately 95 cm at the basal layer just above sterile soil. The uppermost stratum is composed of light brown silt with soft compaction to a depth of 8-37cm. This is likely related to recent plowing we identified based on furrows visible on the surface. Below this stratum the soil becomes a medium brown sandy silt that is significantly more compacted. This stratum was excavated down to sterile soil. Every layer is enriched with Cu, which increases with depth below the surface and peaks at the 60-80cm level with an EF of 35. This is also the only enriched with Pb (EF = 3.7) (Table 4.2 and Table 4.3). The high EFs of these elements and their co-occurrence in the same stratum strongly suggests an anthropogenic origin.

Trench 7 was placed across a field wall in WF442 and was one of the deepest units excavated, approximately 150 cm in depth before reaching sterile soil (Figure 4.7). We discovered evidence for the long-term and repeated use of the field systems in Trench 7 (Figure 4.11). This unit was positioned across a field wall visible on the surface. As with most of the other surface walls, this one was no more than 1-2 courses tall. However, approximately one half meter below the surface we uncovered another terrace wall that was preserved to a height of 6-7 courses (i.e. just over one meter).

Interestingly, this wall is not located underneath the surface wall, and has a very different orientation. A majority of the sediments in this unit are characterized as light reddish brown sandy silt. A generalized trend of fining upward was noticed during excavation - with basal sediments trending toward sand or silty sand, and upper layers containing more silt and clay. As with trench 6, there has been recent plowing on the surface of this unit east of the surface wall, which created the furrows identifiable in the profile. This unit also contained the highest levels of pollution out of all ten excavation trenches (Table 4.2 and Table 4.3). Each level is enriched with Cu, which increases with depth below the surface and peaks at the 100-120cm level. Pb enrichment occurs only in the bottom three levels, between 100-150cm below the surface. The peak EF for both Cu and Pb coincide at the 100-120 cm level (Cu=28, Pb=4), suggesting an anthropogenic origin.

Trench 8, located in the center of the WF442 field system, was a shallow unit in which sterile soil was reached at approximately 20 cm (Figure 4.7). The lack of depth may be an indication of soil deflation in this area, which is also confirmed by a number of large rocks visible on the surface with plow marks. The excavated fill from the level above sterile soil is composed of light brown clayey silt with firm compaction. The upper 20 cm contain no evidence of anthropogenic pollution, whereas the 20-30 cm layer (i.e. sterile soil) is enriched with Cu (EF=13) (Table 4.2 and Table 4.3). So far this is the only measurement from the sterile soil layers interpreted as ancient wadi beds with evidence of enrichment of Cu or Pb.

Trench 9 was placed in the eastern portion of the WF442 field system, abutting a wall visible on the surface (Figure 4.7). Like many other units this field wall did not extend below the first course. The agricultural soils in the upper stratum are composed of light brown sandy clays with gravel and small cobble inclusions. Approximately 50cm below the surface the sediment changes to large cobbles firmly cemented together with highly compacted sediments. The excavations here were completely sterile, and analysis of the sediments revealed no evidence for anthropogenic pollution (Table 4.2 and Table 4.3).

Trench 10 was located in the southeast portion of the WF442 field system, just above the banks of Wadi Faynan (Figure 4.7). A terrace wall, approximately 5-6 courses and 1m in height, separates the agricultural fill from the wadi. These units were the farthest from the hypothesized source of pollution, at the western end of the WF442 fields. Trench 10 was the deepest excavated, at 180 cm before reaching sterile soil. The sediments are composed primarily of light brown sandy silt, and have an overall trend of fining upward: light brown clayey sand at the basal layers and brown sandy clay at the surface. Two lenses of gravel and small cobbles up to 10cm were observed at approximately 50cm and 120 cm below the surface, and are a maximum of 20cm deep. These excavations were completely sterile, as with trench 9, and we found no evidence for anthropogenic pollution in the geochemical analysis (Table 4.2 and Table 4.3).

Overall these results demonstrate that the ancient agricultural fields adjacent to copper production areas were not significantly affected by lead and copper metal contamination. A new model for ancient pollution is presented following the presentation of the OSL results below.

OSL Results

The preliminary OSL ages are presented in Table 4.4. The table also shows the grain size of the measured grains, the dose rate (Gy), and the preliminary equivalent dose (De). OSL dates range from 6.8 to 2.5ka, and confirm that the terraces originally formed during the mid-late Holocene. All of the dates are in stratigraphic order and within the expected range for the formation of the field systems given our understanding of the development and use of the fields. The ages also conform to the general chronology based on the systematic surface collections in fields WF442 and WF443, which dated the fields to the Iron Age and Roman period, with some possible early use during the Early Bronze Age (cf. Newson *et al.* 2007).

Discussion of the Results and a Revised Pollution Model

The preliminary results of OSL dating permit us to place chronological constraints on the deposition of anthropogenic lead in the agricultural fields. Trench 3 has an upper limit of 800-200 BCE based on the OSL measurement taken at 25cm below surface (Figure 4.12, Table 4.4). This would put the most recent accumulation of sediment between the late Iron Age and the Early Roman period. The lower measurement of 2900-700 BCE, taken at 62cm below surface, falls within the Early Bronze II - late Iron Age. Overall Pb enrichment in this excavation unit was low and do not indicate anthropogenic addition during any of the periods currently under investigation.

Dates from Trench 6 are conspicuously older than expected (Figure 4.13), particularly compared to the dates from nearby Trench 7. As such, discussion of these dates is pending more thorough analysis of the data. It is worth pointing out, however, that no matter what the results are this excavation unit revealed no anthropogenic contribution of lead above 60cm, and minor enrichment between 60-96cm. The EF of 3.7 at 60-80cm stands out as the most likely indicator of possible anthropogenic contribution, while the EF of 2.4 in the basal layer is not enough to indicate anthropogenic contribution.

Trench 7 provides the best chronological resolution, with the uppermost layers dating to around 1000-0 BCE, based on the OSL measurement taken at 50cm below surface (Figure 4.14). At these levels the EF reaches unity, indicating no anthropogenic contribution of Pb. The dates from WF31 and WF32 show that the strata enriched with Pb (those below 100cm) must predate the Iron Age (Table 4.4). Sample WF32, dating to 2400-2200 BCE was taken from a depth of 114cm, in the stratum with the highest EF (EF = 4). This date provides a *terminus post quem* for WF31, which measured 3200-1200, but given the age of sample WF32 it must be no older than 2400 BCE. In short, the strata enriched with Pb predate the Iron Age production of copper in the Faynan valley, while later levels that likely continue through the Iron Age and Roman period exhibit no anthropogenic contribution of Pb.

OSL dates from Trench 10 are also earlier than the Iron Age and Roman period (Figure 4.15). The earliest measured date, from 58cm below surface, is 2900-1300 BCE. Sediments from this level reveal no anthropogenic lead, nor do the sediments closer to the surface. Similarly, sample WF57 dates to the 3300-1900 BCE, from 1.37cm below the surface (Table 4.4). These sediments also exhibited no anthropogenic contribution of lead. EF values from this trench, as well as trench 9, are well below 1, reflecting the relatively lower levels of calcium in the sediments. This may be the result of location, as the trenches are located adjacent to a different valley that the rest of the trenches. More data would be required to accurately assess this hypothesis. As the data currently stand, however, a different (or mixed) source for the agricultural sediments would seem plausible.

Revised Pollution Model for Faynan during the Iron Age and Roman Periods

Preliminary OSL results and ICP-MS results are incorporated into a new pollution model, based on the model of adaptive cycles, resiliency theory, and models of landscape modification described above. The location of the excavation units near the tributary wadis that would have provided some of irrigation water is believed to be a potential source of the anthropogenic Pb through processes of natural erosion of the lead-bearing mining and smelting sediments in these wadis (Figure 4.9). Additional confirmation comes from the fact that units located near tributaries lacking metallurgical debris (Trench 9 & 10) have no lead enrichment, while those closest to tributaries with metallurgical debris (Trench 2 & 3) have the highest enrichment close to the surface. Based on the dates from Trench 3 (OSL sample WF05), the surface samples have a high probability of dating to the Roman period or later.

The new data also demonstrate that there is no correlation between anthropogenic lead deposition and periods of major copper mining and smelting. This is most evident in the data from Trench 7, which have enriched Pb in strata predating the Iron Age, but no Pb enrichment in later strata that most likely post-date the Iron Age. Instead, anthropogenic Pb in this excavation unit seems to have accumulated during the end of the EBA. A number of mines and metallurgical features dating to the EBA were identified in the tributary feeding this area (cf. Barker *et al.* 2007a). Further support comes from Trench 3, where no anthropogenic Pb was observed, but begins to increase slightly in strata dating to 800-200 BCE, a period between the metallurgical activity associated with the Iron Age and Roman period.

The preliminary OSL results and ICP-MS results presented above are incorporated into a new pollution model described below and illustrated in Figure 4.16. This model provides an long-term view of settlement in Faynan that considers both social and natural factors in landscape change. Though not included in the model below, the Early Bronze Age settlement in Faynan is worth considering as an important precursor to the socio-natural system of the Iron Age and Roman period, as the EBA was a period of initial agricultural field and mining infrastructure construction. These fields represent an initial biocultural structure (a term from Resiliency theory) that was later incorporated and elaborated by later societies in Faynan. Biocultural structures are similar to *landesque capital* (also described earlier) in that they have long-term productive benefits, and as human constructions would have facilitated "social memory" of irrigation-based agriculture in the Faynan valley.

Early Iron Age (1200-1000 BCE) - Initial α-phase

The initial reorganization of settlement and copper production from previous periods took place during the Early Iron Age, aided by the power vacuum left by the collapse of some of the major empires during the previous Late Bronze Age (ca. 14th-13th century) that permitted reorganization into a new system (Figure 4.16)(Levy *et al.* 2014c). Copper production in the southern Levant by nomadic groups is attested in the Early Iron Age from excavations at the sites Khirbat en-Nahas and Timnah, and agro-pastoralist modes of subsistence were identified in systematic survey of the region. Iron Age economic organization resembles labortasking - involving skilled laborers and specialists from tribal kin groups. A possible slightly more humid climate in Wadi Faynan may have facilitated this growth (Cordova 2007). During this phase residual biocultural structures such as the Wadi Faynan agricultural fields and mining infrastructure may have also been incorporated.

Iron Age II 1000-800 BCE - r-phase

The 10th and 9th centuries BCE were a time of growth and exploitation, as copper mining and production reached peak levels at key production centers in southern Jordan and Israel (Figure 4.16)(Ben-Yosef *et al.* 2012; Levy *et al.* 2014c). Agriculture expanded significantly at Wadi Faynan, though agro-pastoralism seems to have remained the primary mode of subsistence. Extensive copper smelting is attested at Khirbat en-Nahas and adjacent to Khirbat Faynan, and changes in copper smelting technology have been observed in the industrial waste piles from Khirbat en-Nahas. A labortasking economy is continued in this phase, but with increase specialization of managerial segment. This is evident at the site of Khirbat en-Nahas, where architectural styles suggest the emergence of elite groups. During this phase local lowland woody shrubs were exploited for charcoal, and the lack of locally available hardwoods such as juniper and pistachio may have placed some restrictions on fuel production and use.

Late Iron Age II (800-500 BCE) - K-phase

The adoption of sedentary agriculture and increasing political centralization on the plateau marks the beginning of the conservation phase. This is also accompanied by increasing social rigidity on territorial boundaries throughout the southern Levant (Figure 4.16). Although there is sparse evidence for this period in the Wadi Faynan, some small-scale copper production is believed to have taken place. The imposition of top-down structures of agricultural production may indicate the beginnings of a shift to a technotasking economic organization as increased output was required for elites to maintain authority and for tribute payments to the Neo-Assyrian and Neo-Babylonian empires.

Iron Age III (500-300 BCE) - Ω-phase

The collapse of the Edomite polity occurred in the context of increasing incursions and possible conquests from the Neo-Assyrian and Neo-Babylonian empires, as well as under conditions of increasing aridity (Figure 4.16). The major settlement sites are abandoned during this period, and copper production and agricultural production in Wadi Faynan are halted. Based on the OSL dating and geochemical analysis of agricultural sediments from Wadi Faynan, increased Pb may have spread as a result of natural erosion of the metallurgical and agricultural infrastructure, as the overall social collapse of the region resulted in their neglect. The increased dryness during this period combined with local tree-felling from previous periods could have further exacerbated the disintegration of local infrastructure, as less vegetation makes a landscape more susceptible to catastrophic erosion events.

Late Hellenistic (300-100 BCE) - second α-phase

Following the collapse of the Iron Age is the reorganization phase of the early Nabataean society, attested only in historical sources and scant archaeological evidence from Khirbat Faynan (Figure 4.16). Early Nabataean society was characterized by semi-sedentary tribal social organization and an agro-pastoralist mode of subsistence. Such modes of subsistence were common during times of social collapse or under periods of economic or environmental pressure. Exploitation of copper resources or experimentation with agriculture may have occurred during this time in Wadi Faynan.

Early Roman (100 BCE-100 CE) second r-phase

Nabataean society rapidly became settled as social complexity and political centralization increased, coinciding with the growth and expansion of copper production and agricultural production in Faynan and throughout the southern Levant (Figure 4.16). Agricultural and metallurgical infrastructure was reused and intensified as new technologies were adopted for increasing production output. The resilience of the system probably remained high until the Roman annexation of the region in the Late Roman period.

Late Roman (100-400 CE) second k-phase

Under Roman rule agricultural and metallurgical production continued to increase, although rigid administrative structure adopted under the imperial political order likely decreased resilience (Figure 4.16). A large reservoir and a mill were constructed alongside the additions made to existing agricultural infrastructure. Our OSL and geochemical data do not have any strong indication of significant environmental pollution during the late Roman period. Indeed, during the following Byzantine period when metallurgy is abandoned in Faynan, agricultural production continues on a somewhat smaller scale, but more data will ultimately be required to refine the model. A second Ω-phase may have occurred during the end of the Late Roman/Byzantine period due to processes of settlement abandonment and climatic deterioration, but our current data do not provide sufficient information to draw conclusions for this later period with certainty.

Conclusion

Reconstructing the possible negative effects of large-scale copper smelting requires careful examination of the variety of socio-natural factors involved in environmental change. Our results refute the notion of a simple cause-and-effect relationship between people and their environment, and the view of human culture as inevitable destroyers of natural harmony that has characterized the previous ancient pollution studies described above. While lead has certainly been released into the environment in large quantities, its concentration is highly variable and the timing of its spread suggested by the OSL data seem to indicate that only after the region was abandoned did this occur, as described in the indirect degradation model from Chapter 1.

The ancient agricultural fields we tested do not exhibit significant levels of anthropogenic lead, leading us to question previous assertions of metal poisoning during periods of intensive copper smelting. Rather, the data presented here suggests that a multi-causal explanation for the coevolution of human culture and the environment – one that draws on natural and cultural factors, including pre- and post-abandonment processes – is required to fully comprehend the nature of environmental change in the Faynan Valley. The revised pollution model, drawing on models from historical ecology and resilience theory, makes a first step to doing so based on new data collected and analyzed for this dissertation.

With regards to some of the potential implications of the research we produce as anthropological archeologists, it's worth noting that during the late 1970s the Natural Resource Authority of Jordan carried out extensive prospecting in the Faynan region for possible reopening of the copper mines. At the time there was not enough copper to make it worthwhile. But as recent as a few years ago small-scale prospecting was again carried out, as the rise of copper prices is making mining exploits more profitable. Careful archaeological and environmental research on the effects of ancient mining may be able to assist in lessening the environmental impacts of renewed mining should it occur. At the same time, overstating the environmental impacts based on limited data, and especially the use of dramatic language such as "pollution" and "poisoning" can only serve to marginalize the inhabitants of the region – the local

Bedouin, farmers, and migrant workers – whose position relative to the government and global corporations is already precarious enough as it is.

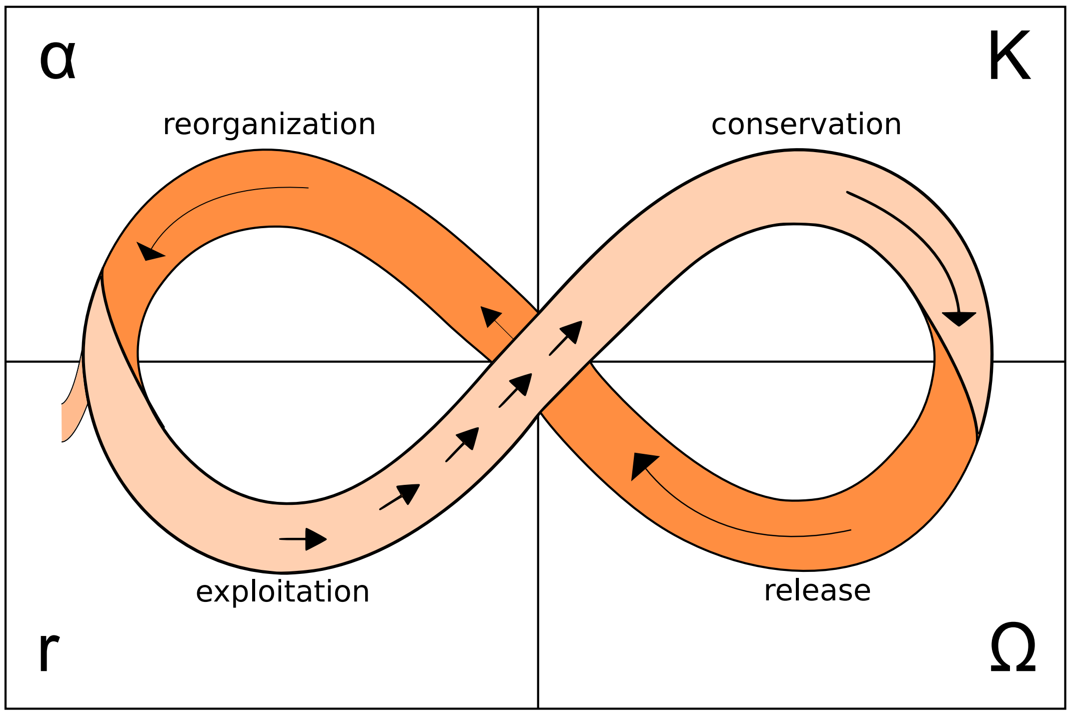


Figure 4.1: Graphical representation of the model of adaptive cycles and the four phases (Ω, α, r, K). The exit to the left of the figure suggests a stage where potential can leak away and a flip to a less productive and organized system is most likely (after Holling and Gunderson 2002, p. 34, Fig. 2.1).

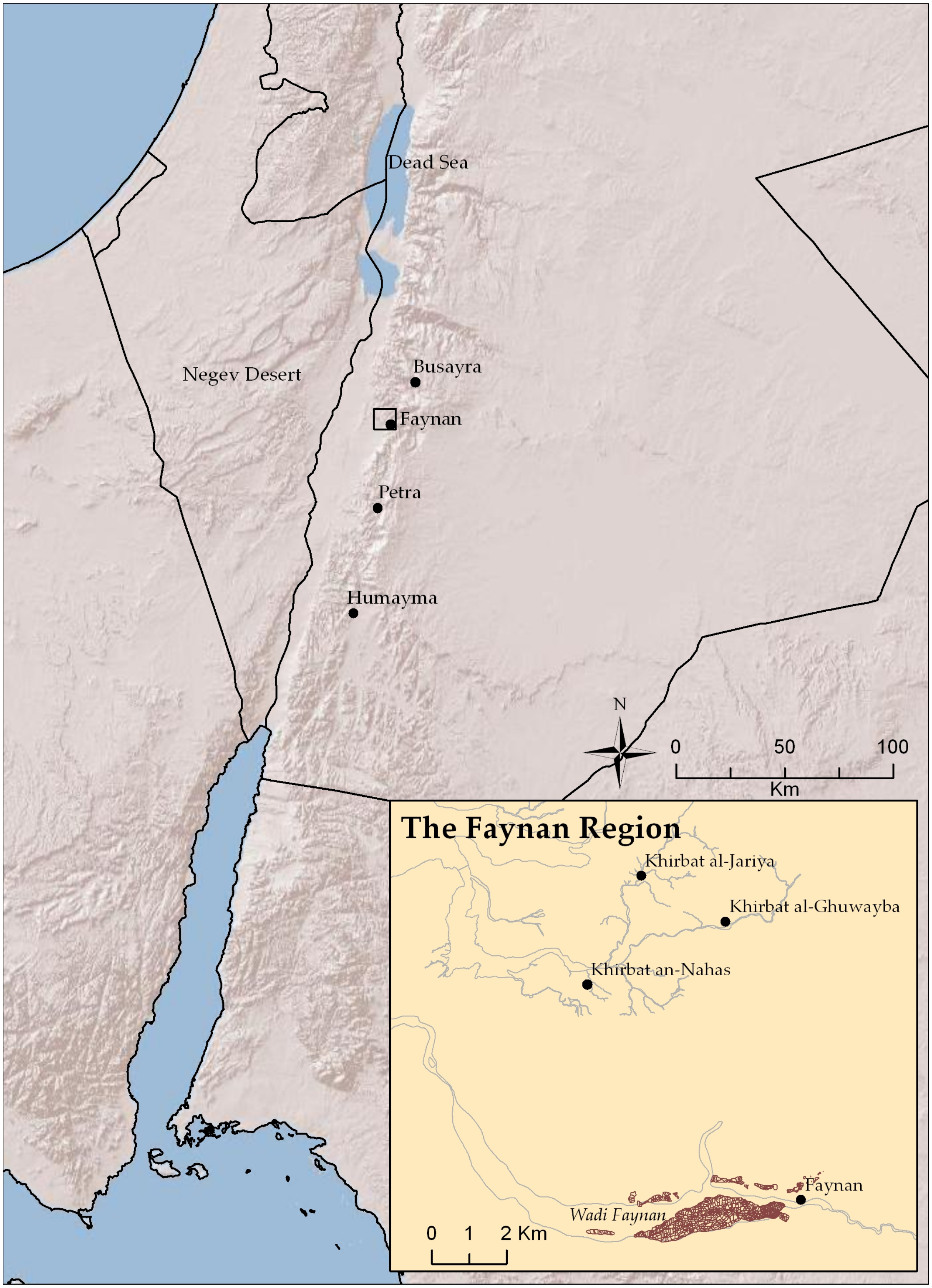


Figure 4.2: Map showing Wadi Faynan region within the eastern Mediterranean, with locations of major wadi systems, agricultural fields, and major smelting sites (inset).

Figure 4.3: Khirbat Faynan, the major settlement in Wadi Faynan and primary location of copper smelting. Wadi Faynan (dry at the time of the picture) cuts through the foreground. Image orientation is to the northeast.

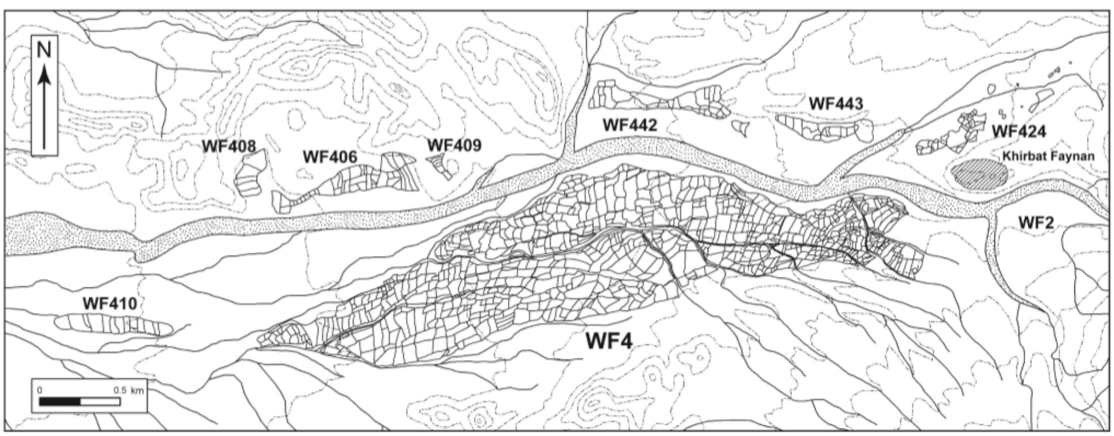


Figure 4.4: Map of the Wadi Faynan field systems as recorded by the WFLS. The two field systems chosen for the study presenter here, WF442 and WF4443, are located to the top right (after Newson *et al.* 2007, p. 142, Fig. 5.1).

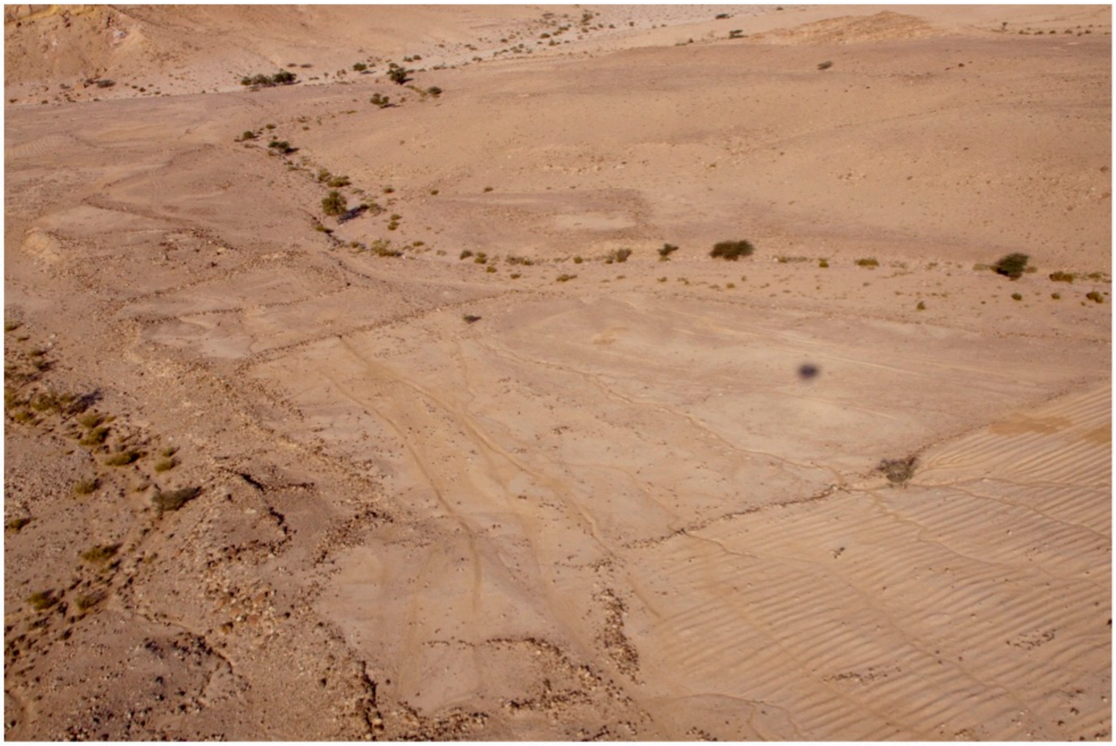


Figure 4.5: Balloon image of field system 442. The terrace walls run perpendicular to the drainages in order to trap water during flooding episodes. A relatively recent (i.e. last 100 years) attempt at plowing is visible in the lower right of the image (credit: UC San Diego Levantine Archaeology Laboratory).

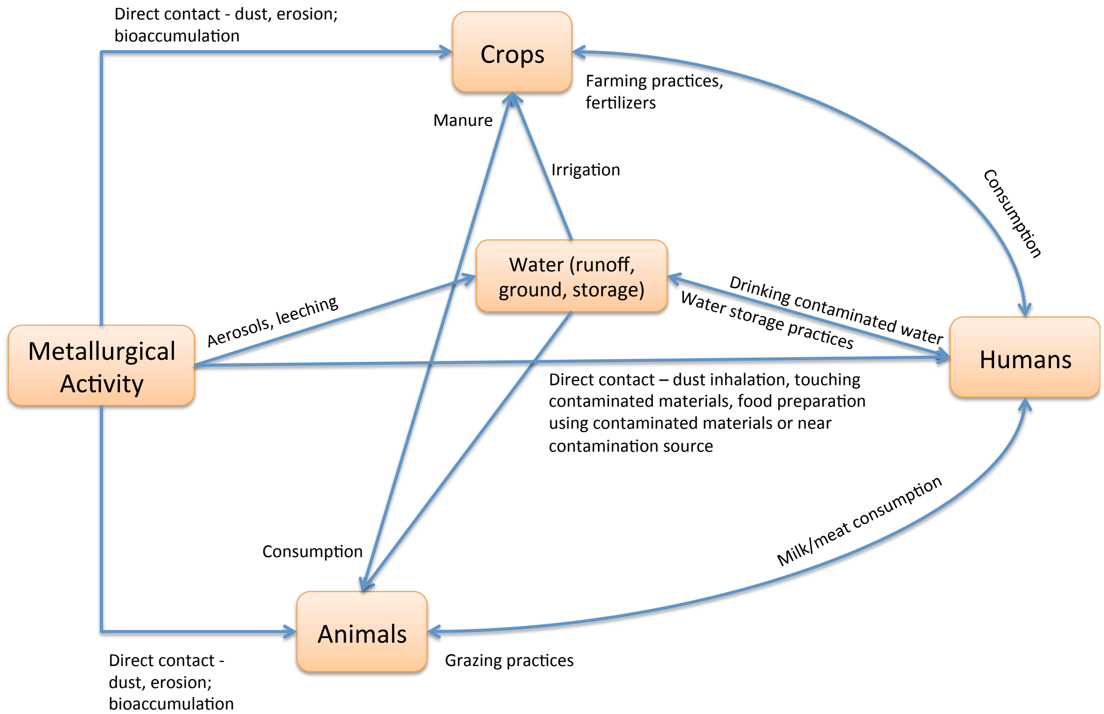


Figure 4.6: Model of the biocultural pathways for lead and other heavy metals to reach living organisms. Multiple feedback mechanisms increase the potential for contamination through daily activities such as farming and herding.

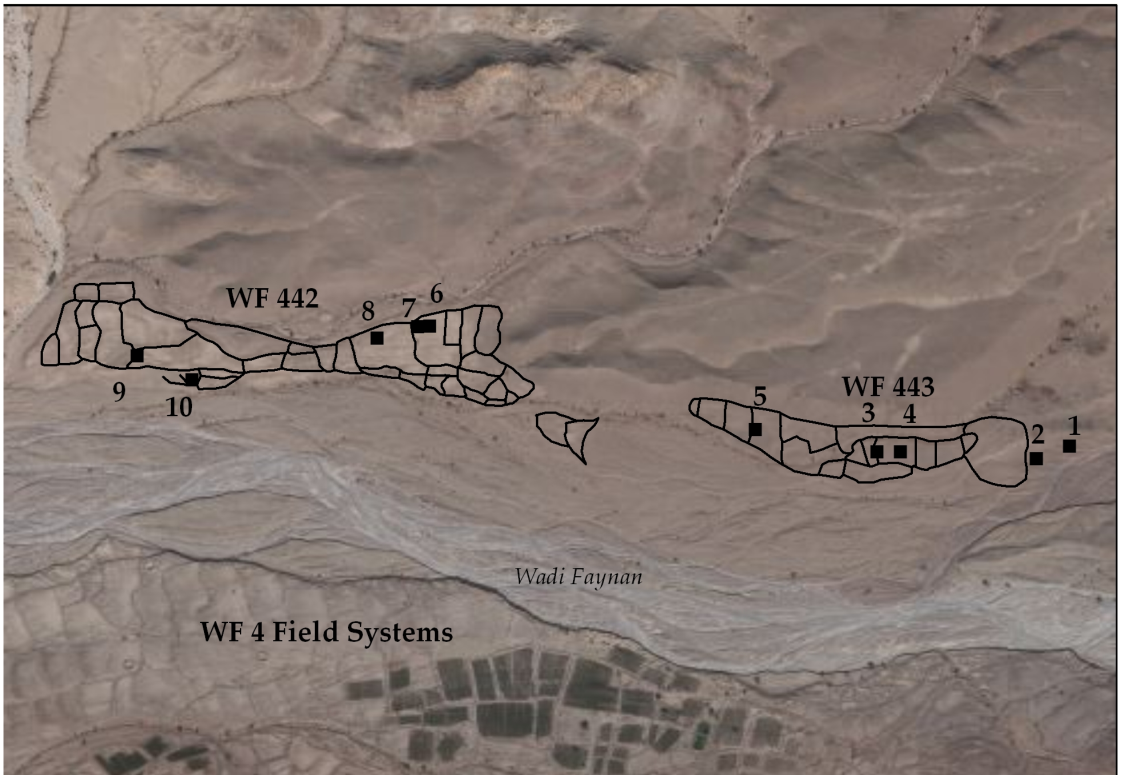


Figure 4.7: Map showing the location of the ten trenches excavated for the pollution study. Five trenches were excavated in both field systems selected for study (WF442 and WF443).

Figure 4.8: Image demonstrating the collection of OSL samples. Because they are light sensitive, the samples were collected before direct sunlight was hitting the profile, using PVC pipe hammered into the sidewall. The ends were packed with paper and wrapped in tinfoil and duct tape to prevent sediments from shifting and eliminate exposure to light.

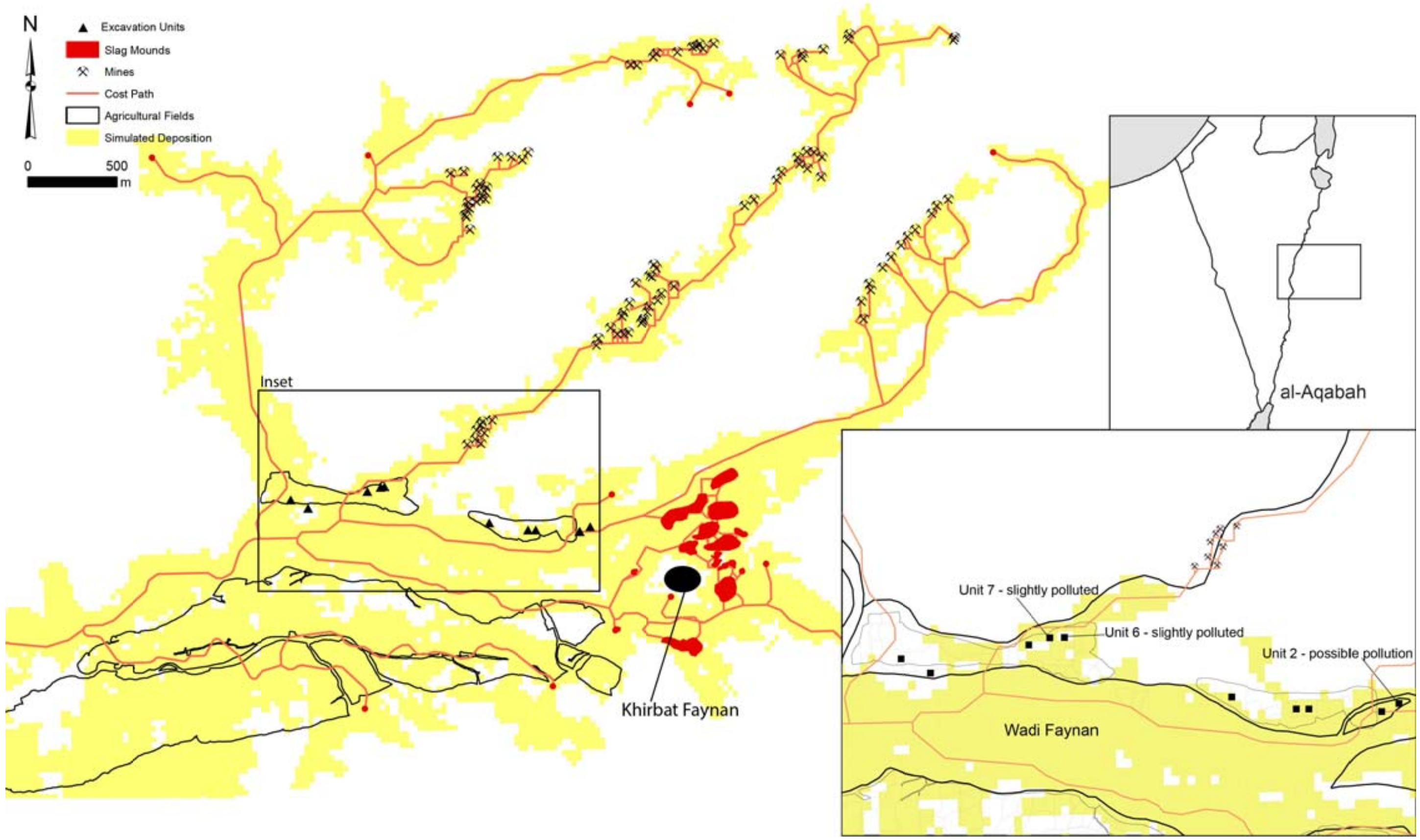


Figure 4.9: Map of Faynan valley showing locations of geochemical testing, sources of ancient pollution, and a simulated prediction of its spread across the landscape (Map courtesy Matthew Howland, UC San Diego Department of Anthropology)

Figure 4.10: Plow marks on a large rock in the WF 442 field system. Presumably this stone would have been buried during antiquity. That this stone is now near the surface may suggest that deflation of the sediments has occurred over time.

Figure 4.11: Image of the buried wall uncovered during the excavation of Trench 7 in field system WF4442. The presence of this second wall implies multiple periods of use of the field systems.

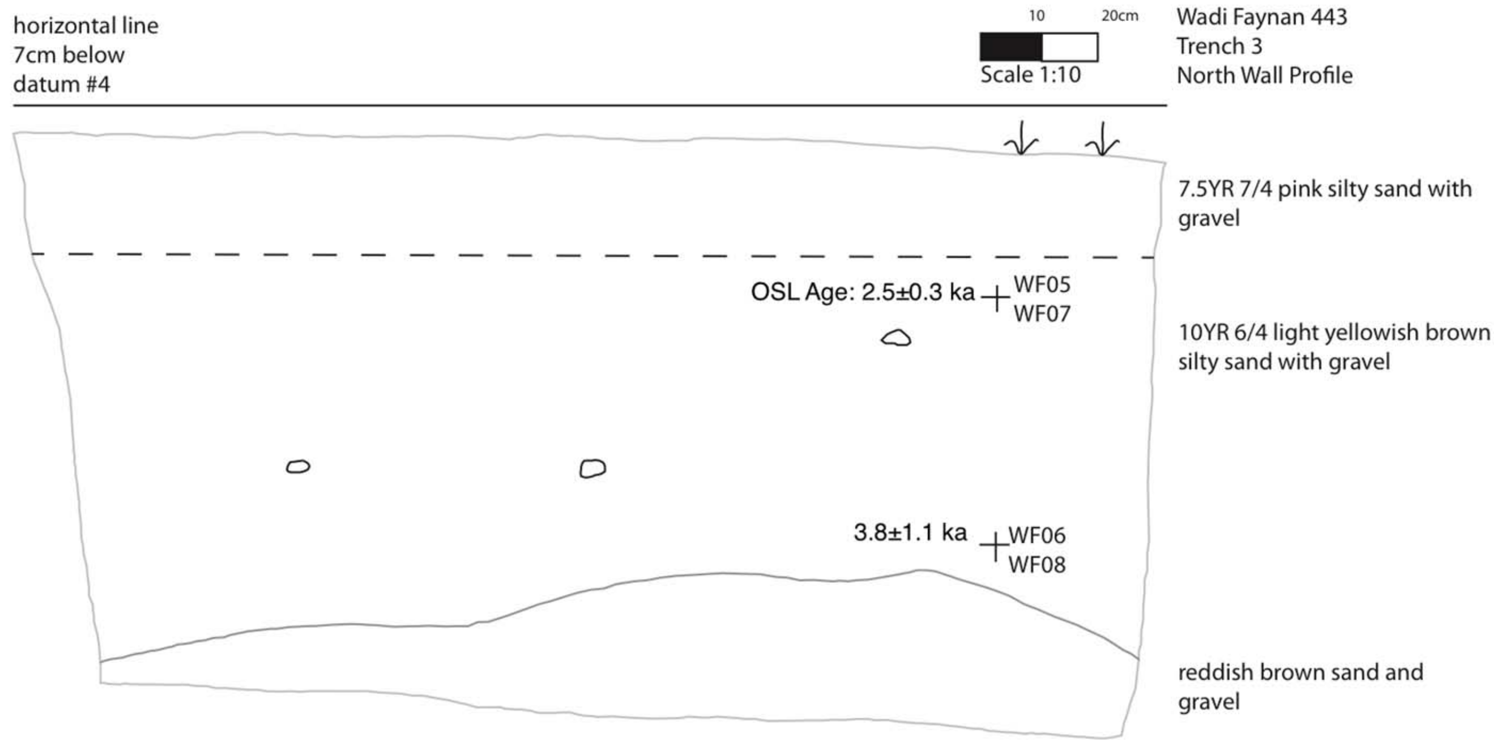


Figure 4.12: Profile drawing of Trench 3 showing the location of OSL dates, sediments collected for geochemical analysis, and other features recorded during the excavations.

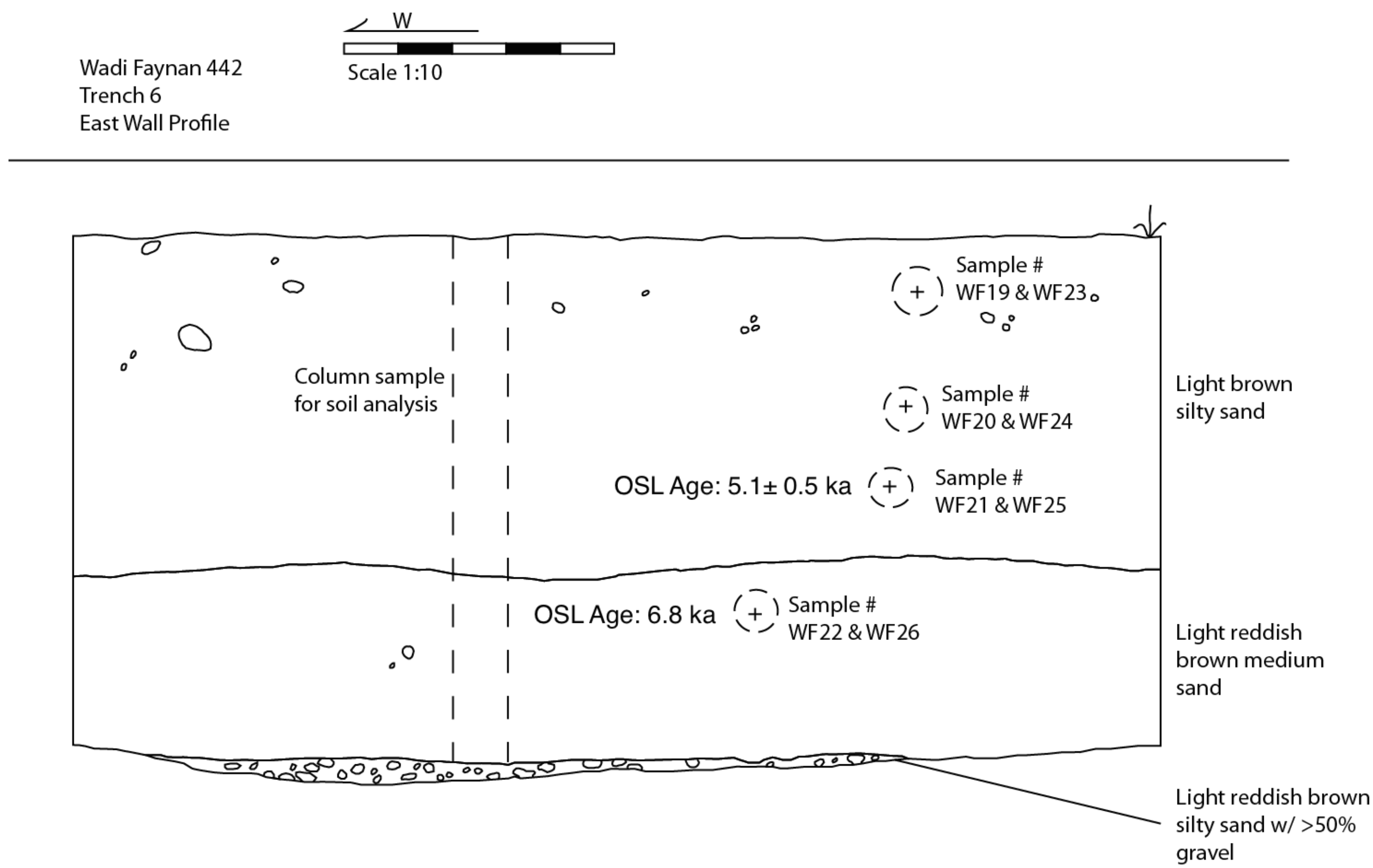


Figure 4.13: Profile drawing of Trench 6 showing the location of OSL dates, sediments collected for geochemical analysis, and other features recorded during the excavations.

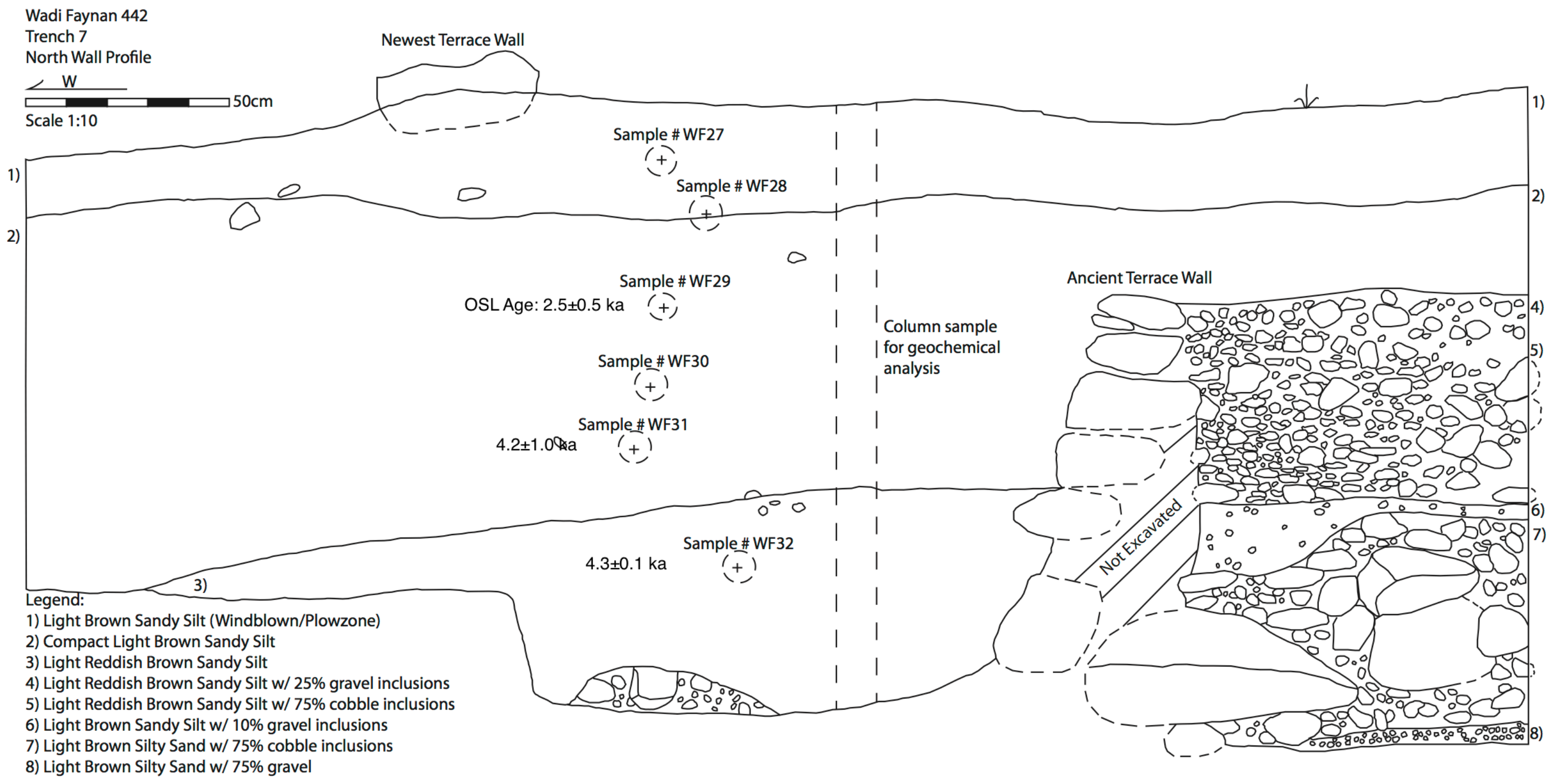


Figure 4.14: Profile drawing of Trench 7 showing the location of OSL dates, sediments collected for geochemical analysis, and other features recorded during the excavations.

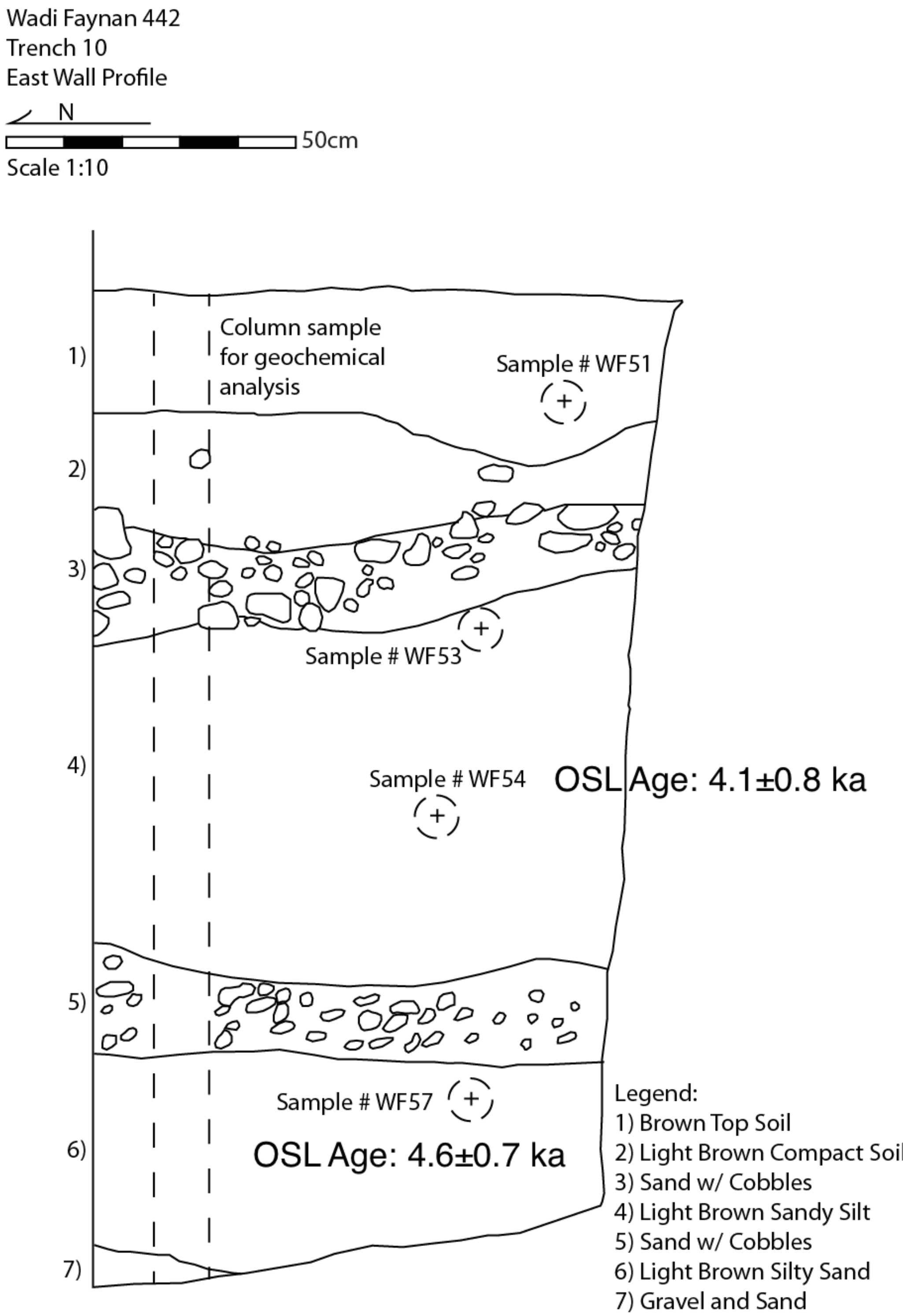
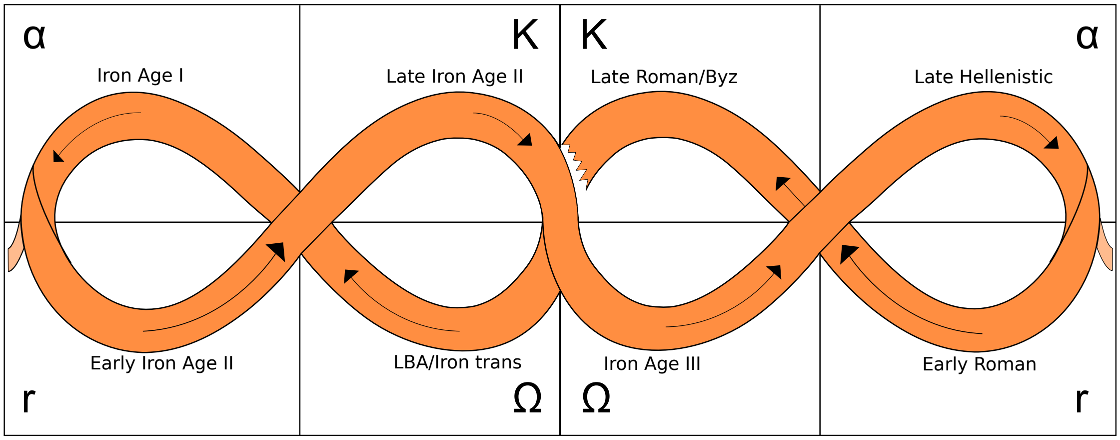


Figure 4.15: Profile drawing of Trench10 showing the location of OSL dates, sediments collected for geochemical analysis, and other features recorded during the excavations.



AC Phase	α	r	K	Ω	α	r	K
	Iron I	Iron II	Late Iron II	Iron III	Late Hellenistic	Early Roman	Late Roman
Climate	Wetter		Aridity			Wetter	
Economy	Labortasking		Technotasking(?)		Labortasking		Technotasking
Anthro. Pb	None	Limited to production areas	None	Yes	None	Some, but mostly limited to production areas	Some, but mostly limited to production areas

Figure 4.16: The adaptive cycle model applied to the Iron Age and Roman period societies in Wadi Faynan and southern Jordan.

Table 4.1: Measured Pb values from previous research in Wadi Faynan.

Sampling location	Sample type	Approx. Pb conc. (ppm)	Sample date range (cal BP)	Locale description	Method	Source
Surface transects	All samples from sedimentary deposits	0-80	Modern	Land surface – slag present	ICP-MS HNO3 extraction	Grattan *et al.* 2007
Surface transects		0-75	Modern	Land surface – slag not present		
WF5512/5017		200-8000	1403-3816	Metallurgical debris behind ancient barrage wall		
WF1491/5741		3500-14000	350-330	Metallurgical debris field north of Khirbat Faynan		
WF1491/5741b		5000-50000	6550-5940	Metallurgical debris field north of Khirbat Faynan		
WF5738		10000-45000	2862-3140	Metallurgical debris field north of Khirbat Faynan		
WF5740		3000-5000	Likely Roman	Mine and mining debris from wadi khaled		
		800-2000	Likely Roman	Post-abandonment infill		
WF5022		10-250	7235-5995	Metalworking and anthropogenic debris		
WF5021		10-200	7240-6990	Pre-metalworking anthropogenic debris		
Khirbat Faynan	Sedimentary	200 (Cu)	Iron Age-Roman	Metallurgical debris piles at KF	Merck Mercko-quant strips	Pyatt *et al.* 1999
	Animal	3-10 (Cu)	Modern	Faynan Region - goat urine, feces, and milk		
Control site	Invertebrate	41687	Modern	Non-metallurgical site 2km SSE of KF	FAAS following acid digestion	Pyatt *et al.* 2002
Khirbat Faynan		13940	Modern	Metallurgical debris piles adjacent to KF		
Field systems		41687	Modern	Agricultural field system		
Site 5037	Sedimentary	18	Likely Neolithic	Pre-metalworking anthropogenic debris	FAAS following acid digestion	Pyatt *et al.* 2000
Control site	Sedimentary	1564	Unknown	2.5km south of KF		
Khirbat Faynan	Vegetation	30-120	Modern	Metallurgical debris piles adjacent to KF		
	Sedimentary	15204	Likely Roman			
	Vegetation	200-1000	Modern			
Faynan region	Animal	200-600	Modern			
Wadi Faynan south cemtery	Human	1-290	Byzantine	Cemetery ~100m south of KF	ICP-MS HNO3 extraction	Grattan *et al.* 2002
Wadi Faynan north cemetery	Animal	200-520	Byzantine	Cemetery ~100m north of KF	FAAS following acid digestion	Pyatt *et al.* 2005
	Human	70-100	Bronze age			
	Human	20-200	Byzantine			
Faynan region	Animal	10-360	Modern			

Table 4.2: Results of newly analyzed sediment samples from agricultural fields

Unit no./sample depth (cm)	Na	K	Rb	Ca	Ca%	Mg	Sr	Ba	Al	Fe	Mn	Ti	SO4	PO4	Cr	As	V	Co	Ni	Cu	Zn	Pb	Ag	Cd	Sb	Sm	U	Th	Nd	Sn	Ce
T2 0-20	2709	7522	32	66889	7	11511	253	483	25556	13922	575	3504	-229	1622	32	4.4	39	5.0	13	81	59	57	0.63	0.7	0.3	3.4	3.6	12.6	17	13	55
T3 0-20	2241	9029	41	97127	10	13000	345	329	36343	17176	535	3269	402	2690	56	6.8	60	7.4	22	360	74	52	0.26	0.8	0.6	3.3	3.3	7.6	17	2.5	35
T3 20-40	3046	8526	38	89367	9	12500	357	306	34398	16296	531	3278	797	2669	56	5.7	56	7.1	22	253	74	42	0.28	0.8	0.4	2.8	4.0	4.7	14	2.9	29
T3 40-60	3151	7704	37	99137	10	11821	410	290	36042	16926	451	3012	3121	2843	62	6.2	60	6.8	23	70	74	33	0.22	0.9	0.4	3.5	3.5	10.3	18	4.5	39
T3 60-80	2835	7970	37	96381	10	11924	384	250	35762	17124	428	3279	4553	2641	63	6.3	62	7.0	23	80	73	33	0.30	0.8	0.4	2.8	3.5	6.9	14	4.2	29
T4 0-20	1337	10234	48	104484	10	11979	381	229	46442	20053	437	3394	-34	2135	60	7.3	70	8.1	23	108	76	34	0.23	0.5	0.4	3.8	3.1	9.1	19	4.5	41
T4 20-40	2180	10565	50	117446	12	12711	426	185	48229	20687	417	3241	1381	1790	60	6.8	70	8.5	23	55	64	29	0.16	0.4	0.3	3.8	3.0	8.7	19	7.8	41
T4 40-60	2565	9140	47	113737	11	11899	440	191	43838	19384	414	3002	1707	2140	60	7.0	66	8.0	23	47	71	29	0.15	0.6	0.4	3.8	2.9	14.5	19	3.4	41
T4 60-80	3245	9248	33	100966	10	10224	432	259	42270	19843	468	3511	1124	2983	71	7.4	74	8.6	28	79	83	34	0.17	0.9	0.4	4.1	3.2	10.0	21	3.0	46
T5 0-20	2002	8880	38	96505	10	12168	363	297	36895	18421	498	3328	69	2793	58	7.8	61	7.6	25	88	78	77	0.26	0.9	0.9	3.8	3.6	11.1	19	112	41
T5 20-40	2345	10356	49	116435	12	11148	539	428	44565	18976	703	3548	646	4521	91	7.6	75	8.4	34	470	105	81	0.35	1.5	0.5	4.3	4.5	14.8	21	4.4	44
T6 0-20	1568	7415	37	127664	13	10121	472	307	34159	16075	450	2863	366	4652	92	7.2	73	7.3	35	246	106	69	0.29	1.7	0.5	3.1	4.3	6.7	15	5.9	31
T6 20-40	2069	8130	42	135922	14	10233	605	403	39825	17806	531	3109	206	5456	113	8.0	82	7.8	39	318	117	59	0.32	2.1	0.6	3.7	5.7	10.9	19	3.4	38
T6 40-60	1874	8215	41	127789	13	10589	547	469	38811	17516	513	2969	276	4789	97	7.1	75	7.4	34	352	106	55	0.28	1.8	0.6	3.5	4.9	7.3	18	2.9	36
T6 60-80	1579	12485	57	76979	8	8775	398	528	37309	15485	794	3014	163	2954	58	7.1	54	7.7	24	922	100	118	0.42	1.1	0.4	3.5	4.1	10.6	18	8.5	38
T6 80-96	1884	10716	51	91330	9	9651	437	459	36193	15633	651	3537	384	3157	64	7.6	59	7.2	24	555	89	89	0.45	1.1	0.5	3.5	4.1	10.2	18	4.4	36
T7 0-20	2066	8070	38	142584	14	10219	583	378	36899	16966	474	2939	1119	5361	112	7.8	82	7.3	38	270	108	52	0.25	1.8	0.6	3.1	5.2	5.7	16	5.1	31
T7 20-40	2199	8375	39	130000	13	10070	555	384	37714	16512	523	2921	1882	4750	95	7.2	73	7.2	34	257	100	50	0.26	1.7	0.5	3.4	4.9	8.7	17	3.4	35
T7 40-60	1947	7602	39	123364	12	9773	549	352	37718	16627	494	2942	689	5225	106	7.3	77	7.3	36	298	110	54	0.28	1.9	0.6	3.0	5.3	7.0	15	3.0	31
T7 60-80	1935	7515	39	127292	13	10331	553	335	38958	17375	492	2880	278	5180	104	7.5	78	7.5	37	297	105	52	0.26	1.8	0.5	3.4	4.7	8.3	17	6.6	35
T7 80-100	2076	9052	42	99875	10	9835	462	360	39156	16542	609	3099	605	3952	79	6.4	65	7.4	29	408	92	71	0.29	1.3	0.5	3.5	3.9	10.2	18	3.8	37
T7 100-120	1564	9220	40	55367	6	6581	305	414	28486	11183	683	2732	86	2361	44	4.6	39	5.5	17	526	73	91	0.38	0.7	0.3	2.8	3.0	10.6	14	2.9	30
T7 120-140	1896	10798	50	74202	7	8214	395	477	34927	13835	890	3439	-27	2890	53	6.6	50	6.9	21	616	85	120	0.48	1.1	1.1	3.4	4.1	10.2	17	41	36
T7 140-150	2044	10111	47	90957	9	9047	435	496	35681	14904	723	3367	13	3214	65	6.7	54	9.9	25	536	86	95	0.46	1.2	0.4	3.5	4.2	11.8	18	3.8	37
T8 0-20	2260	6930	32	108560	11	9536	407	277	33304	14720	365	2712	3025	5292	98	7.8	82	6.8	37	136	101	31	0.21	1.8	0.6	2.6	4.9	5.0	13	4.4	24
T8 20-30	3694	7876	34	84931	8	12621	466	335	40069	18805	813	4005	3303	3464	68	7.3	76	8.4	27	377	81	54	0.38	1.0	0.5	3.7	4.3	9.4	19	8.4	39
T9 0-20	2265	6285	32	131376	13	10037	475	321	32743	14954	297	2503	1768	5447	100	7.9	85	6.7	39	66	101	21	0.22	1.7	0.6	2.8	4.8	4.8	15	3.9	27
T9 20-40	1955	4169	19	71105	7	8192	264	217	18488	9169	221	1858	3238	3191	49	4.3	44	4.3	20	36	50	11	0.13	1.0	0.3	1.7	2.6	3.9	9	1.8	16
T9 40-60	2983	6098	23	123871	12	9901	401	516	23484	13656	303	2955	1832	5504	73	5.6	58	5.8	29	42	71	17	0.24	1.9	0.5	2.2	4.2	4.4	11	2.1	20
T9 60-80	3114	6088	26	106424	11	11087	383	578	26087	15391	335	3390	2137	5550	82	6.1	68	6.4	31	46	82	34	0.29	1.8	0.5	2.4	4.4	5.2	12	21	21
T10 0-20	1743	6004	31	136667	14	9049	582	354	37708	18208	349	2766	1556	6481	126	7.7	91	7.6	44	95	117	30	0.21	2.5	0.7	3.5	6.4	5.3	18	5.8	34
T10 20-40	2493	5445	29	133333	13	9286	507	240	36177	17833	308	2789	2629	7677	134	7.9	99	7.6	50	50	127	28	0.24	2.9	0.7	2.9	6.0	4.1	15	4.7	27
T10 40-60	2528	5950	8	89109	9	1952	326	291	10257	10020	338	792	1593	3961	69	6.1	82	8.7	51	41	115	18	0.29	3.1	0.5	1.7	5.5	3.3	8	0.5	20
T10 60-80	1894	5869	32	129479	13	10095	467	217	36656	18688	330	2859	834	6283	123	7.7	93	7.9	46	40	114	20	0.22	2.4	0.7	2.7	5.3	4.4	14	4.2	24
T10 80-100	1981	6163	29	110182	11	9364	417	238	34455	17409	320	2956	922	5462	103	7.6	83	7.5	40	38	100	17	0.20	1.9	2.2	2.8	4.7	4.5	14	30	27
T10 100-120	2141	6358	33	129294	13	10233	510	257	36882	18612	334	2926	1030	6031	114	7.3	87	7.8	40	41	112	19	0.27	2.2	0.6	3.1	5.3	6.4	16	3.5	29
T10 120-140	1992	5858	32	136000	14	10202	517	254	35744	17878	317	2790	1142	6472	118	7.6	90	7.5	44	37	116	16	0.22	2.2	0.6	3.0	5.3	4.4	16	2.7	29
T10 140-160	2055	5649	28	123409	12	10000	441	317	31670	16068	316	2826	1749	6682	109	6.7	81	6.7	41	36	109	18	0.27	2.1	0.6	2.9	5.2	6.8	14	3.6	27
T10 160-180	2462	5507	25	110309	11	10381	379	523	25381	15010	312	3256	1351	5627	77	5.5	63	5.8	30	35	85	27	0.33	1.9	0.4	2.5	4.6	6.5	13	7.4	23

Table 4.3: Enrichment Factor (EF) values of ICP-MS results. EF = 1 is expected natural levels of Pb. EF > 5 is an indicator of anthropogenic contribution. EF < 5 may still indicate anthropogenic contribution, but with less certainty and/or only minor contribution.

Unit no./sample depth (cm)	PO4	Cr	Ni	Cu	Zn	Pb	U
T2 0-20	0.7	0.6	0.4	3.6	0.7	2.1	0.9
T3 0-20	0.8	0.7	0.5	11	0.6	1.3	0.6
T3 20-40	0.8	0.7	0.5	8.3	0.7	1.1	0.7
T3 40-60	0.8	0.7	0.5	2.1	0.6	0.8	0.6
T3 60-80	0.8	0.8	0.5	2.4	0.6	0.8	0.6
T4 0-20	0.6	0.7	0.5	3.0	0.6	0.8	0.5
T4 20-40	0.4	0.6	0.4	1.4	0.4	0.6	0.4
T4 40-60	0.5	0.6	0.4	1.2	0.5	0.6	0.4
T4 60-80	0.8	0.8	0.6	2.3	0.7	0.8	0.5
T5 0-20	0.8	0.7	0.6	2.7	0.6	1.9	0.6
T5 20-40	1.1	0.9	0.6	12	0.7	1.7	0.6
T6 0-20	1.0	0.8	0.6	5.7	0.7	1.3	0.6
T6 20-40	1.1	1.0	0.6	6.9	0.7	1.1	0.7
T6 40-60	1.0	0.9	0.6	8.1	0.7	1.0	0.6
T6 60-80	1.1	0.9	0.7	35	1.0	3.7	0.9
T6 80-96	0.9	0.8	0.6	18	0.8	2.4	0.7
T7 0-20	1.0	0.9	0.6	5.6	0.6	0.9	0.6
T7 20-40	1.0	0.9	0.6	5.8	0.6	0.9	0.6
T7 40-60	1.2	1.0	0.6	7.1	0.7	1.1	0.7
T7 60-80	1.1	1.0	0.6	6.9	0.7	1.0	0.6
T7 80-100	1.1	0.9	0.6	12	0.7	1.7	0.7
T7 100-120	1.2	0.9	0.7	28	1.0	4.0	0.9
T7 120-140	1.1	0.8	0.6	24	0.9	3.9	0.9
T7 140-150	1.0	0.8	0.6	17	0.8	2.5	0.8
T8 0-20	1.3	1.1	0.7	3.7	0.7	0.7	0.7
T8 20-30	1.1	0.9	0.7	13	0.8	1.6	0.8
T9 0-20	1.1	0.9	0.6	1.5	0.6	0.4	0.6
T9 20-40	1.2	0.8	0.6	1.5	0.6	0.4	0.6
T9 40-60	1.2	0.7	0.5	1.0	0.5	0.3	0.6
T9 60-80	1.4	0.9	0.6	1.3	0.6	0.8	0.7
T10 0-20	1.3	1.1	0.7	2.1	0.7	0.5	0.8
T10 20-40	1.6	1.2	0.8	1.1	0.8	0.5	0.7
T10 40-60	1.2	0.9	1.2	1.4	1.0	0.5	1.0
T10 60-80	1.3	1.1	0.8	0.9	0.7	0.4	0.7
T10 80-100	1.4	1.1	0.8	1.0	0.7	0.4	0.7
T10 100-120	1.3	1.0	0.7	0.9	0.7	0.4	0.7
T10 120-140	1.3	1.0	0.7	0.8	0.7	0.3	0.6
T10 140-160	1.5	1.0	0.7	0.9	0.7	0.4	0.7
T10 160-180	1.4	0.8	0.6	0.9	0.6	0.6	0.7

Table 4.4: Preliminary results of OSL dating.

Sample #	USU #	depth (m)	grain size (µm)	# disks	dose rate (Gy/ka)	Preliminary De, Gy (2 SE)	**Preliminary OSL age, ka (2SE)**
WF05 (DR=WF07) Trench 3	**USU-1639**	0.25	125-250	**21 (32)**	1.69 ± 0.10	4.16 ± 0.44	**~2.5 ± 0.3**
WF06 (DR=WF08) Trench 3	**USU-1640**	0.62	125-250	**8 (12)**	1.57 ± 0.09	5.92 ± 1.61	**~3.8 ± 1.1**
WF21 (DR=WF25) Trench 6	**USU-1641**	0.45	75-150	**2 (4)**	2.22 ± 0.13	11.25 ± 0.67	**~5.1 ± 0.5**
WF22 (DR=WF26) Trench 6	**USU-1642**	0.7	125-212	**1 (4)**	2.35 ± 0.13	16.08 ±	**~6.8**
WF29 (DR=WF35) Trench 7	**USU-1643**	0.5	125-250	**11 (12)**	1.97 ± 0.12	4.91 ± 0.99	**~2.5 ± 0.5**
WF31 (DR=WF37) Trench 7	**USU-1644**	0.7	90-180	**8 (12)**	2.28 ± 0.13	9.46 ± 2.21	**~4.2 ± 1.0**
WF32 (DR=WF38) Trench 7	**USU-1645**	1.14	125-250	**6 (12)**	1.51 ± 0.09	6.52 ± 1.38	**~4.3 ± 0.1**
WF54 (DR=WF56) Trench 10	**USU-1646**	0.58	63-250	**10 (12)**	2.08 ± 0.12	8.43 ± 1.53	**~4.1 ± 0.8**
WF57 (DR=WF58) Trench 10	**USU-1647**	1.37	125-250	**7 (12)**	1.85 ± 0.11	8.60 ± 1.14	**~4.6 ± 0.7**

Chapter 5: Models of Resistance, Centralization, and the Political Landscape – Marginality in Anthropological and Historical Perspective

Introduction

Having demonstrated the relationship between increasing sociopolitical complexity and environmental change in the previous chapter, this chapter will focus on the political landscape of southern Jordan, identifying expressions of political authority in the built environment and the perspectives of groups who would contest it. The chapter expands upon the settlement pattern analysis from Wadi al-Feidh and includes the wider territory of southern Jordan during the late Iron Age and Roman period. Southern Jordan is an ideal place to carry out this investigation due to its deep history of political strife, fluctuating borders and frontiers, and its history of interregional conflict amongst indigenous polities and foreign empires. This is particularly true for the Iron Age and Roman period, times of rapid political change. The historical context of the Iron Age and Roman periods is one of diversity and variability in the nature of political authority. Both chronological periods share some interesting characteristics that make this comparative investigation enticing: the formation of an autochthonous political entity; interaction with a mobile and semi-autonomous component of society; and the eventual subjugation of the local polity by an empire. This chapter will conceptualize the spatial dimensions of political authority and resistance in contexts of imperial expansion, indigenous political centralization, and nomadic-sedentary interaction.

In conceptualizing the territory of a complex polity, be it a chiefdom, state, or empire, it is often assumed that political boundaries are continuous and homogenous. This straightforward dichotomy oversimplifies the relationship between ruler and ruled, reinforcing artificial binaries of sovereignty and resistance, subject and non-subject, inside and outside, subject and enemy, and so on. This chapter aims to deconstruct the dichotomies that have been used to describe political relationships in the archaeological record (cf. Crumley 1995; Fowles 2010; Frachetti 2012; Greene and Lindsay 2013; Miller *et al.* 1995; Morrison 2001; Smith 2003). Based on archaeological and historical data, this chapter will elucidate the complex pluralism of political relationships in southern Jordan's Iron Age and Roman period, arguing that even within the political borders there are communities that maintain some degree of political autonomy from state sovereignty, and that under conditions of increasing centralization autonomy does not merely disappear, but instead is displaced and pushed to more marginal locations.

It is important to make clear from the start that in using terms such as sovereignty, authority, and resistance, terms that in the social sciences can be highly contentious, I am not implying that there existed structural inequalities that can only be understood as the product of elites, as a "top-down" process of state-making. Rather, in agreement with other scholars on the role of the subaltern in the mutual construction of power relations (Morrison 2001; Scott 1976, 1985; Stein 2002).

Subaltern actions are not simply reactive, and subaltern consciousness is capable of cooperation and reciprocity, more than the term resistance may seem to imply (Brown 1996; Ortner 1984). It is in this sense that the terms sovereignty and resistance are employed as more flexible descriptors of sociopolitical process and product. For sociopolitical process on the periphery, such as that of southern Jordan described here, this is a particularly important consideration given the passive role assigned to the region for much of its history.

Political Landscapes – Models of Territoriality and Resistance

In writing about the political landscape this chapter owes a considerable intellectual debt to the work of Adam T. Smith, whose work on the constitution of political authority in early complex polities was the first systematic attempt to explain the relationship between spatial organization and politics from an anthropological perspective. According to Smith, "what makes the power to produce landscapes socially significant is that landscapes reflexively place limits on practices. Thus an ability to produce landscapes confers significant ability to influence, regulate, delimit, and control daily life," (2003: 70). All individuals participate in the production of landscape to some extent: even in practices as basic as walking, our actions leave an imprint on the landscape (de Certeau 1984). When speaking of political practices, however, we are concerned with instances where there is unequal access to the production of physical spaces and the meanings attached to them. Unequal access to the production of physical spaces might include projects requiring significant investment in labor, resources, and permissions/contracts. These spaces tend to be created by institutions such as universities, corporations, and political regimes. Inequality in the production of meaning is perhaps less tangible but important nonetheless (Smith 2003: 71). Political landscapes, just as the landscapes discussed in previous chapters, have a reflexive relationship with human culture (Lefebvre 1984). Landscapes are not merely shaped by political structure, they also feed into that structure.

A salient feature of the political landscape is the territory encompassed by the state. But territorial boundaries are not the static, clearly bounded spaces we often conceive of on maps of the ancient world (Greene and Lindsay 2013; Parker 2006a; Rodseth and Parker 2005). Instead, humans and landscape interact reciprocally over time. VanValkenburgh argues that "rather than seeing territories as either entirely material or entirely conceptual, we regard territoriality, the dynamic configuration of boundaries within the landscape, as a product of the engagement of political institutions, physical environments, and human subjectivities… Territorial behaviors and built environments "feed back" on the individuals and entities that create them, shaping social identity and political institutions in the process," (2013: 2). In this sense, territories are fluid and contingent, structuring and contested, the products of multiple modalities of social behavior. Of course these modes include political behavior, but they also encompass a variety of intra- and inter-regional interactions, such as economic and subsistence strategies, community and household interests, and perceptions of the build environment.

James Scott has dealt with the spatial dimensions of territorial sovereignty and resistance in his work on autonomous communities in the rugged and remote zones of Burma. He notes that whereas states portray their own territory using sharply delineated, contiguous borders, the sociopolitical reality of these borders and what's inside versus outside is much more complicated. Burma, for example, can be divided between the lowland, rice-growing, state centers, and the upland, mixed agricultural, semi-autonomous communities who seek refuge from state control in the highlands. As Scott argues, the state's ability to exert cultural and political influence is subject to a number of limitations, one of which is physical isolation and the friction of distance:

> Imagine a map constructed along [topographic] lines, designed to represent relative degrees of political sovereignty and cultural influence. One way of visualizing how the friction of distance might work is to imagine yourself holding a rigid map on which altitudes were represented by the physical relief the map itself. Further, let's imagine that the location of each rice-growing core is marked by a reservoir of red paint filled to the very brim. The size of the reservoir of paint would be proportional to the size of the wet-rice core and hence the population it might accommodate. Now visualize tilting this map, now in one direction, now in another, successively. The paint as it spilled from each reservoir would flow first along the level ground and along the lowland water courses. As you increased the angle at which the map was tilted, the red paint would flow slowly or abruptly, depending on the steepness of the terrain, to somewhat higher elevations. The angle at which you had to tilt the map to reach particular areas would represent, very roughly, the degree of difficulty the state would face in trying to extend its control that far. If we assume that the intensity of the red fades both in proportion to the distance it has traveled and the altitude it has attained, we have an approximation, again very roughly, of the diminishing influence and control, or alternatively, the relative cost of establishing direct political control in such areas (2009: 54-57).

In Burma, topography and friction of distance are the major impediments to state hegemony, but other characteristics of the landscape may play a role as well. The

Berber of North Africa made efficient use of the High Atlas mountains and desert hyper-aridity, combined with an intimate, local knowledge of resources such as water, to reinforce an anarchic tribal organization and avoid incorporation into the state. This is what Gellner calls marginal tribalism, noting "that the inconveniences of submission make it attractive to withdraw from political authority, and the balance of power, the nature of mountainous or desert terrain, make it feasible. Such tribalism is politically marginal. It knows what it rejects," (1969: 2)l. Rejection of state authority represents one of the essential qualities of Berber sociopolitical organization. And anarchy against the centralized state was supported by, among many other things, the Berber homeland, which they utilized to great geographical advantage.

The efficacy with which states extend their control may also be influenced by non-ecological forms of remoteness from political centers. Societies at the frontier of an empire, or between two empires, for example, may make use of their peripheral position to resist complete incorporation and retain some degree of autonomy. Expansionary strategies of ancient states varied based on geographical distance, the polities encountered, and political economic motivations. This is captured nicely by Parker's (2013) continuum of imperial power, ranging from direct territorial control to outright opposition by enemy states. Rather than viewing state expansion as discrete categories, this model predicts degrees of autonomy along a spectrum of possible forms of interaction (Figure 5.1). Territorial and hegemonic power grants little to no autonomy from imperial rule (D'Altroy 1992; Parker 2013). Under this structure empires rule directly or create a vassal state. Additional forms of imperial power include neutral and negative modes of power. While the state may have limited influence within a neutral zone, its power is severely restricted and thus imperial control should be considered negligible. This could play out in a number of ways depending on where the particular interaction falls on the continuum of power. Buffer states whose neutrality is force by an empire would be less autonomous than, say, buffers whose neutrality is sovereign. Even further to the right are zones of negative power, that is, independent states who oppose imperial rule, ranging from neutral states who oppose imperial rule but do not seek to actively destroy it to hostile states who actively oppose the empire (Parker 2013: 137).

For the settlement pattern data presented here, this concept of territoriality as flexible and varied, allowing for the possibility - even expecting - various forms of resistance to centralized political authority, is useful for conceiving of the political landscape of southern Jordan during the Iron Age and Roman period. For these periods, the formation of ethnic identities certainly played a role in resistance to political authority and the formation of territorial constructs (Emberling 1997; Faust 2006; Smith 2005). Though there is not the space to devote further discussion of ethnicity, it is certainly worth keeping in mind. During these times, the political order underwent significant changes reflecting major developments in the indigenous societies inhabiting the area. How these changes are reflected in the landscape, in the use of space as territory for expressions of political power and resistance is a subject that has yet to receive significant attention in the archaeological literature. This is made possible by the many archaeological surveys that have been conducted in Jordan over the last century, and it is from these surveys, as well as those I conducted with UC San Diego's ongoing fieldwork projects, that such a regional analysis is possible.

Marginality in Southern Jordan

Marginal regions – whether mountain, desert, or jungle – have often been a locus of lasting decentralized political organization and resistance to the state (Barker and Gilbertson 2000; Clastres 1987; Fowles 2010; Scott 2009). The reasons for this vary, but often included highly variegated resource distributions that placed limitations on elites' ability to accumulate social capital, expensive transport costs that restrict movement and communication, and an ethos against hierarchy and centralization. For ancient states, arable land was an essential commodity for the production of agricultural surplus, and the state's ability to expand and intensify agricultural production into less hospitable zones required significant resource capital and became increasingly risky the further it attempted to go (Rosen 2000).

The political landscape of southern Jordan was characterized by its marginality. There were at least two ways this marginality was experienced by ancient people: it was physically marginal in terms of the climate and geography; and it was culturally marginal as a periphery of ancient states and empires. Both of these interrelated qualities played a significant role in the historical development of ancient complex polities and how they related to their neighbors. It may be tempting to treat the area as unique in this regard, that the marginal landscape played an even more significant role for social institutions than landscapes would in other locations. But it is equally likely that landscape stands out because it is easier to perceive marginality.

Perception certainly affects how we approach and understand our role within the broader structure of daily life. This applies equally well to how we navigate our daily lives and how we think about daily life in past societies.

Southern Jordan's physical and cultural marginality presented myriad opportunities and limitations for indigenous polities. Acting as a buffer against expansionary states, marginality was often exploited by local elites, who often had a highly intimate knowledge of the landscape. This knowledge was used to avoid taxation or tribute demands, military forces, and other imperial strategies of incorporation or exploitation. In these ways, marginality served as a deterrent to centralization. The flip side, however, was that this deterrent to centralization could also work against elites trying to bolster their own political position. As I will demonstrate below, there are archaeological signatures of local communities in southern Jordan engaging in these practices to avoid integration and incorporation into state political and economic structures.

Political authority 1200 BCE - 400 CE

What exactly did political authority look like in southern Jordan during the periods under investigation? To answer this question there are two perspectives we must consider: first, that of indigenous polities ruling in southern Jordan, and second, that of imperial regimes whose relationship to indigenous polities varied through time. In reality the nature of these two political authorities are closely interwoven in relationships of power, subjugation, and dependence, but for heuristic purposes it is worthwhile to investigate them separately. The imperial perspective, however, will only be covered insofar as its role is important for understanding historical events in southern Jordan, and since this chapter is not about empires it will be limited to that extent.

Elite Authority during the Iron Age (ca. 1200-500 BCE)

Iron Age Edom was the first indigenous complex polity to emerge in southern Jordan, and was one of several Iron Age (ca. 1200 - 500 BCE) polities to develop in the southern Levant, along with ancient Israel, Judah, Phoenicia, Ammon, and Moab. These polities are characterized by social stratification, territorial boundedness, political centralization, monumental architecture, warfare, and craft specialization. Explanations of the emergence of these polities are informed by historical sources such as the Hebrew bible, and advances in archaeological theory, including social evolution (Dever 1998; Holladay 1998; LaBianca and Younker 1998; Levy 2009), secondary states (Joffe 2002), patrimonial states (Master 2001; Schloen 2001), and segmentary states (Routledge 2000, 2004). Whereas many of these studies have effectively characterized the nature of political organization in general terms, less often have they detailed what political elites actually do and how their strategies diverge. Based on some 10 years of early Iron Age research in the copper ore region of Faynan in the lowlands, and in particular the industrial site of Khirbat en-Nahas, a complex nomadic polity organized around the extraction and production of copper has been identified (Levy *et al.* 2014a). By the later Iron Age, settlement activities and the local center of power shifts to the highlands of Edom (Bienkowski 1992a; Smith *et al.* 2014a).

Edomite political organization during the late Iron Age (beginning ca. 800 BCE) is described as a tribal kingdom comprised of segmentary groups loosely united by kinship (Bienkowski 1992a; Bienkowski and van der Steen 2001; LaBianca and Younker 1998). Historical evidence suggests that Edom may have traced its origins to nomadic tribes inhabiting the southern deserts of what is modern day Israel and Jordan, and the northwest portions of Saudi Arabia, roughly the same borders attributed to the polity after it's political coalescence. Late Bronze Age Egyptian sources depict the region inhabited by tent-dwelling pastoralists, with significant-enough occupation to make it worthwhile to have raided the land and subdued the people (Kitchen 1992: 26-27). Later Biblical sources depict the relationship between Edom and Israel as adversarial, reporting that Israelites conquered Edom and subjugated its people from 1000 - 850 BCE (1 Samuel 14:47–8; 2 Samuel 8:13–14), and during this time period dominated the region politically and economically (Bartlett 1989, 1992). While there is no archaeological evidence to compliment this part of the narrative, reading against the grain, one can infer that this period was likely characterized by political struggle and conflicts over territorial sovereignty.

Imperial expansion into Edom began around the 8th century BCE with the Neo-Assyrian empire (Millard 1992; Weippert 1987). Following this initial encounter, successive waves of imperial control continued with the Neo-Babylonian and Persian empires (Bienkowski 2001; Crowell 2007). Each of these empires exhibited varying degrees of political and economic control over Edom, who was made a tributary polity by each. What Edom had to offer was agricultural products (livestock and grains), a gateway to Arabian and Red Sea trade routes, and a buffer zone against hostile groups. While it is often cited that Edom had significant copper resources available, recent research suggests that by this time there was little to no copper production happening in Edom at this time (Ben-Yosef *et al.* 2010; Levy *et al.* 2004).

How exactly did elites cultivate the political authority to affect such changes in the polity? Porter (2004) outlines five strategies employed by Edomite elites to garner authority: fostering the adoption of sedentary agriculture, promoting the spread of a unified cult, territorial expansion, the creation of a political center at Busayra, and the redistribution of prestige items to loyal subjects.

Sedentary agriculture is an important tool used by elites to create communities that are easier to control, and excavations and surveys of late Iron Age sites supports the adoption of sedentary agricultural subsistence throughout much of southern Jordan during this period (Bienkowski 1992b; LaBianca and Younker 1998). Agricultural villages are virtually immobile, must settle in lands with abundant arable land (which is consequently easier for administrators to reach), and susceptible to taxation because the goods they produce are a highly visible component of the landscape. Mobile groups, on the other hand, can avoid administrators by moving camps, hiding their goods, and settling in areas away from the capitals reach (Porter 2004).

Though the Qos cult precedes the formation of the Edomite polity and was adopted elsewhere in the southern Levant, its spread throughout southern Jordan may reflect the growing unification of previously disparate groups under a shared identity.

A unifying ideology has been identified as an important tool for centralization and authority in a number of contexts. Political legitimacy is often tied to the approval of local gods. The use of a god, in this case Qos, as a patronymic metaphor is consistent with other Levantine polities during the Iron Age (Schloen 2001). Archaeological and historical evidence suggests the spread of Edomite territory into parts of the Negev desert, including a possible cultic installation dedicated to Qos. While the exact nature of the spread of Edomite territory is debated, it is clear that Edomite material culture extends much farther than the original area ascribed to the Edomites (Beit-Arieh 1995; Cohen and Yisrael 1995). Whether this reflects economic, territorial, or some other form of expansion remains to be seen.

The construction of the political capital Busayra during the late Iron Age is perhaps the strongest statement of political authority, as the site is unparalleled throughout Edom. Busayra is the largest Iron Age site in Edom, measuring well over 8 ha (Bienkowski 2002). The site is composed of two platformed monumental complexes surrounded by a perimeter wall. Both complexes share affinities with Neo-Assyrian architectural styles. Relative to the construction of villages elsewhere, Busayra stands out as a conspicuous sign of political authority and grandiosity. As the capital, the settlement was the locus for the distribution of prestige items found at many Edomite villages. These included goods tied to the regional economy, such as seals, seal impressions, and weights, as well as items for visual display, such as cosmetic palettes, jewelry, bone furniture inlay, ivory, and imported shells (Porter 2004). Redistribution of these items helped ensure the legitimacy of elites and the allegiance of disparate segments of society, and likely became an important element of the regional economy, as signs of wealth, prestige, and sociopolitical affiliation.

Multiple strategies facilitated elites' accumulation of political power. Most important were creating a unique identity amongst a fragmentary order of social groups. This was accomplished by encouraging the adoption of a sedentary agriculturalist lifestyle, promoting the god Qos as a patronymic metaphor recognized by loyal subjects, expanding the territorial boundaries of Edom, the construction of a monumental political center, and redistribution of prestige goods to reward those who allied with and accepted the authority of Edom's elites. Elites' ability to rule was highly contingent and required constant attention to recognizing the limitations of their authority, a subject we will turn to later. In addition, the new political order of the Iron Age led to significant changes in the political landscape observable in the regional settlement patterns.

Elite Authority during the Hellenistic (400 - 100 BCE) and Roman period (100 BCE - 400 CE)

Nabataean strategies of political authority reflect the mix of international, imperial interests in the region combined with a uniquely Nabataean political order. As mentioned in previous chapters, the earliest stages of Nabataean political formation are known to us historically, not archaeologically. But the two or so hundred years leading up to the earliest well-established archaeological evidence are rich with historical information. One of the hurdles has been with addressing the Romano-centric nature of historical sources, and a critical approach that highlights the perspective of the Nabataeans has been rare amongst classical historians. In later periods when Nabataean society adopted a fully settled lifestyle political organization becomes more clear (Kouki and Lavento 2013; Parr 2007; Schmid 2001, 2005). However, even in these cases interpretive frameworks are highly influenced by Greco-Roman perspectives, and Nabataean society, overall, is granted little agency in the scholarly discourse, which "still focuses largely on the activities of civilizations *in* (i.e. the Greeks and Romans) and not *of* (i.e. the Nabataeans) this Near Eastern context," (Pearson 2011: 1). Recently this trend has been changing, especially as new archaeological discoveries are made that enrich the physical and historical record of ancient life in Nabataean society.

Historical sources describe early Nabataean society during the Hellenistic period (4th-2nd century BCE) as a pastoral nomadic society, presumably one of many in the southern Levant, who neither farms nor builds houses (Schmid 2001, 2005). Not surprisingly, precious little is said about what they do, how their society is organized, etc. The archaeological record is likewise silent – to date no record of nomadic settlements has been recorded prior the earliest Nabataean settlement at Petra in the 2nd century BCE. Nabataean material culture from the Roman period (ca. 1st century BCE - 4th century CE) reflects considerable modification to the political order and social organization of the previous two centuries, including a shift to settled, agricultural life. In addition, Nabataean elites utilized a number of strategies to accumulate and maintain political authority. These strategies included construction of monumental architecture, control of overland trade routes, maintenance of a standing army, and construction of military fortresses and garrisons.

Monumental architecture primarily included tomb burials and works of hydraulic engineering. The significance of the built environment as an expression of political authority is clear from the tomb facades and cityscape of Petra, the Nabataean capital city, where elites went to considerable effort to inscribe their authority into the canyon walls and valleys (Bedal 2001; McKenzie 1990). Elite tombs were carved into the sandstone cliffs throughout Petra. Their size reveals the considerable level of organization required to execute the design, while the aesthetic details demonstrate the presence of a highly specialized group of artisans. The artistic style reflects both Roman and Parthian influences in addition to a local Nabataean style (Anderson 2002; McKenzie 1990).

The spice and incense trade from southwest Arabia was an important source of wealth for Nabataean elites. As early as the 4th century, we learn from historical sources that the Nabataeans invested considerable resources in the control of maritime and land routes. During the Roman period this continues at a much larger scale. The Petra region was also of significance to this trade, as not only did overland trade routes pass through the capital, but also the region was home to indigenous plants such as balsam, whose oil was harvested for mixing with incense (Johnson 1987; Schmid 2001). These plants were important enough that they appear as motifs on Nabataean fine painted pottery.

Nabataean military forces circulated throughout the southern Levant as far back as the 4th century when they defended against attacks from the Seleucid *diadoch* Antigonous Monophthalamos (Pearson 2011: 1). By the 1st century the military appears to have expanded, with the Nabataean kings sending out forces to support neighboring kingdoms as well. What this shows in particular is the intimate knowledge Nabataean elites held of the geopolitics of the regions, as well as their ability to recruit a sizable military when needed.

Even as a relatively small nomadic polity, the Nabataeans can be seen utilizing multiple strategies for political authority. Of course, once settled these strategies were intensified as the centralization of political power allowed elites to extend their rulership to farther and farther regions. Under Roman annexation, the Romans coopted many of these strategies for their own. The nature and scale of centralized political authority created dramatic changes in the political landscape that can be observed in the settlement patterns of the region, discussed below.

Models of Iron Age Political Organization and Resistance in Southern Jordan

Resistance to centralized political organization was probably a common feature in ancient complex polities, whether or not this information can easily be gleaned from either archaeological or historical records. A case in point is the Iron Age of the southern Levant where researchers have examined the formation of the Israelite identity through the process of ethnogenesis (Faust 2006; Levy and Holl 2002). The arid and rugged deserts of the southernmost portions of the Levant offered an ideal location for groups aiming to resist incorporation into states and empires. In fact, southern Jordan has often been a focal point of resistance to state power for the last 3000 years. For the Iron Age, this is particularly true of a certain type of settlement found throughout the plateau and steppe regions, what I will refer to as mountaintop settlements. These settlements exhibit considerable diversity in their size, location, and in the material finds recovered by archaeologists. Nevertheless, they also share some common characteristics which suggest that many of these groups retained substantial autonomy from state power that was beginning to coalesce at centers like Busayra. For the present study, mountaintop settlements include a number of sites defined by: their remote and somewhat isolated location; and their construction on a mountaintop, inselberg, monadnock, hilltop, or other similar landscape feature that is difficult to access.

If Iron Age sociopolitical organization on the plateau reflects a trend of increasing political centralization, then the rugged, mountainous zones reflect one of maintaining autonomy and resistance to the new political order. The marginal landscape of those inhabiting mountaintop settlements surely played a significant role in structuring sociopolitical relationships within local communities and inter-regionally. In fact, many of these sites share some basic characteristics of autonomous societies: a location in remote and isolated areas, a subsistence strategy of mixed agro-pastoralism, construction of local paths and trails, and interaction with the Edomite polity.

Mountaintop settlements have been generally conceived in two ways: the first emphasizes the fragmentary nature of tribal social organization and the resulting heterogeneity of Iron Age settlements; the second focuses on the idea that tribe were united under a system of extended kinship, real or fictive, and thus interprets mountaintop sites as being within the political order of the Edomite polity, explaining heterogeneity as a contingency of the historical development of the southern Levant. Both of these approaches have strengths, but neither satisfactorily captures the nuance of political development in southern Jordan.

When a number of mountaintop settlements were discovered in the 1980s, Zeitler initially proposed that settlement location was correlated with observable differences in Iron Age pottery typologies (Lindner *et al.* 1996a; Lindner *et al.* 1996b; Zeitler 1992). His 'bipartite' hypothesis stated that similar locations led to similar ceramic assemblages, and that two types of Edomite settlements could be identified: first, those in high mountainous zones, with a high ratio of undecorated coarse wares and restricted variety of functional shapes, mostly related to storage; and second, those in favorable, low-relief areas, with a higher ratio of fine ware and decorated pottery, diversity of ceramic types and decorations, and similar ratios of tableware and vessels for storage. Mountaintop settlements lack significant amounts of the painted pottery Bennett ascribed to the Edomite elites (Bennett 1975), indicating an absence of a ruling class. As many of the sites dominate rich sectors of arable land, while at the same time occupying an extremely marginal position, Zeitler believes they may have functioned as centers of regional control, an extension of the emerging central polity at Busayra.

Archaeologists have since elaborated on Zeitler's hypothesis, especially because it can be made to fit nicely with an historical interpretation of Edom. Lindner *et al.* argue that mountaintop settlements may have been used as refuges from the end of Edomite history, when hostile Arab tribes invaded the plateau and displaced its former inhabitants (Lindner *et al.* 1996b). Prior to this, however, they argue that mountaintop sites developed as "citadels" or "strongholds" of individual competing clans or tribes who were subjected under a colonial occupation by the Assyrians. Of course, this is problematic for two reasons: first, the dual conception of tribalism as primitive groups striving for independence while at the same time warring amongst each other is outdated and oversimplified; and second, it implies the sites served a defensive purpose, which does not stand up to further scrutiny (see below).

Lindner *et al.* further propose that the mountaintop settlements constituted part of broader settlement system (Lindner *et al.* 1996b). Assuming that the presence of fine wares indicates a the centrality of a site, they assert that the small, agricultural villages such as Khirbat al-Mu'allaq and at-Tayyiba would have been the interface between local tribes and state administration. The mountaintop sites, then, would have been occupied temporarily, either by the pastoralist contingent of the nearest village, or during times of duress as in the case of a foreign invasion. Accordingly, mountain zones were mostly used by the pastoralist segment of the population, while the villages on the plateau provided a secure water supply and source of cereals.

In the broader context of Edom's position within the regional political economic system, Lindner *et al.* state that significant agricultural land would have been required to produce a surplus once Edom was integrated into the larger regional economy of the Near East: "The precocity of Edom's economic position may serve as an additional explanation for the construction of the mountain strongholds as a last and desperate attempt to increase the area of crop and meat production," (1996b: 163) Thus, an additional explanation for the broader context of the mountaintop settlements relates Edom's extreme marginal location to the agricultural needs imposed during the Assyrian induced "Edomite agricultural revolution."

Lindner and Knauf would later revisit this synthesis of Edomite mountaintop settlements (1997). Still adhering to the bipartite hypothesis originally proposed by Zeitler, Lindner and Knauf suggested that the mountaintop sites share four common characteristics: non-permanent settlement; severely restricted accessibility; agricultural storage facilities; small pockets of farmland nearby; and the absence, or near absence, of fine-wares. Their explanation essentially points to the largely pastoral occupation of the inhabitants of the mountainous regions, and their relationship to the agricultural settlements on the plateau, which they viewed as complimentary. What the mountains provided to the plateau villages was security and livestock, while mountain settlements were dependent on the villages for agricultural products, evidenced by the many agricultural storage facilities. Overall then, the dichotomous settlement pattern is to be understood as a regional framework of complimentary economy and ecology in which mountaintop settlements are integrated within the newly centralized state hierarchy (Bienkowski 2011a; Lindner and Knauf 1997).

Resistance - Another Perspective

What these models of sociopolitical organization share is the view that Iron Age society was united under a centralized settlement system. Mountaintop villages exist as the farthest extension of the political center at Busayra – pastoralist satellites integrated within the tribal structure of the Edomite polity. Unfortunately this postulated political structure is lacking in archaeological evidence. Rather, the model relies most heavily on historical descriptions of the Edomite kingdom, and outdated theories of agriculturalist-pastoralist dichotomies. Aside from occupying a similar geographic area, there is little to suggest that mountaintop settlements were integrated into the regional political structure. Instead, we must consider these settlements as outliers, perhaps partially integrated but semi-autonomous communities who intentionally avoided the new centralized political system. In this section I argue that mountaintop communities strived to retain autonomy from the new centralized political institution at Busayra, in many ways resisting conformity to the political structure, outlining several features of mountaintop communities that parallel archaeological and ethnographic examples of societies resistant to state imposed political structure. These features include: settlement locations in remote, difficult terrain; a flexible, agropastoralist subsistence base; unique forms of territoriality expressed primarily through the construction of local paths and trails; and limited interaction with Edomite political centers.

Compared to settlement in the core area of the Edomite polity, mountaintop settlements are an enigma in their extremely marginal and remote locations. As we have seen, Edomite political authority was partially based on the sedentarization of previously nomadic groups and the adoption of agriculture. The sedentarization occurred primarily on the flat, arable reaches of the Jordan plateau, where rain-fed agriculture was possible. These agricultural settlements were often unwalled, and were surrounded by flat, arable land; overall they were easily accessible and transport was facilitated by the major north-south route running along the plateau (Figure 5.2).

Life on the plateau stands in stark contrast to the lives of those who inhabited mountaintop settlements. These settlements were typically built atop a prominent mountaintop or inselberg, which rises high above the flatter terrain below (Figure 5.3). Extreme topography and isolation seem to have been at the forefront of criteria for deciding where to live, as there are no earlier settlements on the mountaintops. The topography affords natural defensibility, both in terms of isolation as well as physically. While some settlements appear to be walled, it is unclear whether these serve a defensive purpose or played another functional role. Such sites are often referred to as "strongholds" (Beit-Arieh 1999; Lindner and Farajat 1987; Lindner *et al.* 1996b), and indeed they are naturally defensible, which may have initially played a role in the choice of location. But the conclusion that these were mainly defensively-oriented sites is surely premature. In agropastoralist societies, for example, there is evidence for large walls being used as windbreaks and hunting blinds, to delineate territory, to facilitate storage, and especially in mountainous regions, to protect vulnerable, exposed parts of the slope with retaining walls (Bienkowski and Chlebik 1991). As previous systematic surveys around mountaintop sites have demonstrated (Bienert *et al.* 2000), the local landscape was utilized to serve the subsistence needs of the local community, for facilitating travel, and to reinforce sociopolitical organization.

Site 116 (henceforth Qurayat Mansur), for example, which measures approximately 1.2 ha, was built on an inselberg in the westernmost part of the survey area, and resembles a mesa overlooking the Wadi Arabah (Figure 5.4 and Figure 2.5). Due to the paleo-topography, when the site was established in the Iron Age natural cliffs surrounded the site on more than 75% of its circumference. To the north of the settlement the stream descends westward into the Arabah Valley via a series of 12 waterfalls, some 50-60 m high (Figure 5.5). This landscape is impassible without rock climbing gear. Pools of fresh water, fed by the Wadi al-Feidh spring, accumulate below the waterfalls year round.

Perhaps in opposition to the sedentarization and adoption of agriculture that occurred among plateau sites, mountaintop settlements did not fully convert to sedentary agricultural life. This has become clear from surveys and excavations at the sites, which showed that mixed agropastoralism was likely practiced (Bienert *et al.* 2000, and Chapter 2 of this dissertation). These findings call to question Knauf's suggestion that the mountaintop settlements represent a pastoralist segment of Edomite society. Of course, subsistence and social organization are closely related and changes to one often impact changes to the other. So the adoption of a mixed agropastoral subsistence pattern, and the refusal to fully sedentarize and produce cereals and grains should be considered as more than just a way to get food: it's a profound social statement that positioned local communities in opposition to nascent political order.

Systematic survey around the area of Qurayat Mansur demonstrated that small terraces were used during the Iron Age for the cultivation of crops (see Chapter 2). The rugged nature landscape prevented extensive agriculture, especially directly adjacent to the site, but it seems that many small, arable patches of land - all within a few kilometers - were utilized during the late Iron Age (Figure 5.6). Similarly, Ba'ja III was constructed high atop an inselberg where the cultivation of crops would have been difficult or impossible (Bienert *et al.* 2000). Nearby, however, the excavators identified many small terraces and plots where small-scale cultivation would have been possible (Figure 5.7). In short, the hypothesis that these sites were used exclusively by pastoralists must be rejected, and the agropastoralist subsistence practices identified at many of the mountaintop settlements suggests the sociopolitical organization of the marginal regions of Edom was precarious, if not fragmented and autonomous.

Another common features of mountaintop settlements is the construction of local paths and trails. As Snead (2011) has argued, paths and trails connect people to other nodes on the landscape, but are meaningful places in their own right whose significance emerges from quotidian associations of movement. Snead makes an important distinction between formal "roads of control" associated with activities of state power, and local paths and trails. From the perspective of ancient states, constraints on movement between places was an integral part of state power.

Archaeologically, roads have often been examined as part of the infrastructure of war, particularly as pertains to ancients states. Road networks as essential elements of the Andean, Mayan, and Roman states and empires have been discussed at length (Chevalier 1976; Davies 2002; Hyssop 1984; Kennedy 1997; Shaw 2008). Formal road features associated with these networks facilitated the movement of armies and supplies, and acted as elements of administration. Their relative formality reflects functional practices but also symbolizes political power (Laurence 1999). These roads differ from local paths and trails in their scale, daily use, and association with state institutions. For paths and trails, they are less mechanisms of political domination than ways to connect social groups and territories. Formality would have been reflected in associated features such as shrines, landmarks, and especially in the visible wear of the path itself. In the process we can also see reflections of ideology and identity, but in a more fluid and negotiable way than formal roads.

In a landscape of steep crags, cliffs, and deep ravines, the presence of local paths and trails is not surprising, but the evidence of significant investments of time and labor stand out. While these trails do not reflect resistance to state incorporation per se, it is more likely that they demonstrate the connection of the groups inhabiting mountaintop sites to the local landscape. Since we now know that the subsistence economy at many of these sites was mixed agropastoralism, the functional importance of these trails cannot be understated in the functioning of daily routines leading individuals between their homes and their crops. Beyond this, it is not uncommon in ethnographic and archaeological examples for these features to demarcate a groups territory, or to carry symbolic significance of rite of passage through the landscape. One can imagine how local trails may have led certain groups to family owned agricultural plots, reinforcing the manner in which social relations played out on the landscape.

Many mountaintop settlements made extensive use of trails. Qurayat Mansur, for example, is accessed by a single trail from the valley bottom. This trail has been built into the hillside by cutting into rock in some places, and through the construction of switchback trails in others (Figure 5.8). At Umm al-Biyara and Ba'ja II trails were elaborately carved into the sandstone bedrock, and in many places stairs were even carved to lead the way to the site. Interestingly, these paths are fairly secluded, and despite the time and labor invested in them, it would seem they were not meant for just anyone to find and travel along. Their subtlety and isolation suggests they were intended for the inhabitants of the site, rather than as a statement of power or wealth meant for others to behold.

Inasmuch as political autonomy was strived for by mountaintop communities, excavations at many sites suggest that there was interaction with Edomite political centers. The exact nature of this regional interaction is somewhat unclear, as extensive excavations have only been conducted at Umm al-Biyara, where the excavator recovered Neo-Assyrian and Neo-Babylonian seal bullae, an Edomite ostracon, and a number of small prestige items, including Bronze implements and jewelry, and an alabaster cosmetic palate (al-Ghul 2011; Bienkowski 2011c; van der Veen 2011). Still, one would be safe in assuming that such interaction was a salient feature of settlement in southern Jordan. What this information tells us is two-fold: first, that mountaintop sites and plateau settlements were contemporaneous, and second, that communities inhabiting the remote, mountainous areas were fully aware of the political order on the plateau. Regional interaction need not exclude the possibility of political autonomy.

Interaction between marginal communities and centralized states can take many forms, including raiding, warfare, trade, and exchange. In this sense, Lindner and Knauf's suggestion that Edomite political economic structure reflects geographical complementarity is worth recalling: the primarily agropastoralist communities engaging in exchange relationships with plateau agriculturalists. However, one must be critical of assuming that these relationships were always positive – always serving the needs of the political center. An alternative to this top-down perspective, the one advocated here, would view mountaintop settlements as agents acting in their own best interests. This might have involved trade in subsistence goods or other consumables, marriage alliances, payments to prevent raiding of villages (or to raid a neighboring village!), and permission to graze animals following a harvest.

Models of Roman period Political Organization and Resistance in Southern Jordan

Dealing with the issue of political authority and resistance during the Hellenistic and early Roman periods is complicated by a number of factors. First, classical historiography and much of classical archaeology has largely maintained a top-down perspective focused on Greco-Roman imperialism, military institutions, and economic strategies. As this west-centric bias has been greatly influenced by classical works by Greek and Roman authors, those who would oppose the spread of "civilization" are marginalized to the category of barbarians. The nuance of tribal sociopolitical organization was surely lost on most ancient historians, as was the complexity of many of the smaller polities the Greco-Roman empires encountered during periods of expansion. In turn, this has shaped much of our current understanding of ancient nomadic peoples.

Second, the bottom-up perspective that has become popular in some anthropological approaches to states and empires has only recently made its way to the southern Levant. Recent book titles on Near Eastern archaeology under the Roman empire make this clear: "The Roman and Byzantine Near East" "The Roman Army in the East" "The Late Roman Army in the Near East" "The Defense of the Roman and Byzantine East" "The Roman Frontier in Central Jordan". Chapters in these volumes have made great strides in our understanding of imperial strategies, frontier studies, and the interregional political economy. However, archaeological studies of indigenous communities, small-scale political complexity, subaltern studies, and resistance have been relatively fewer in comparison. Some notable recent exceptions include work in the Libyan valleys (Barker *et al.* 1996), southern Jordan (Barker *et al.* 2007b), and the Greek countryside (Alcock 2002). These novel projects have made significant contributions to the archaeology of people without history.

A third issue stems from the archaeology of southern Jordan during the formative period of the Nabataean kingdom. While historical sources put the emergence of a complex, nomadic society at the beginning of the 4th century BCE (see below), the earliest reliable archaeological evidence dates to the 2nd century BCE. Our understanding of the processes behind the sedentarization of Nabataean society and the adoption of agriculture is severely limited by this lack of archaeological data, as are many of the sociopolitical changes that occurred during those 200 or so years. This is further complicated by the lack of textual data from the perspective of the Nabataeans.

Despite these hurdles, loci of resistance can be identified in the archaeological and historical record. In general, there are two ways this can be framed. The first is resistance on the part of marginalized polities to an imperial political order. The Nabataeans, both in their early stages as a nomadic polity and in their later development as a sedentary kingdom, often expressed their independence and native identity in the face of pressure from imperial encounters. Most commonly this occurred with the Roman empire, but also with the Seleucids, the Ptolemies, and the Persians. The second frame is the resistance to a centralized political order. In this case it was often Nabataeans political authority that was being avoided by nomadic and tribal groups. Through time it seems these groups were pushed farther and farther to the margins as the frontier of the Roman empire extended to the southeast and became increasingly militarized. The data presented below are derived from both historical sources and from archaeological research – in particular, the settlement pattern data from my 2009 survey of the Wadi al-Feidh, as well as the surveys by MacDonald, Parker, and Fireman have been particularly useful in reconstructing the geography of resistance in southern Jordan's Hellenistic and Roman period.

Hellenistic Period (4th-1st century BCE)

Early Nabataean resistance to complex states can be gleaned from 4th century historical accounts of their encounters with the *diadoch* Antigonos Monopthalmos. Though historical sources have tended to portray Nabataean society through the common trope of the marginal nomad, Pearson (2011: 5-7) has suggested that early Nabataean society retained considerable autonomy and economic influence, taking advantage of the local desert landscape and their position between two hostile empires. There is regrettably little archaeological evidence for this time period in southern Jordan. Archaeological surveys report little or no ceramics from these formative days of the Nabataean society, so at present, we must rely on the historical sources for evidence of resistance and political autonomy.

Recounting a story in Diodorus Siculus' universal history, Pearson explains that after the death of Alexander the Great in 323 BCE, the *diadochoi* shaped much of the political landscape of the ancient Near East. Under Antigonos Monopthalmos' expansionist policy the "Arabs called Nabataeans" were targets for raiding and tribute collection. Antigonos sent his friend Athenaios to lead 4000 light infantry and 600 cavalry into the Nabataean homeland, and upon their arrival in Petra found that the adult Nabataean men were away for an assembly. With only the women, children, and old men left behind it was easy for Athenaios and his troops to plunder what spices, incense, and silver talents they could find. When the Nabataean men returned they pursued Athenaios and his troops with a force of 8000, easily overtaking them and destroying all but 50 cavalry. In addition, the Nabataeans wrote to Antigonos in

Aramaic, the *lingua franca* of the time, to complain, which suggests the Nabataeans had regular dealings with other regional powers.

In return, Antigonos sent his son Demetrius Poliorcetes with 4000 infantry and 4000 cavalry against the Nabataeans. His troops were easily spotted in the desert, and alerted by fire signals, the Nabataeans sent their property and many troops into Petra; at the same time they divided their flocks and sent them into the desert. Despite the size of his force, Demetrius could not take the Nabataean's stronghold, and during parley he was chastised for making war on desert people, who had no grain or wine. It made no sense for the Greeks to stay there, as they had no water and would never be able to force any of the Arab tribes to change their lifestyle. Demetrius was therefore left with no other option but to depart with gifts and hostages.

Unsatisfied with this results, Antigonos sent a third force to the region under the general Hieronymus with instructions to collect asphalt from the Dead Sea. However, a force of 6000 Nabataeans, sailing on reed rafts, killed most of Hieronymus' troops with arrows. On this third defeat Antigonos finally gave up, instead turning his attention to the growing threat from Seleucus in central Asia.

What makes these three encounters particularly interesting is the information we can glean regarding early Nabataean society. Despite the Greco-Roman tendency to portray nomadic peoples inhabiting unincorporated regions as barbaric, dangerous, and antithetical to civilization, we learn from Diodorus that the Nabataeans commanded a sizable military, accumulated substantial material wealth, and wrote in Aramaic. In addition, the Nabataeans traded frankincense, myrrh, and other spices from *Arabia felix*, harvested asphalt from the Dead Sea, held a monopoly on Balsam production, and built sophisticated reservoirs. As nomads, they did farm grain to a relatively small extent, build houses, and could easily retreat to the desert if necessary to escape a threat. Their knowledge of the deserts resources, especially sources of water, imparted a huge advantage over foreign powers, who were less maneuverable and familiar with the landscape.

From this perspective, formative Nabataean society exhibited considerable complexity, advanced political and economic organization, and autonomy from foreign powers, all whilst keeping their relatively non-settled lifestyle. Despite the lack of archaeological data it is still possible to identify episodes of resistance and autonomy expressed in the historical records.

Early Roman Period (1st century BCE-1st century CE)

As a settled society Nabataean sociopolitical order underwent some dramatic changes, apparent in both the archaeological settlement pattern data and historical records. On one hand, the Nabataean kingdom emerged as a secondary state that made significant effort to maintain autonomy from foreign empires such as Rome and Persia. This independence and new sociopolitical complexity can be seen in the rapid expansion of agricultural production on the part of the Nabataean kingdom, evidenced by surveys in the hinterlands of Petra. On the other hand, as a secondary state, the Nabataeans themselves became an object of resistance. Unlike the previous Iron Age period, Nabataean political centralization and integration had more completely spread throughout their territory. Even in the mountainous zones of autonomy discussed for the late Iron Age, Nabataean political hegemony was able to extend and influence the settlement patterns in the region. Before discussing this settlement pattern data, however, evidence from historical sources will briefly be reviewed.

Evidence from coinage has been cited as among the most reliable evidence on the new political economic order, particularly because of the relative certainty in their date and ethnic attribution: the earliest mints are credited to Aretas II (120/10-96 BCE) or Aretas II (87/84-62 BCE) (Bowsher 2007; Schmid 2001; Schmitt-Korte 1990). Originally these were minted in Damascus, but within a half century were minted in Petra (Schmitt-Korte and Price 1994). In the years following 63 BCE Nabataean coinage displays a distinctly Nabataean character. This can be seen both in the use of Nabataean script instead of Greek inscriptions, as in previous Nabataean coin issues, and in the title given to the king Obodas II. While it has been suggested that these changes reflect the Roman domination of the area and their liberal attitude toward vassal kings in frontier regions, this rests on the assumption that Nabataea became a vassal or client state of Rome following the subjugation of neighboring areas. Truthfully, though, the status of the Nabataean kingdom changed little with the expansion of Roman hegemony into the eastern Mediterranean, at least in the 1st century BCE. Another perspective of the coinage views the minting as statement of Nabataean autonomy and an expression of their growing political and cultural influence (Pearson 2011; Schmid 2001). And though Rome had certainly demonstrated its new role in the regional political economic landscape, from the Nabataean perspective this did not necessarily signal subjugation.

In the larger context of Nabataean cultural development, the information from this early coinage fits into a trend of increasing Nabataean socio-political complexity, coincident with production of new and highly technical ceramics, monumental architecture, and urban construction during the 1st century BCE (Joukowsky 1998; Schmid 2001). The general view of this development has been that Nabataean culture lacked indigenous artistic forms and thus turned to the outside world for models, of which the Hellenistic world was the primary source. Facing increasing Roman influence after the year 63 BCE, Nabataeans became increasingly "Romanized," and only around the end of the 1st century BCE did they develop a distinctive Nabataean style of their own.

While this general outline is unproblematic in its broad form, Pearson argues that Nabataean cultural development has not been sufficiently explained with relation to the geopolitics of the region, in particular during the early Roman period. He writes, "in the elements of their material culture discernable [sic] in the archaeological record, the Nabataeans did not slavishly adopt Hellenistic or Roman forms. One must fully credit the Nabataeans for their actions in the cultural as well as in the political spheres and must be continually wary of viewing cultural innovation, or historical events, through the prism of the inevitability of Roman domination," (2011: 30). In fact, the monuments at Petra reflect an international character, combining Assyrian, Persian, Egyptian, Hellenistic, Roman, and Arabian traditions (McKenzie 1990).

During this time the Roman and Parthian empires were at odds, warring over territories on their borders in Asia minor, the southern Levant, and northern Arabia. The Nabataean kingdom not only fell on this boundary, but also occupied valuable territory on the Red Sea trade routes. Such a position surely bestowed on them a certain level of autonomy, as no one wanted to interrupt the flow of goods coming from Arabia, nor would they have wanted to overplay their hand and disrupt the delicate balance of power between the East and the West that centered over the Levant. In this sense, it may be more accurate to describe the Nabataean kingdom as a buffer state (using the model by Parker above), rather than a vassal of Rome. There is abundant evidence for this degree of autonomy in historical sources, where we repeatedly see the Nabataean kingdom negotiating with foreign powers, including Rome, Parthia, the Ptolemaic Kingdom, and the Judean kingdom under Herod.

Early Roman period settlement patterns parallel the development of the Nabataean kingdom during the 1st century BCE (Figure 5.9). Throughout southern Jordan, new settlements were founded by the Nabatean kings, reflecting trends of sedentarization, state-building, and enhanced monarchy in an effort to stay competitive in long distance trade, to fill the power gap left by Seleucids, and to compete with the Ptolemies. Humayma, for example, was founded sometime in the 1st century BCE by either King Aretas III or Aretas IV (Oleson 2010: 50). The settlement was located in an area well suited for agricultural production and close to the King's Highway, one of the main trade routes and road systems created or extended under the early Nabataean kingdom (Figure 5.10).

Surveys throughout southern Jordan have revealed a marked increase in survey sites and ceramics of the early Roman period ('Amr and al-Momani 2001; 'Amr *et al.* 1998; Abudanh 2004, 2006; Frösén *et al.* 1998; Hart and Falkner 1985; Kouki 2009, 2012; Lavento *et al.* 2007; MacDonald 1992; MacDonald *et al.* 2004). The results of these surveys parallel those of recent work in central Jordan east of the Dead Sea, where Early Roman settlements increase greatly in number (cf. Parker 2006b). Additionally, these new settlements seem to have been protected by number of small forts and watchtowers, presumably for the protection of newly extended farming and long-distance trade.

The results of the Wadi al-Feidh survey provide additional support for these observations (see Chapter 2). During the early Roman period the number of agricultural sites increases dramatically (Figure 5.11), and the major habitation settlements are abandoned. Furthermore, any indications of the Wadi al-Feidh as a zone of autonomy have been erased by Nabataean agricultural infrastructure. This pattern reflects the significant expansion of agriculture and political authority into the rugged countryside under the autonomous Nabataean kingdom. Unlike the late Roman period, however, there is no indication from the archaeological or historical sources of substantial conflict or animosity between the Nabataean kingdom and nomadic tribes, but this is beyond the scope of the dissertation. In short, archaeological surveys have demonstrated the marked increase in building construction and extensive agriculture undertaken by the Nabataeans, particularly around the area of Petra, but beyond the core area of the Nabataean kingdom as well, and the effect of this new economic organization on the political landscape.

Nabataean cultural fluorescence and settlement expansion reflects the strategies of independent Nabataean kings in the process of state-building, surely influenced by the growing influence of Rome, but still standing on its own two legs. Resistance to political authority, then, is primarily seen in the attempts made by the developing Nabataean polity to maintain its independence from neighboring empires. The Nabataean kings were able to do this using a combination of strategies: by controlling land and sea trade routes coming from the Red Sea and Arabia, by maintaining (usually) neutral diplomatic relationships with other kingdoms and empires, by expressing their own political and economic capabilities via coin minting and monumental construction, and by expanding urban and agricultural construction throughout their territory.

Late Roman Period (100-400 CE)

The Roman annexation of Nabataea around 106 CE represents a major loss of political autonomy for the Nabataean kingdom. The exact nature of the annexation is yet unclear, as a number of excavated sites in the Negev and in southern Jordan, including Oboda, Sbaita, Moje Awad Dhiban, Khirbet edh-Dharih, Petra, Humayma, and Aila, have revealed evidence of either discontinuity or destruction levels around the beginning of the 2nd century CE (Parker 2009; Schmid 2001). Additionally, there were some significant changes instituted by the Roman empire following the annexation. This includes the construction of military forts and garrisons at a number of Nabataean settlements, the extension of the *Via Nova Traiana* south to the port of Aqaba, and the subsequent militarization of the southeastern border along this new road (Graf 1992, 2001; Parker 1986, 1987b).

The Romans likely anticipated the possibility of substantial Nabataean resistance, and employed legionary and auxiliary forces from Egypt, Palestine, and Syria. If there were hostilities, we do not know the extent or duration of such resistance. However, Parker argues that this may explain some of the inconsistencies in the beginning of the annexation in 106 CE, and the dating of the first milestones along the *via nova Traiana* and the first coins commemorating the annexation to the year 111 CE and later. There cannot have been too significant of a resistance given that much of the Nabataean army was incorporated into Roman military service (Kennedy 2000) and transferred to the eastern frontier (Parker 2009). Unfortunately, there is ambiguity in the sparse literary sources dating to this period, and archaeological studies have revealed that despite the evidence for extensive destruction, whatever resistance was made was soon followed by a continuation of characteristically Nabataean material culture. Many of the Nabataean cultural styles persist throughout this period, leading some scholars to suggest the Roman annexation may not have greatly impacted some elements of Nabataean society.

There is some evidence that the effect of the annexation on the region varied. The results of intensive surveys east and southeast of the Dead Sea, as well as the Wadi al-Feidh survey presented in Chapter 2, show a decline in the number of rural settlement in beginning in the 1st century CE, especially at small sites in marginal areas

(Clark *et al.* 2006; MacDonald 1988; Miller 1991; Smith *et al.* 1997). If there was an impact it may very well have led to changes in the hinterland of the Nabataean kingdom more than anything else. Under a situation of occupation, and possible resistance to occupation, it would not be surprising if rural areas, which would have mainly been small farming settlements, were negatively impacted. Many of the main Nabataean centers were either resettled or rebuilt shortly after the annexation and subsequent destruction. The new Roman administration also constructed a number of fortresses and garrisons at important Nabataean settlements in southern Jordan and Israel (Figure 5.12). Overall, the survey data from Wadi al-Feidh and beyond suggest that the zones of autonomy identified for the Iron Age settlement pattern had disappeared in the mountainous zones, which were exploited for agricultural purposes. Even if annexation interrupted the rural economy, it soon after recovered. While the mountainous zones may have lost their capability to support autonomous groups, it seems the construction of a newly militarized frontier instead pushed these groups further to the margins of the eastern desert (Figure 5.13).

The construction of new fortresses and garrisons, along with the transfer of major military troops reflects a trend of increasing militarization along the southeastern frontier. Initially this may have had to do with stabilizing the region, but at the end of the late Roman period, militarization was also initiated in response to increasing pressure and hostility from nomadic Arab tribes (Parker 1986). These hostilities between the Roman empire and nomadic tribes are the final example of resistance to state hegemony and political authority I will discuss in this chapter.

In *Romans and Saracens*, Parker (1986) first suggested that Diocletian significantly militarized the Arabian frontier in response to increasing hostilities with the Arab tribes. Numerous Arab tribes had, of course, inhabited the region more or less continuously for thousands of years. As the Nabataean kingdom grew in complexity and centralization, one can imagine how the requirements of living under a state regime would have led some groups to seek refuge, while others may have simply been displaced by the extension of agricultural production and new settlement centers. Under Roman annexation this may have been intensified – even leading some members of Nabataean society to seek political autonomy.

The precise nature of relations between the Roman empire and Arab tribes has been a source of some debate. The disagreement arises over the question of whether there was conflict or cooperation between nomadic tribes and settled society, and the purpose of the militarization of the Arabian frontier. Based on evidence from the Wadi al-Hasa survey, Banning (1986) argues that the relationship between the sedentary and nomadic segments of the population were characterized by "mutualism" rather than the traditional view of conflict, citing ethnohistoric and archaeological examples of mutually beneficial farming-pastoralist relationships. He suggests that previous archaeological survey methods were often biased toward the collection of data from settled societies, while the remains of nomadic groups were often missed. The "total coverage" methods employed by the Wadi al-Hasa survey, he states, are likely to yield more reliable results, i.e. the recovery of non-sedentary sites, which they do. Based on these results then, he argues that evidence for both sedentary and nomadic populations are identifiable and contemporaneous, and that the settlement patterns suggest cooperation rather than conflict.

Parker (1987a) responded with an cogent critique, noting importantly that the Wadi al-Hasa survey area was entirely to the west of the *Via Nova Traiana*, and therefore west of the zone of military buildup. Overall, his argument states that while the area within the control of the Roman empire was witness to cooperation between agricultural producers and pastoral nomads, but by virtue of the fact that this area was west of the frontier and well within the imperial territory. The area to the east (that is, past the frontier and the line of fortresses and watchtowers) was outside of the zone of control (Figure 5.13). Parker's *Limes Arabacus* survey in central Jordan east of the Dead Sea demonstrates this nicely. His survey extended well beyond the main line of fortresses and towers, and it is clear from the density of sites that settlement was concentrated to the west of the militarized border. To the east of the border settlement is much sparser, and most sites in the eastern region appeared to have been small military installations (Parker 2006b). It is from this region that the Arab tribes mentioned in historical sources lived, and from here that they would raid agricultural villages, caravans, and other travelers along the *Via Nova Traiana.* Overall, then, the Roman goal on the Arabian frontier was to monitor and control raiding by the nomadic tribes. This was accomplished by the system of fortresses, watchtowers, and caravanserai constructed along the major road systems along the frontier.

That the region beyond the frontier was home to a variety of autonomous, nomadic tribes is not new, but the extent to which the Roman empire invested in infrastructure against raiding is worth considering in more detail. This is especially true given that nomadic tribes tend to appear in the scholarly literature similarly to how they were presented in Greco-Roman sources: as homogenous raiders, with a tribal social organization lacking the complexity of their settled neighbors. The agency and the capabilities of Arabian nomadic tribes cannot be understated. Indeed, Mayerson (1989) takes Parker's model of the frontier a step further, arguing that the Romans were largely unable to control the movement of Arab tribes along their borders. According to Mayerson, Rome and it's nomadic neighbors had long engaged in a relationship characterized by both mutualism and conflict, as the Arab tribes both traded with and raided the territory west of the *limes*. In fact, he goes as far to say that:

> we do not possess a recorded instance of a military unit "controlling" a nomadic raid; nor do we have a citation of Romans denying invaders food, water, and fresh mounts, nor of a mobile strike force taking preemptive action to intercept and destroy raiders. On the other hand, there are more than ample citations… to demonstrate the inability of the Romans to control raids by Arab tribes. It is apparent that the Romans were aware that they could not do so, for the military strategy that Diocletian initiated was designed not to control the movement of tribes, but to react defensively to attacking forces (1989: 75)

In this view, the relationship with Arab tribes was more than precariously balanced between trading and raiding. It would seem that tribal groups were frequently able to get the better of the Romans, at least to the extent that the focus of the military installations along the border was not for controlling the movement of the Arabs so much as it was to provide advanced notice of incoming raids, and to monitor and observe their movement so as to be on alert against attacks. That the Arab tribes were so able to keep the Romans at odds attests to their organizational abilities, knowledge of the landscape and Roman methods of surveillance and military organization, and the complexity of tribal relationships with imperial powers.

Conclusion

This chapter has argued that decentralized political organization and resistance to state hegemony were common occurrences throughout the history of the ancient Near East, and that these instances are worth our attention. The material correlates of resistance are often difficult to identify through archaeological survey and excavation, often requiring archaeologists to read "against the grain." The same can be said for the historical sources, which tend to belie the state's frequent dealings with decentralized polities and with resistance to political authority.

That political order is manifested in the landscape is not a new concept, but the application of concepts of territoriality and the spatiality of political landscapes is fairly new particularly to the southern Levant. As southern Jordan represents both a culturally and environmentally marginal landscape, it embodies an ideal location for the study of intersecting histories of political centralization, imperialism, novel strategies of authority, and the various modes of resistance that accompany these processes.

For the late Iron Age polity of southern Jordan, I argued that a unique type of settlements, "mountaintop settlements," reflect not just a pastoralist segment of society, but one that was attempting to resist the emerging complex polity centered at Busayra. The Edomite polity was very successful at controlling a number of areas in southern Jordan, and the dramatic increase in settled, farming villages on the plateau represents one of the successful efforts of Edomite elites in fostering a new centralized polity. In contrast, mountaintop settlements exhibited a number of characteristics that separate them from the typical Edomite settlements, which included settling in remote, isolated, and mountainous terrain, practicing mixed agropastoralism and utilizing a variety of resources available locally, developing unique forms of territoriality expressed primarily through the construction of local paths and trails, and maintaining limited economic ties to settled Edomite sites. Overall, then, the mountaintop settlements can be seen as a "societies against the state," to borrow from Clastres' title, who consciously avoided incorporation into the newly forming Edomite polity. This, in turn, says a lot about the limitations facing Edomite elites and the extent of their territory of control, within which are islands of political autonomy and resistance that would otherwise be lost on a map of contiguous, discrete borders.

The complex political economic changes that occurred from the late Hellenistic period until the end of the late Roman period had a lasting effect on settlement in the region. I argued that the complexity and autonomy of the early Nabataean society – initially a nomadic polity – has not been adequately represented in the historical and archaeological literature. Initially, resistance can be observed in the interactions between formative Nabataean elites and imperial powers. Much of this derives from historical sources, as little, if any, archaeological information exists for these early periods. Following the Roman annexation of southern Jordan, we see increased tension between the Roman empire (and the rural settlement it was protecting), and the nomadic tribes who were pushed to the margins of the Roman frontier. While some evidence of peaceful coexistence between nomads and farmers existed within the boundaries of Roman political control, to the east of the *limes* was a different picture. The tribal groups inhabiting the desert margins engaged in relationships of both trading and raiding with Rome, and frequently kept the Roman military on its toes. Spatially, Roman political authority excluded the potential for the "islands" of autonomy under the Edomite polity. But autonomy and resistance never ceased to exist, but were merely shifted to a new location.

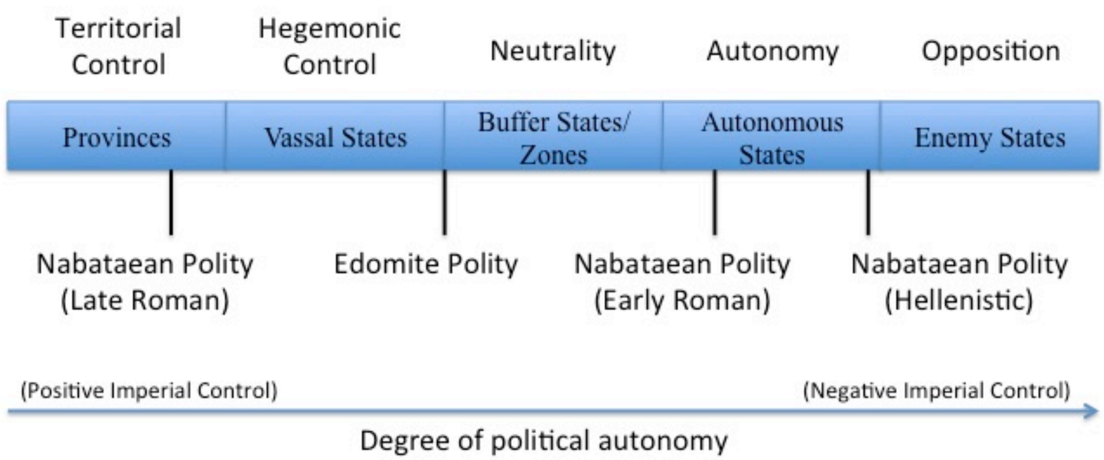


Figure 5.1: Continuum of imperial power showing degrees of autonomy, indicating relative position of Iron Age and Roman period polities in southern Jordan (after D'Altroy 1992; Parker 2013).

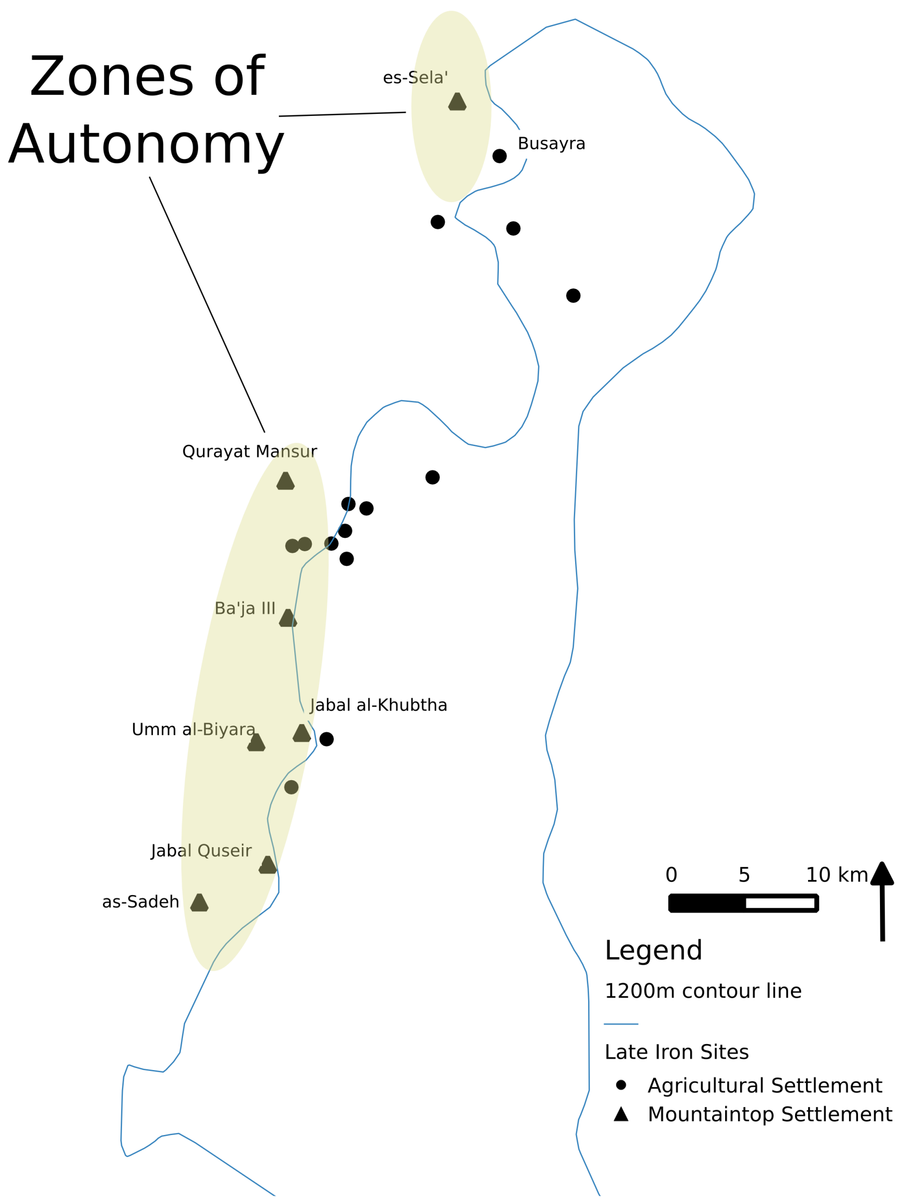


Figure 5.2: Map of Iron Age Settlements showing the location of agricultural sites and 'mountaintop' settlements. The 'mountaintop' settlements are located in a geographical zone below 1200 masl in which the landscape is highly rugged and isolated. This landscape provided "zones of autonomy" for Iron Age communities to resist the new political authority of the Edomite kingdom.

Figure 5.3: Image of mountainous, high relief terrain characteristic of mountaintop settlement locations.

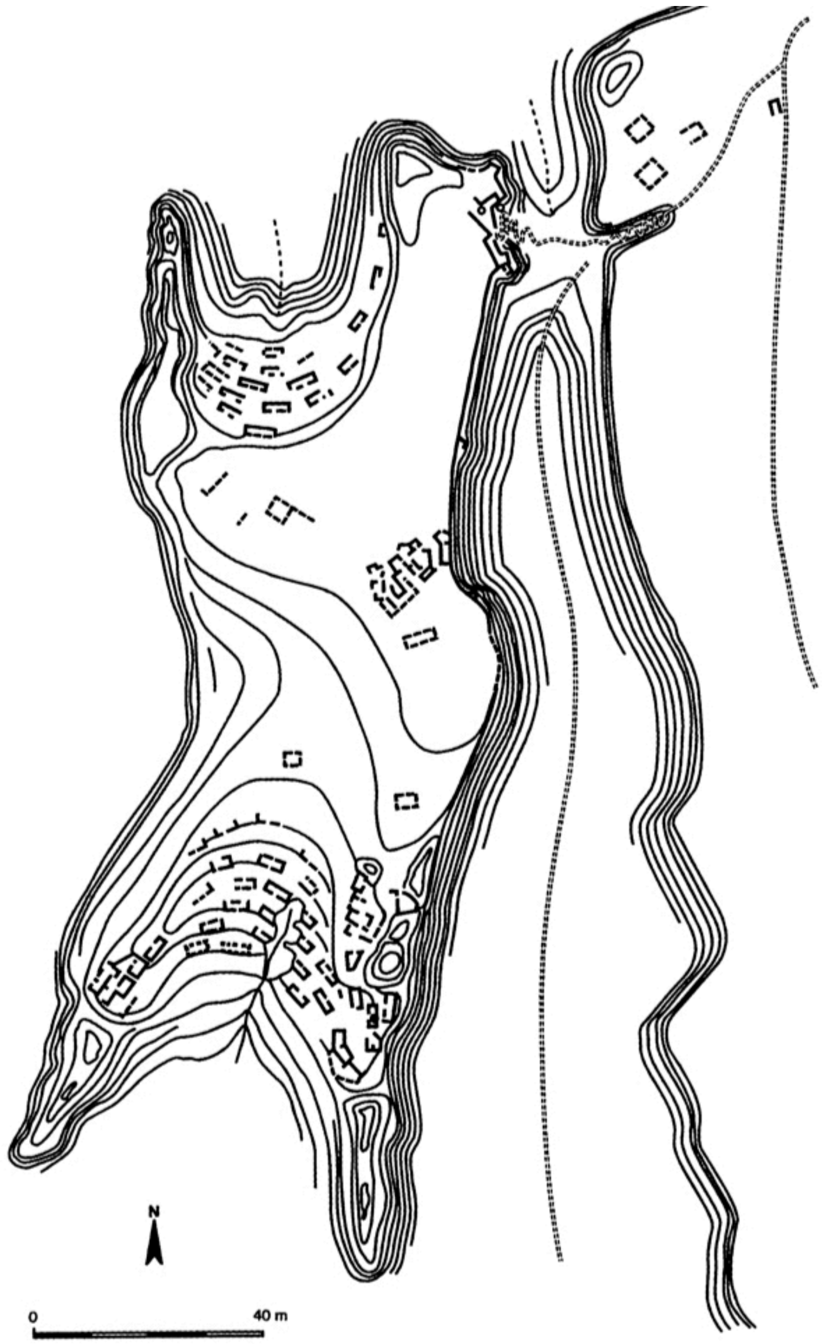


Figure 5.4: Map of Site 116 (Qurayat Mansur) showing architecture mapped by previous surveys and the topography the inselberg the site has been constructed on (after Hubner 2002, p. 266, Fig. 4).

Figure 5.5: Image of pools of water below the waterfalls adjacent to Qurayat Mansur. The settlement is located atop the hill in the upper middle of the photograph, where a steep slope provides access to water from the site.

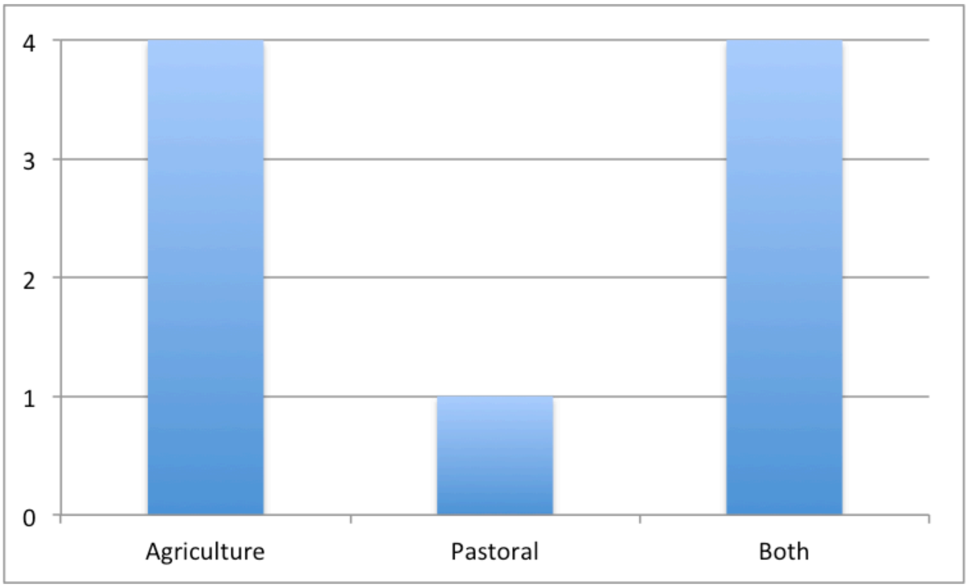


Figure 5.6: Histogram of late Iron Age settlement functions from sites recorded during the Wadi al-Feidh survey. Mixed practices of agriculture and pastoralism are suggested by the survey results. See also Table 2.2.

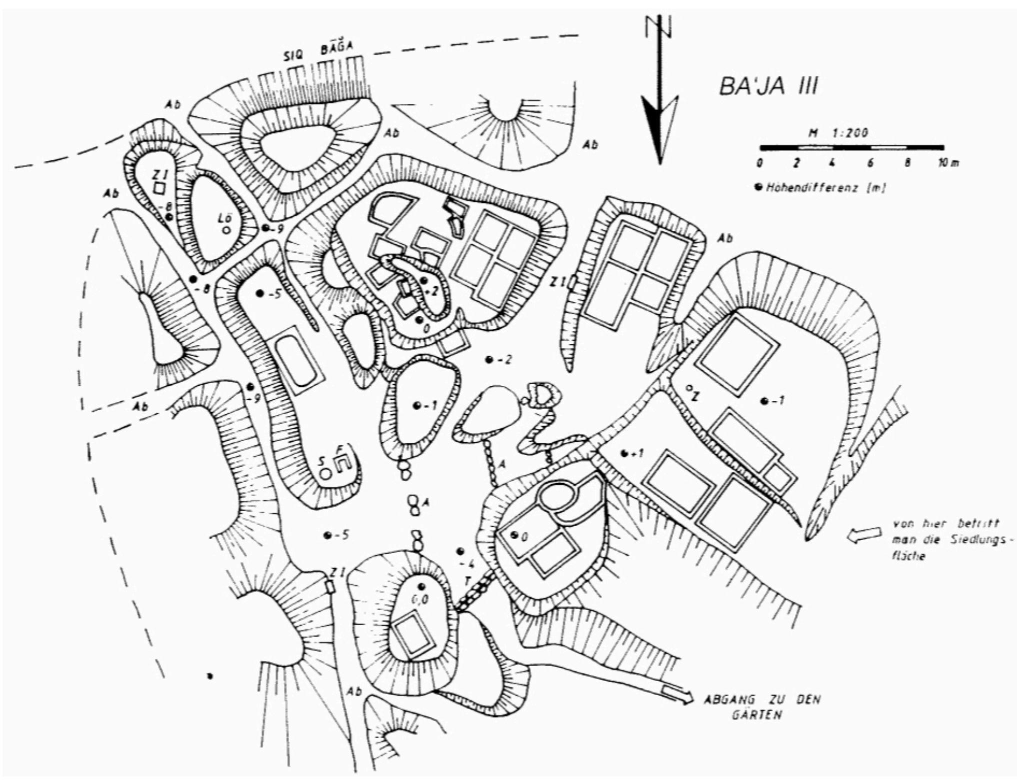


Figure 5.7: Sketch map of the site of Ba'ja III, where excavators identified small terraces and 'garden' plots for small scale cultivation (after Bienert *et al.* 2000, p. 124, Fig. 6).

Figure 5.8: Surveyors walking along the rock hewn trail to Qurayat Mansur. The path is relatively secluded from view from the valley, and would have required a significant labor investment for its construction.

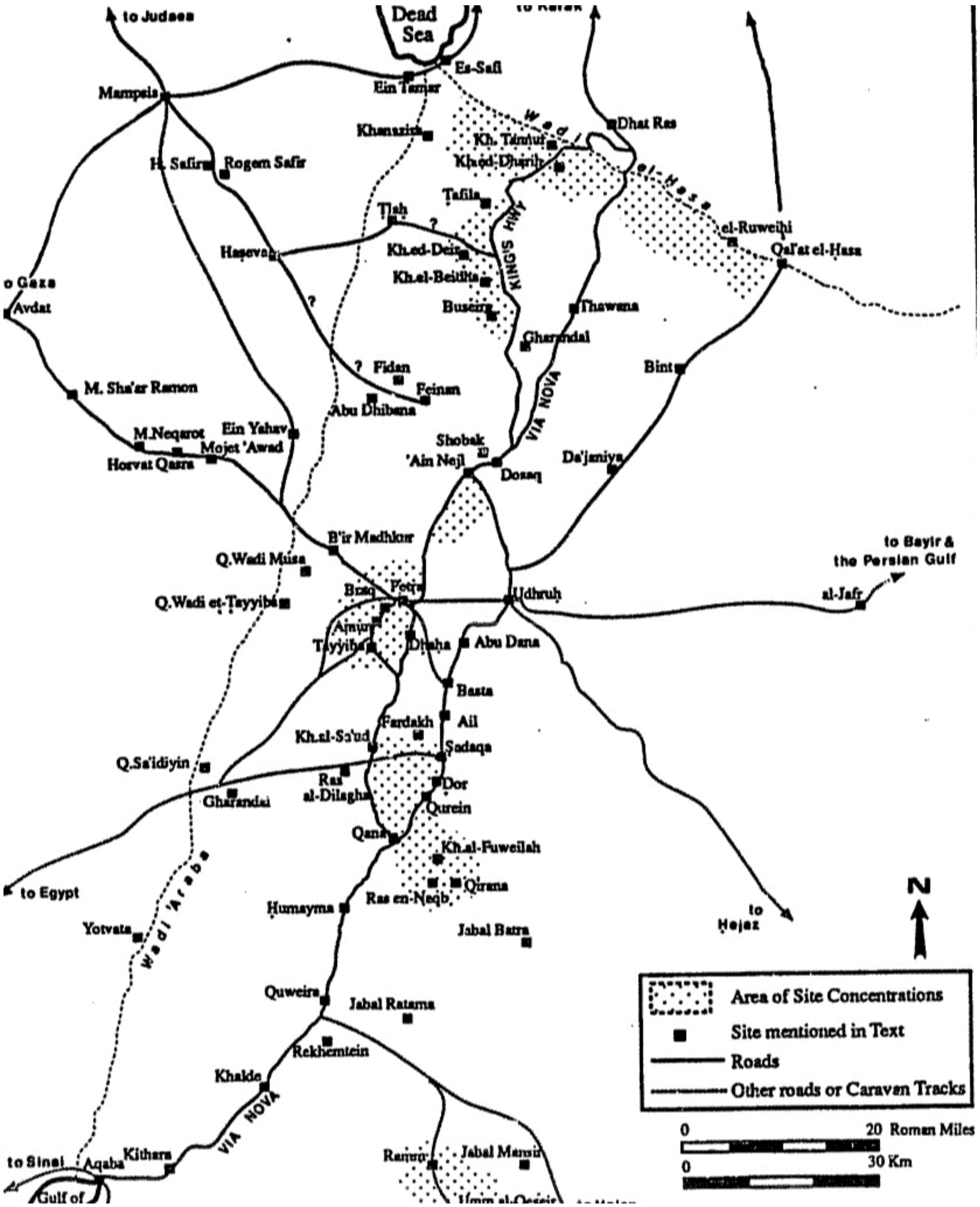


Figure 5.9: Early Roman period settlement patterns for the region of southern Transjordan. Many new settlements were founded by the Nabataean kingdom during this period due to the sedentarization of the inhabitants to enhance political authority (after Fiema 1991: p. 279, Map 5).

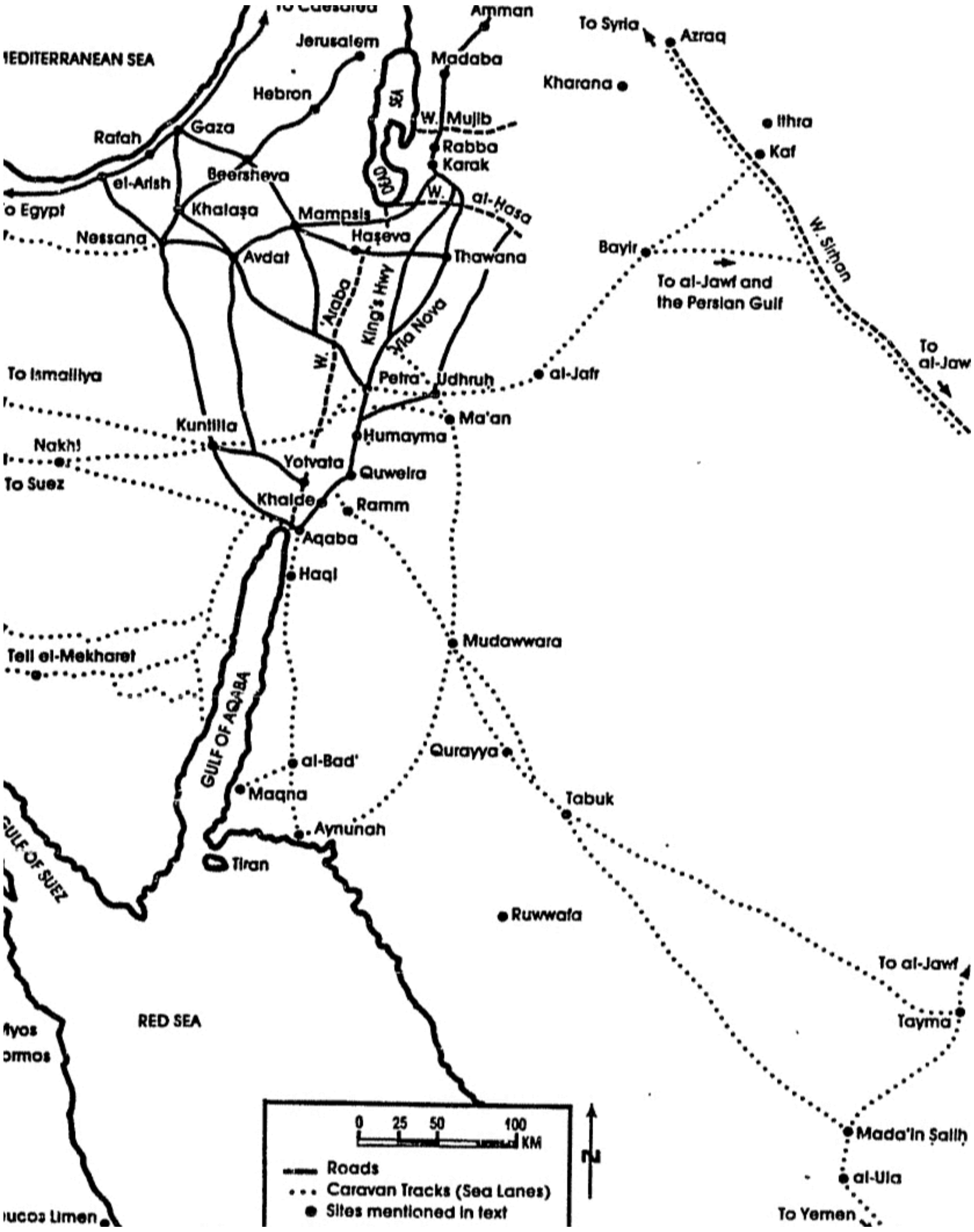


Figure 5.10: Early Roman period trade routes in southern Transjordan and Arabia. (after Fiema 1991: p. 278, Map 4).

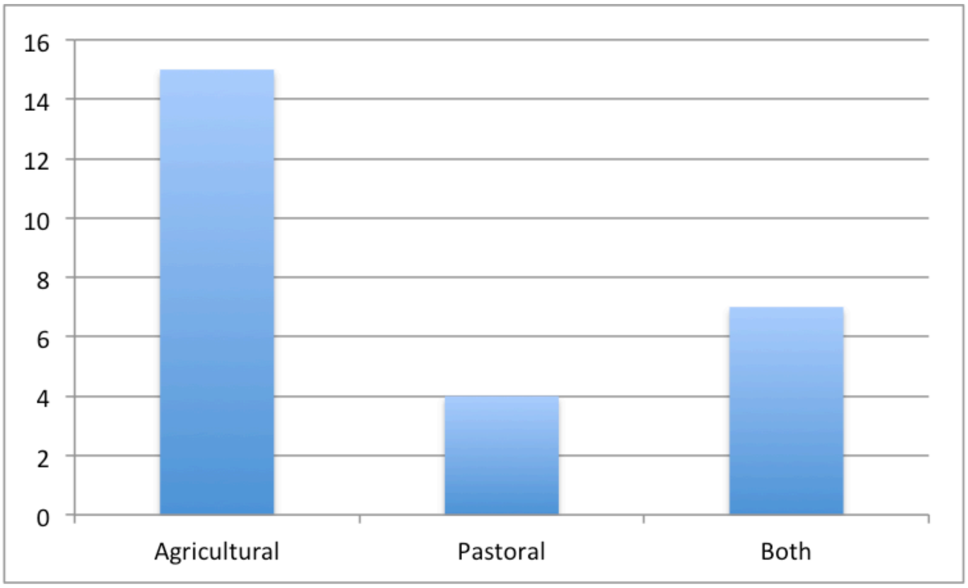


Figure 5.11: Histogram of Roman period settlement types from sites recorded during the Wail al-Feidh survey, showing an increase in the number of agricultural sites. See also Table 2.2.

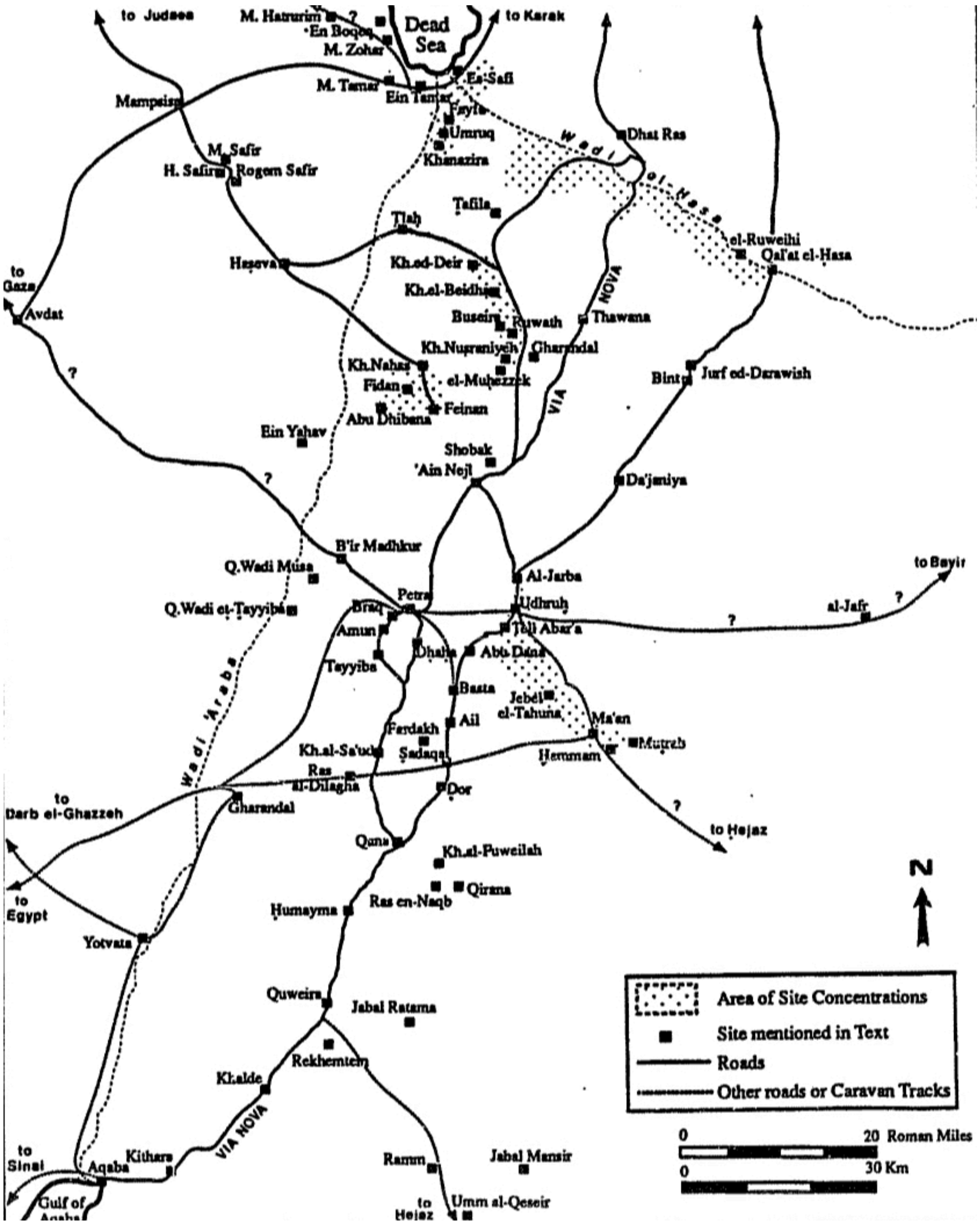


Figure 5.12: Late Roman period settlement patterns for the region of southern Transjordan. Following Roman annexation the new Roman administration constructed many new fortresses and garrisons at important Nabataean settlements in the region. (after Fiema 1991: p. 281, Map 7)

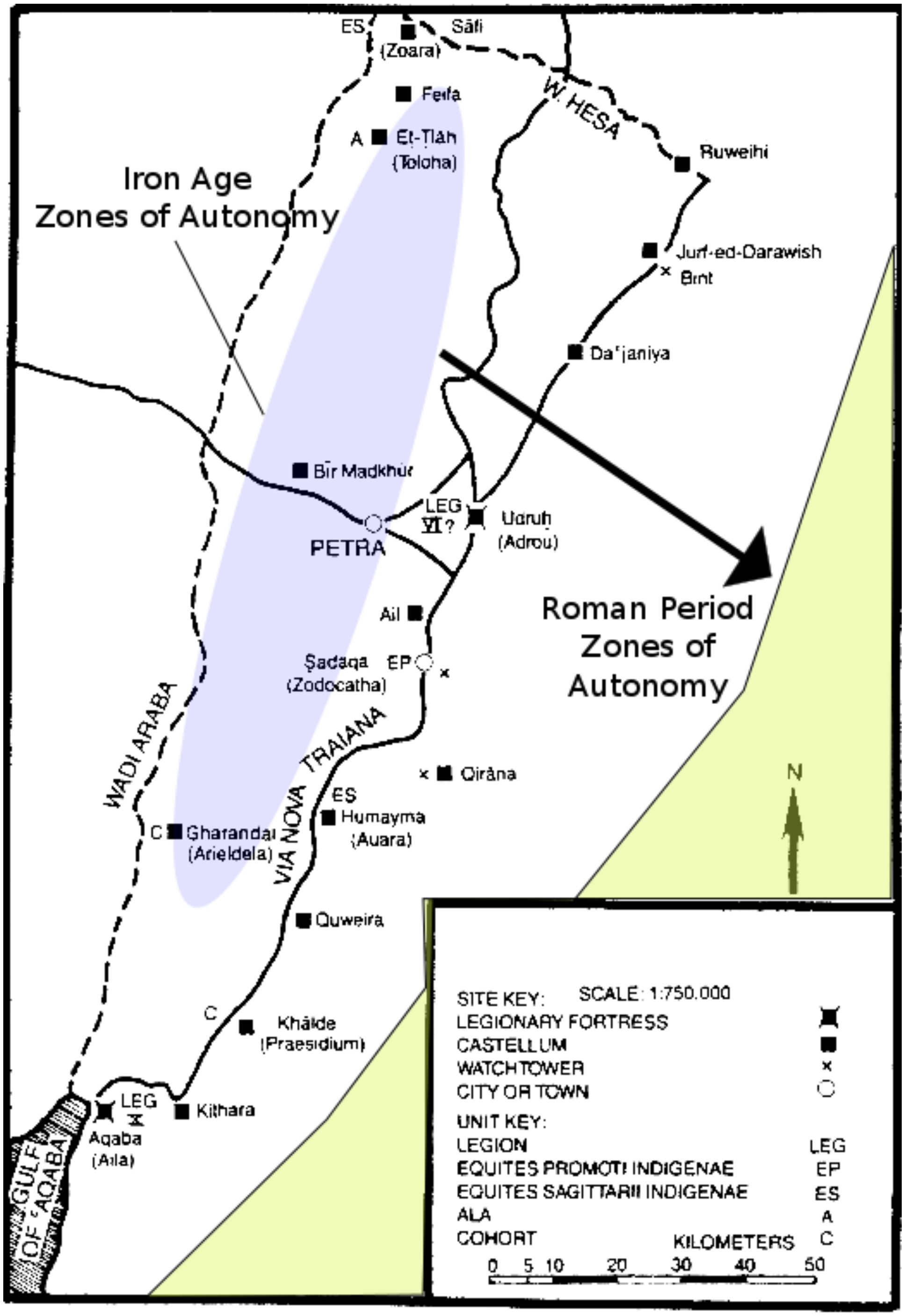


Figure 5.13: The southeastern frontier along the eastern deserts of Transjordan. During the Roman period the mountainous zones were no longer capable of supporting autonomous communities, as increasing centralization and integration allowed political sovereignty to permeate into these remote regions. However, the frontier merely seems to have pushed the previous zone of autonomy to the southeast, into the eastern desert (after Parker 1987, p. 42).

Chapter 6: Conclusion

This dissertation ends as it began: with a consideration of outsiders' perspectives of the people and landscape of southern Jordan. For the Old Testament prophet Obadiah, the Edomites are an object of derision, cursed by god because of their treachery against their neighboring polity of Judah. His polemic against the Edomites chastises their practice of living in the "cleft of the rock" and "dwelling in the heights." The Greek historian Diodorus Siculus similarly describes the early Nabataeans as nomadic brigands who dwell in the waterless deserts, unconquered and eternally leaderless. Facing danger or hostilities, they will flee to the desert regions where only they have the knowledge to survive. It is interesting how outsiders have so often used landscape terms to paint both the people and their territory as uncivilized and dangerous. Understanding the Edomites and Nabataeans on their own terms has been made difficult by the fact that they lacked their own historical narratives. Despite this hurdle, the area of southern Jordan presents a rich source of diversity and variety in human social organization certainly worth investigating, and archaeology presents an opportunity to better understand these societies on their own terms.

I have argued that one method of accomplishing this goal is to use a landscape approach for understanding variation and change on the periphery of ancient states and empires (cf. Alcock 2002; Anschuetz *et al.* 2001; Ashmore 2004; Bender 1998; Ingold 1993; Knapp and Ashmore 1999; Smith 2003; Snead *et al.* 2006; Tilley 1994). Landscape archaeology, as discussed in Chapter 1, is an approach to interpreting the archaeological record that focuses on the ways in which people used and constructed the physical and cultural environment around them. An important development in the landscape approach has been the focus on spatial practices and understanding how people's interactions with the environment are structured. As the research presented here has largely included settlement patterns from archaeological survey, directing our attention to the spatiality of various dimensions of human culture was essential. While the dimensions of human culture are many, the scope of the dissertation was limited to a focus on subsistence practice, historical ecology, and political organization, and for each of these dimensions my goal has been to provide a clearer picture of their relation to the marginal landscapes of southern Jordan's Iron Age and Roman period.

Subsistence Practices in Southern Jordan's Marginal Landscapes

A central addressed in this dissertation was how to better understand the relationship between subsistence practices and social organization? Recent studies have shown that the explanation of subsistence change as a product of social change can be problematic (cf. Blanton 2005; Crumley 1995; Fowles 2010; Frachetti 2012; McGuire 1983; Peterson and Drennan 2005; Porter 2013; Schwartz and Falconer 1994b; Stein 1994; Tainter 2006; Trigger 1990). This is particularly true for the hinterlands or periphery, where subsistence practice and social complexity may take on a variety of forms. Settlement pattern studies are a method of reconstructing social practices and subsistence practices by looking beyond the site itself and integrating a range of landscape features. This analysis has facilitated the investigation of both bottom-up and top-down processes of social change, and along the lines of the community-based and political centralization outlined in Chapter 1.

The fieldwork conducted for the settlement pattern analysis has targeted the remote, isolated environments of southern Jordan where very little research had previously been carried out. Much of the data for this analysis has come from a survey of Wadi al-Feidh, a rugged, mountainous zone between the Arabah lowlands and the highlands of the Jordanian plateau and discussed in Chapter 2. The results of this survey suggest that from the late Iron Age to the Roman period settlement patterns and subsistence practices shifted significantly, from small-scale, mixed agro-pastoral modes during the Iron Age, to intensive agricultural production during the Roman period. The settlement pattern data reflect more diversity and variability in late Iron Age subsistence economies in Edom than previously recognized, and for the Wadi al-Feidh region specifically, a bottom-up organizational structure devoted to the extraction of subsistence resources from local microenvironmental niches. Two small late Iron Age settlements that were recorded during the survey would have been the centers of this local social organization. That settlements would be built in such remote and isolated areas must have been a strong social statement reinforcing community identities.

For the Roman period the Wadi al-Feidh data reflect increasing homogeneity as top-down structures of agricultural production were adopted fairly ubiquitously. Rather than the bottom-up processes structuring late Iron Age settlement patterns, during the Roman period regional political economic processes played a significant role in structuring the settlement patterns recorded by the Wadi al-Feidh survey. This analysis was made possible though the careful attention to the local landscape and ecology on the part of the surveyors, and a focus on carefully recording small, off-site features. The combination of a systematic and intensive survey methodology, and a survey located in such a marginal zone, further contributed to the conclusions of the chapter.

In contrast to the settlement in the transitional mountainous zone, surveys from the Faynan region presented in Chapter 3 have provided huge amounts of data on Iron Age social organization in the context of intensive copper metallurgical production. Again, a focus on recording small sites, and off-site features has enabled the analysis of ephemeral settlement patterns left by semi-nomadic tribes engaged in copper mining and smelting, as well as small-scale cultivation and pastoralism. These data provide a better understanding of how Iron Age tribes lived while they were mining and smelting copper.

Landscapes of Ecology in Wadi Faynan

Moving from settlement patterns to the question of economic production and environmental degradation, the second question addressed in this dissertation has been whether human culture is inherently maladaptive. Throughout this dissertation, the notion of socio-natural systems has been employed to help elucidate the relationship between both physical landscapes (e.g. landforms, sediments, soils, plants, animals), and social and ideational landscapes (e.g. arrangements of people, communities, fields, monuments). For archaeologists seeking a nuanced understanding of society and environment together, humans are seen as an important part of the socio-natural system rather than independent from it (Balée 1998b; Blaikie and Brookfield 1987;

Cronon 1995; Crumley 1994b; Fisher *et al.* 2009a; Gunderson and Holling 2002; Hill 2006; Kohler and Leeuw 2007; Redman 2005; van der Leeuw and Redman 2002). Thanks to the contributions of these scholars, our attention has been directed to the study of human-environment interrelatedness, rather than the divide between society and nature. This new focus also places the environmental degradation within the realm of human perception and cognition, so that episodes of degradation are seen as the result of multiple interrelated processes of decision making, perception, and memory. An important message to be conveyed is that human cultures can just as easily preserve the environment as they can degrade it.

Chapter 4 of this dissertation has examined how copper production during the Iron Age and Roman period effected the local landscape of Wadi Faynan based on research carried out in the agricultural field systems near the major settlement in the valley, Khirbat Faynan. Based on the results of test excavations in Wadi Faynan and geochemical analysis conducted in collaboration with the Hebrew University's Earth Science Institute we have provided new data that challenge the previous pollution studies in Faynan that suggested widespread environmental pollution resulted from copper mining and smelting (Grattan *et al.* 2002; Grattan *et al.* 2007; Grattan *et al.* 2013; Pyatt *et al.* 2002a; Pyatt *et al.* 1999; Pyatt *et al.* 2000; Pyatt and Grattan 2001; Pyatt *et al.* 2002b; Pyatt *et al.* 2005). Rather than viewing the ancient inhabitants of Wadi Faynan as unconscious polluters of their environments, research carried out for this dissertation suggests something quite different: that metal pollution is far less widespread than previously thought, and may be restricted to specific loci of metallurgical debris. Engaging with theoretical models from historical ecology and socio-natural studies, a new pollution model is proposed in which the presence of humans is as important a factor for landscape preservation as it is in degrading it. The new model predicts that maintaining the agricultural and metallurgical infrastructures may have been a significant factor in preventing the spread of metal ions such as lead. The application of OSL dating of agricultural sediments also presents a new way to place chronological constraints on the data in a situation where absolute dates would be otherwise absent.

Political Landscapes and Resistance in Southern Jordan

In Chapter 5 we end on the subject of political organization and perspectives on domination and resistance in the extreme periphery, the third question addressed in this dissertation has been how to better understand the limits of political authority and how to identify them in the archaeological record. To do so, the dissertation expands upon the settlement pattern analysis from Wadi al-Feidh to include the wider territory of southern Jordan during the late Iron Age and Roman period. Employing theoretical perspectives on territoriality as dynamic, fluid constructs that are the product of political institutions, physical environments, and human subjectivities (Greene and Lindsay 2013; Parker 2006a; Rodseth and Parker 2005; VanValkenburgh and Osborne 2013). This perspective provides a way to look at the landscape that acknowledges both the role of political institutions in carving out a space for political sovereignty, as well as the role of groups outside of the state, and the decisions they make in response to state authority (Clastres 1987; Given 2004; Miller *et* *al.* 1995; Morrison 2001; Scott 1990, 2009; Smith 2003, 2011; Yoffee 2005). These decisions can include a variety of responses ranging from revolt to assimilation, but whatever the response, it is often the case that geographies of resistance can be identified in the archaeological record, and one way of doing so is through the settlement pattern analysis described throughout this dissertation.

The marginality of the landscape of southern Jordan during the Iron Age and Roman period provided indigenous polities with a number of strategies for resistance that were in many ways structured by the landscapes they inhabited. During the late Iron Age, communities inhabiting the rugged mountainous zone between the lowlands and the highlands were able to maintain a relative degree of autonomy from the Edomite polity centered at Busayra. In contrast, during the Roman period the isolation provided by the mountainous zone disappears under conditions of increased political centralization and integration. Zones of autonomy did not completely disappear, however. For the Roman period it seems that groups resistant to state incorporation would have found refuge in the eastern deserts, among the myriad tribes inhabiting the region. These geographies of resistance are closely interrelated with the marginality of the landscape of southern Jordan, and as such were an enduring structure of political relationships for the complex polities we know as the Edomites and the Nabataeans. In antiquity they were often portrayed as homogenous desert dwellers, or as an object to be conquered, but it would be inaccurate to understand their history in such singular terms.

Bibliography

'Amr, K., and A. al-Momani. 2001. "Preliminary Report on the Archaeological Component of the Wadi Musa Water Supply and Wastewater Project (1998-2000)," *Annual of the Department of Antiquities of Jordan* 45: 253-285.

'Amr, K., A. al-Momani, S. Farajat, and H. Falahat. 1998. "Archaeological Survey of the Wadi Musa Water Supply and Wastewater Project Area," *Annual of the Department of Antiquities of Jordan* 42: 503-548.

Abudanh, F. 2004. "The Archaeological Survey for the Region of Udhruh, 2003 (Preliminary Report)," *Annual of the Department of Antiquities of Jordan* 48: 51-69.

---. 2006. "Settlement Patterns and Military Organization in the Region of Udhruh (Southern Jordan) in the Roman and Byzantine Periods."Unpublished PhD Thesis. Newcastle University Library.

Adams, R.B. 2003. "External Influences at Faynan During the Early Bronze Age: A Re-Analysis of Building I at Barqa El-Hetiye, Jordan," *Palestine Exploration Quarterly* 135: 6-21.

Adams, R.B., J.D. Anderson, J.P. Grattan, D.D. Gibertson, L. Rouse, H.A. Friedman, M.M. Homan, and H. Toland. 2010. "Report on the First Season of the Barqa Landscape Survey, South-West Jordan," *Annual of the Department of Antiquities of Jordan* 54: 95-120.

Adams, R.B., and H. Genz. 1995. "Excavations at Wadi Fidan 4: A Copper Village Complex in the Copper Ore District of Feinan, Southern Jordan," *Palestine Expedition Quarterly* 127: 8-20.

Adams, R.M. 1965. *Land Behind Baghdad*. Chicago: University of Chicago Press.

---. 1978. "Strategies of Maximization, Stability, and Resilience in Mesopotamian Society, Settlement, and Agriculture," *Proceedings of the American Philosophical Society* 122: 329-335.

---. 1981. *Heartland of Cities*. Chicago: University of Chicago Press.

Aitken, M.J. 1989. "Luminescence Dating: A Guide for Non-Specialists," *Archaeometry* 31: 147-159.

al-Ghul, O. 2011. "The Ostracon," in P. Bienkowski, ed., *Umm Al-Biyara: Excavations by Crystal-M. Bennett in Petra*. Oxford: Oxbow Books, 85-92.

Alcock, S.E. 1993. *Graecia Capta: The Landscapes of Roman Greece*. Cambridge: Cambridge University Press.

---. 2002. *Archaeologies of the Greek Past: Landscape, Monuments, and Memories*. Cambridge: Cambridge University Press.

Alcock, S.E., and J.F. Cherry, eds. 2004. *Side-by-Side Survey: Comparative Regional Studies in the Mediterranean World*. Oxford: Oxbow Books.

Ammerman, A.J., H. Koster, and E. Pfenning. 2013. "The Longitudinal Study of Land-Use at Acconia: Placing the Fieldwork of the Survey Archaeologist in Time," *Journal of Field Archaeology* 38: 291-307.

Anderson, B. 2002. "Imperial Legacies, Local Identities: References to Achaemenid Persian Iconography on Crenelated Nabataean Tombs," *Ars Orientalis* 32: 163-207.

Anschuetz, K., R. Wilshusen, and C. Scheick. 2001. "An Archaeology of Landscapes: Perspectives and Directions," *Journal of Archaeological Research* 9: 157-211.

Ashmore, W. 2004. "Social Archaeologies of Landscape," in L. Meskell and R. W. Preucel, eds., *A Companion to Social Archaeology*. Malden, MA: Blackwell Publishing, 255-271.

Avni, Y., N. Porat, and G. Avni. 2012. "Pre-Farming Environment and Osl Chronology in the Negev Highlands, Israel," *Journal of Arid Environments* 86: 12-27.

Baierle, H.U., W. Frey, C. Jagiella, and H. Kurschner. 1989. "Die Brennstoffressourcen Im Raum Fenan (Wadi Araba, Jordanien) Und Die Bei Der Kupferezverhuttung Verwendeten Brennstoffe," in A. Hauptmann, E. Pernicka and G. A. Wagner, eds., *Archaometallurgie Der Alten Weld / Old World Archaeometallurgy, Der Anschnitt, Beiheft*. Germany: Deutsches Bergbau-Museum, 213-222.

Balée, W., ed. 1998a. *Advances in Hisotrical Ecology*. New York: Columbia University Press.

---. 1998b. "Historical Ecology: Premises and Postulates," in W. Balée, ed., *Advances in Hisotrical Ecology*. New York: Columbia University Press, 13-29.

Balkansky, A.K. 2006. "Surveys and Mesoamerican Archaeology: The Emerging Macroregional Paradigm," *Journal of Archaeological Research* 14: 53-95.

Balkansky, A.K., S.A. Kowalewski, V.P. Rodríguez, T.J. Pluckhahn, C.A. Smith, L.R. Stiver, D. Beliaev, J.F. Chamblee, V.Y.H. Espinoza, and R.S. Pérez. 2000.

"Archaeological Survey in the Mixteca Alta of Oaxaca, Mexico," *Journal of Field Archaeology* 27: 365-389.

Banning, E.B. 1986. "Peasants, Pastoralists and "Pax Romana": Mutualism in the Southern Highlands of Jordan," *Bulletin of the American Schools of Oriental Research*: 25-50.

Banning, E.B. 1996. "Highlands and Lowlands: Problems and Survey Frameworks for Rural Archaeology in the near East," *Bulletin of the American School of Oriental Research* 301: 25-45.

Bar-Matthews, M., and A. Ayalon. 2004. "Speleothems as Palaeoclimate Indicators, a Case Study from Soreq Cave Located in the Eastern Mediterranean Region, Israel," in R. W. Battarbe, F. Gasse and C. E. Stickley, eds., *Past Climate Variability through Europe and Africa, Volume 6*. Dordrecht: Springer, 363-391.

Bar-Yosef, O., and A. Khazanov, eds. 1992. *Pastoralism in the Levant: Archaeological Materials in Anthropological Perspectives*, *Monographs in World Archaeology, 10*. Madison: Prehistory Press.

Barfield, T.J. 1993. *The Nomadic Alternative*. Englewood Cliffs, N.J.: Prentice Hall.

Barker, G. 2012. "The Desert and the Sown: Nomad–Farmer Interactions in the Wadi Faynan, Southern Jordan," *Journal of Arid Environments* 86: 82-96.

Barker, G., R. Adams, O. Creighton, H. el-Rishi, D. Gilbertson, J. Grattan, C. Hunt, P. Newson, B. Pyatt, and T. Reynolds. 2007a. "Chalcolithic (C. 5000-3600 Cal. Bc) and Bronze Age (C. 360001200 Cal. Bc) Settlement in Wadi Faynan: Metallurgy and Social Complexity," in G. Barker, D. D. Gilbertson and D. J. Mattingly, eds., *Archaeology and Desertification: The Wadi Faynan Landscape Survey, Southern Jordan*. Oxford: Oxbow Books; CBRL, 227-270.

Barker, G., and D. Gilbertson. 2000. "Living at the Margin: Themes in the Archaeology of Drylands," in G. Barker and D. Gilbertson, eds., *The Archaeology of Drylands: Living at the Margin*. London: Routledge, 3-17.

Barker, G., D. Gilbertson, B. Jones, and D. Mattingly. 1996. *Farming the Desert : The Unesco Libyan Valleys Archaeological Survey*. 2 vols. Paris: UNESCO Publishing.

Barker, G., D. Gilbertson, and D. Mattingly, eds. 2007b. *Archaeology and Desertification: The Wadi Faynan Landscape Survey, Southern Jordan*. Oxford: Oxbow Books; CBRL.

---. 2007c. "The Wadi Faynan Landscape Survey: Research Themes and Project Development," in G. Barker, D. Gilbertson and D. Mattingly, eds., *Archaeology* *and Desertification: The Wadi Faynan Landscape Survey, Southern Jordan*. Oxford: Oxbow Books; CBRL, 3-23.

Bartlett, J.R. 1989. *Edom and the Edomites*. Sheffield: Shefield Academic Press.

---. 1992. "Biblical Sources for the Early Iron Age in Edom," in P. Bienkowski, ed., *Early Edom and Moab: The Beginning of the Iron Age in Southern Jordan*. Sheffield: J.R. Collis.

Beckers, B., B. Schütt, S. Tsukamoto, and M. Frechen. 2013. "Age Determination of Petra's Engineered Landscape – Optically Stimulated Luminescence (Osl) and Radiocarbon Ages of Runoff Terrace Systems in the Eastern Highlands of Jordan," *Journal of Archaeological Science* 40: 333-348.

Bedal, L. 2001. "A Pool Complex in Petra's City Center," *Bulletin of the American Schools of Oriental Research*: 23-41.

Beherec, M.A., M. Najjar, and T.E. Levy. 2014. "Wadi Fidan 40 and Mortuary Archaeology in the Edom Lowlands," in T. E. Levy, M. Najjar and E. Ben-Yosef, eds., *New Insights into the Iron Age Archaeology of Edom, Southern Jordan: Surveys, Excavations and Research from the University of California, San Diego – Department of Antiquities of Jordan, Edom Lowlands Regional Archaeology Project (Elrap)*. Los Angeles: Cotsen Institute of Archaeology Press, 665-721.

Beit-Arieh, I., ed. 1995. *Horvat Qitmit: An Edomite Shrine in the Biblical Negev*. Tel Aviv: Institute of Archaeology of Tel Aviv University.

---, ed. 1999. *Tel 'Ira - a Stronghold in the Biblical Negev*. Tel Aviv: Tel Aviv University Institute of Archaeology.

Ben-Yosef, E. 2010. "Technology and Social Process: Oscillations in Iron Age Copper Production and Power in Southern Jordan." Ph.D. Ph.D. Dissertation, University of California, San Diego. La Jolla.

Ben-Yosef, E., and T.E. Levy. 2014. "The Material Culture of Iron Age Copper Production in Faynan," in T. E. Levy, M. Najjar and E. Ben-Yosef, eds., *New Insights into the Iron Age Archaeology of Edom, Southern Jordan: Surveys, Excavations and Research from the University of California, San Diego – Department of Antiquities of Jordan, Edom Lowlands Regional Archaeology Project (Elrap)*. Los Angeles: Cotsen Institute of Archaeology Press, 887-959.

Ben-Yosef, E., T.E. Levy, T. Higham, M. Najjar, and L. Tauxe. 2010. "The Beginning of Iron Age Copper Production in the Southern Levant: New Evidence from Khirbat Al-Jariya, Faynan, Jordan," *Antiquity* 84: 724-746.

Ben-Yosef, E., T.E. Levy, and M. Najjar. 2009a. "New Iron Age Copper-Mine Fields Discovered in Southern Jordan," *Near Eastern Archaeology* 72: 98-101.

---. 2009b. "Ras Al-Miyah Fortresses: New Discoveries at One of the Gateways to the Iron Age Copper Production District of Faynan, Jordan," in A. Hadidi, ed., *Studies in the History and Archaeology of Jordan*. Amman: Department of Antiquities, Jordan.

Ben-Yosef, E., M. Najjar, and T.E. Levy. 2014a. "Local Iron Age Trade Routes in Northern Edom: From the Faynan Copper Ore District to the Highlands," in T. E. Levy, M. Najjar and E. Ben-Yosef, eds., *New Insights into the Iron Age Archaeology of Edom, Southern Jordan: Surveys, Excavations and Research from the University of California, San Diego – Department of Antiquities of Jordan, Edom Lowlands Regional Archaeology Project (Elrap)*. Los Angeles: Cotsen Institute of Archaeology Press, 493-575.

---. 2014b. "New Iron Age Excavations at Copper Production Sites, Mines, and Fortresses in Faynan," in T. E. Levy, M. Najjar and E. Ben-Yosef, eds., *New Insights into the Iron Age Archaeology of Edom, Southern Jordan: Surveys, Excavations and Research from the University of California, San Diego – Department of Antiquities of Jordan, Edom Lowlands Regional Archaeology Project (Elrap)*. Los Angeles: Cotsen Institute of Archaeology Press, 767-885.

Ben-Yosef, E., R. Shaar, L. Tauxe, and H. Ron. 2012. "A New Chronological Framework for Iron Age Copper Production at Timna (Israel)," *Bulletin of the American School of Oriental Research* 367: 31-71.

Bender, B. 1990. "The Dynamics of Nonhierarchical Societies," in S. Upham, ed., *The Evolution of Political Systems: Sociopolitics in Small-Scale Sedentary Societies*. Cambridge: Cambridge University Press, 247-263.

---. 1998. *Stonehenge: Making Space*. Oxford: Berg.

Bennett, C.-M. 1975. "Excavations at Buseirah, Southern Jordan, 1973: Third Preliminary Report," *Levant* 7: 1-19.

Bennett, C.-M., and P. Bienkowski. 1995. *Excavations at Tawilan in Southern Jordan, British Academy Monographs in Archaeology No. 8*. Oxford: Oxford University Press.

Betts, A.V.G., ed. 1991. *Excavations at Jawa 1972-1986 : Stratigraphy, Pottery and Other Finds: Excavations and Explorations in the Hashemite Kingdom of Jordan*. Edinburgh: Edinburgh Universiy Press.

Bevan, A., and J. Conolly. 2002. "Gis, Archaeological Survey, and Landscape Archaeology on the Island of Kythera, Greece," *Journal of Field Archaeology* 29: 123-138.

---. 2009. "Modelling Spatial Heterogeneity and Nonstationarity in Artifact-Rich Landscapes," *Journal of Archaeological Science* 36: 956-964.

Bienert, H.-D., R. Lamprichs, and D. Vieweger. 2000. "Ba'ja - the Archaeology of a Landscape 9000 Years of Human Occupation: A Preliminary Report on the 1999 Field Season," *Annual of the Department of Antiquities of Jordan* 44: 119-148.

Bienkowski, P. 1992a. "The Beginning of the Iron Age in Southern Jordan: A Framework," in P. Bienkowski, ed., *Early Edom and Moab: The Beginning of the Iron Age in Southern Jordan*. Sheffield: J.R. Collis.

---. 1992b. "The Date of Sedentary Occupation in Edom: Evidence from Umm El-Biyara, Tawilan and Buseirah," in P. Bienkowski, ed., *Early Edom and Moab: The Beginning of the Iron Age in Southern Jordan*. Sheffield: J.R. Collis, 99-112.

---. 2001. "New Evidence on Edom in the Neo-Babylonian and Persian Periods," in J. A. Dearman and M. P. Graham, eds., *The Land That I Will Show You: Essays on the History and Archaeology of the Ancient near East in Honor of J. Maxwell Miller*. Sheffield: Sheffield Academic Press.

---. 2002. *Busayra: Excavations by Crystal-M. Bennett 1971-1980*. Oxford: Oxford University Press.

---. 2011a. "The Iron Age Landscape of Umm Al-Biyara," in P. Bienkowski, ed., *Umm Al-Biyara: Excavations by Crystal-M. Bennett in Petra*. Oxford: Oxbow Books, 114-126.

---. 2011b. "The Pottery," in P. Bienkowski, ed., *Umm Al-Biyara: Excavations by Crystal-M. Bennett in Petra*. Oxford: Oxbow Books, 55-78.

---. 2011c. "The Small Finds," in P. Bienkowski, ed., *Umm Al-Biyara: Excavations by Crystal-M. Bennett in Petra*. Oxford: Oxbow Books, 93-105.

---, ed. 2011d. *Umm Al-Biyara: Excavations by Crystal-M. Bennett in Petra 1960-1965*. Oxford: Oxbow Books.

Bienkowski, P., R.B. Adams, R.A. Philpott, and L. Sedman. 1997. "Soundings at Ash-Shorabat and Khirbat Dubab in the Wadi Hasa, Jordan: The Stratigraphy," *Levant* 29: 41-70.

Bienkowski, P., and B. Chlebik. 1991. "Changing Places: Architecture and Spatial Organization of the Bedul in Petra," *Levant* 23: 147-180.

Bienkowski, P., and L. Sedman. 2001. "Busayra and Judah: Stylistic Parallels in the Material Culture," in A. Mazar, ed., *Studies in the Archaeology of the Iron Age in Israel and Jordan*. Sheffield: Sheffield Academic Press, 310-325.

Bienkowski, P., and E. van der Steen. 2001. "Tribes, Trade, and Towns: A New Framework for the Late Iron Age in Southern Jordan and the Negev," *Bulletin of the American School of Oriental Research* 323: 21-47.

Billman, B.R. 1999. "Settlement Pattern Research in the Americas: Past, Present, and Future," in B. R. Billman and G. M. Feinman, eds., *Settlement Pattern Studies in the Americas: Fifty Years since Viru*. Washington: Smithsonian Institution Press, 1-5.

Bintliff, J. 1997. "Regional Survey, Demography, and the Rise of Complex Societies in the Ancient Aegean: Core-Periphery, Neo-Malthusian, and Other Interpretive Models," *Journal of Field Archaeology* 24: 1-38.

Bintliff, J., E. Farinetti, P. Howard, K. Sarri, and K. Sbonias. 2002. "Classical Farms, Hidden Prehistoric Landscapes and Greek Rural Survey: A Response and an Update," *Journal of Mediterranean Archaeology* 15: 259.

Bintliff, J., and K. Sbonias, eds. 1999. *Reconstructing Past Population Trends in Mediterranean Europe (3000 Bc-Ad 1800)*. Oxford: Oxbow Books.

Bishop, P., D.C.W. Sanderson, and M.T. Stark. 2004. "Osl and Radiocarbon Dating of a Pre-Angkorian Canal in the Mekong Delta, Southern Cambodia," *Journal of Archaeological Science* 31: 319-336.

Blaikie, P., and H. Brookfield. 1987. *Land Degradation and Society*. New York: Methuen and Co.

Blanton, R.E. 2001. "Mediterranean Myopia," *Antiquity* 75: 627-629.

---, ed. 2005. *Settlement, Subsistence and Social Complexity: Essays Honoring the Legacy of Jeffrey R. Parsons*. Los Angeles: Cotsen Institute of Archaeology, UCLA.

Botkin, D.B. 1990. *Discordant Harmonies: A New Ecology for the Twenty-First Century*. New York: Oxford University Press.

Bowsher, J.M.C. 2007. "Monetary Interchange in Nabataean Petra," in K. D. Politis, ed., *The World of the Nabataeans. Volume 2 of the International Conference the World of Herods and the Nabataeans*. Stuttgart: Franz Steiner, 337-343.

Bray, F. 1986. *The Rice Economies: Technology and Development in Asian Societies*. Oxford: Basil Blackwell.

Brookfield, H.C. 1984. "Intensification Revisited," *Pacific Viewpoint* 25: 15-44.

---. 2001. *Exploring Agrodiversity*. New York: Columbia University Press.

Brown, M.F. 1996. "On Resisting Resistance," *American Anthopologist* 98: 729-735.

Brumfiel, E. 1998. "The Multiple Identities of Aztec Craft Specialists," *Archeological Papers of the American Anthropological Association* 8: 145-152.

Brumfiel, E.M. 1987. "Elite and Utilitarian Crafts in the Aztec State," in E. M. Brumfiel and T. K. Earle, eds., *Specialization, Exchange, and Complex Societies*. Cambridge: Cambridge University Press, 102-118.

Butzer, K.W. 1982. *Archaeology as Human Ecology: Method and Theory for a Contextual Approach*. Cambridge: Cambridge University Press.

---. 1996. "Ecology in the Long View: Settlement Histories, Agrosystemic Strategies, and Ecological Performance," *Journal of Field Archaeology* 23: 141-150.

Butzer, K.W. 2005. "Environmental History in the Mediterranean World: Cross-Disciplinary Investigation of Cause-and-Effect for Degradation and Soil Erosion," *Journal of Archaeological Science* 32: 1773-1800.

Butzer, K.W., and G.H. Endfield. 2012. "Critical Perspectives on Historical Collapse," *Proceedings of the National Academy of Sciences* 109: 3628-3631.

Caraher, W.R., D. Nakassis, and D.K. Pettegrew. 2006. "Siteless Survey and Intensive Data Collection in an Artifact-Rich Environment: Case Studies from the Eastern Corinthia, Greece," *Journal of Mediterranean Archaeology* 19: 7-43.

Casana, J. 2013. "Radial Route Systems and Agro-Pastoral Strategies in the Fertile Crescent: New Discoveries from Western Syria and Southwestern Iran," *Journal of Anthropological Archaeology* 32: 257-273.

Chepstow-Lusty, A. 2011. "Agro-Pastoralism and Social Change in the Cuzco Heartland of Peru: A Brief History Using Environmental Proxies," *Antiquity* 85: 570-582.

Chew, S.C. 2001. *World Ecological Degradation: Accumulation, Urbanization, and Deforestation 3000 B.C.-A.D. 2000*. Walnut Creek: Altamira Press.

Clark, V.A., F.L. Koucky, and S.T. Parker. 2006. "The Regional Survey," in S. T. Parker, ed., *The Roman Frontier in Central Jordan: Final Report on the Limes Arabicus Project, 1980-1989*. Washington, D.C.: Dumbarton Oaks, 25-107.

Clastres, P. 1987. *Society against the State: Essays in Political Anthropology*. Translated by R. Hurley. New York: Zone Books.

Cohen, R., and Y. Yisrael. 1995. "The Iron Age Fortresses at ‹En Ḥaṣeva," *The Biblical Archaeologist* 58: 223-235.

Cordova, C.E. 2007. *Millennial Landscape Change in Jordan: Geoarchaeology and Cultural Ecology*. The University of Arizona Press: Tucson.

---. 2008. "Floodplain Degradation and Settlement History in Wadi Al-Wala and Wadi Ash-Shallalah, Jordan," *Geomorphology* 101: 443-457.

Costin, C.L. 2004. "Craft Economies of Ancient Andean States," in G. M. Feinman and L. M. Nicholas, eds., *Archaeological Perspectives on Political Economies*. Salt Lake City: The University of Utah Press, 189-221.

Cronon, W., ed. 1995. *Uncommon Ground: Toward Reinventing Nature*. New York: W.W. Norton & Co.

Crook, D. 2009. "Hydrology of the Combination Irrigation System in the Wadi Faynan, Jordan," *Journal of Archaeological Science* 36: 2427-2436.

Crowell, B.L. 2007. "Nabonidus, as-Silaʿ, and the Beginning of the End of Edom," *Bulletin of the American Schools of Oriental Research*: 75-88.

Crumley, C.L. 1994a. "The Ecology of Conquest: Contrasting Agropastoral and Agricultural Societies' Adaptation to Climate Change," in C. L. Crumley, ed., *Historical Ecology: Cultural Knowledge and Changing Landscapes*. Santa Fe: School of American Research, 183-201.

---. 1994b. "Historical Ecology: A Multidimentional Ecological Orientation," in C. L. Crumley, ed., *Historical Ecology: Cultural Knowledge and Changing Landscapes*. Santa Fe: School of American Research, 1-16.

---. 1995. "Heterarchy and the Analysis of Complex Societies," *Archeological Papers of the American Anthropological Association* 6: 1-5.

D'Altroy, T. 1992. *Provincial Power in the Inka Empire*. Washington, D.C.: Smithsonian Institution Press.

Dark, K.R. 2008. "Roman-Period and Byzantine Landscapes between Sepphoris and Nazareth," *Palestine Exploration Quarterly* 140: 87-102.

---. 2013. "Archaeological Evidence for a Previously Unrecognised Roman Town near the Sea of Galilee," *Palestine Exploration Quarterly* 145: 1-18.

Davidovich, U., N. Porat, Y. Gadot, Y. Avni, and O. Lipschits. 2012. "Archaeological Investigations and Osl Dating of Terraces at Ramat Rahel, Israel," *Journal of Field Archaeology* 37: 192-208.

de Certeau, M. 1984. *The Practice of Everyday Life*. Berkeley: University of California Press.

Dearing, J.A. 2008. "Landscape Change and Resilience Theory: A Palaeoenvironmental Assessment from Yunnan, Sw China," *The Holocene* 18: 117-127.

Denevan, W.M. 2001. *Cultivated Landscapes of Native Amazonia and the Andes*. New York: Oxford University Press.

Descola, P., and G. Pálsson. 1996a. "Introduction," in P. Descola and G. Pálsson, eds., *Nature and Society : Anthropological Perspectives*. London: Routledge, 1-21.

---, eds. 1996b. *Nature and Society : Anthropological Perspectives*. London: Routledge.

Dever, W.G. 1998. "Social Structure in Palestine in the Iron Ii Period on the Eve of Destruction," in T. E. Levy, ed., *The Archaeology of Society in the Holy Land*. London: Leicester University Press, 416-445.

Diamond, J. 2005. *Collapse: How Societies Choose to Fail or Succeed*. New York: Viking.

Drennan, R. 2010. "Chiefdoms and States in the Yuncheng Basin and the Chifeng Region: A Comparative Analysis of Settlement Systems in North China," *Journal of Anthropological Archaeology* 29: 455-468.

Drennan, R.D., L.G. Jaramillo, E. Ramos, C.A. Sánchez, M.A. Ramírez, and C.A. Uribe. 1991. "Regional Dynamics of Chiefdoms in the Valle De La Plata, Colombia," *Journal of Field Archaeology* 18: 297-317.

Duller, G.A.T. 2004. "Luminescence Dating of Quaternary Sediments: Recent Advances," *Journal of Quaternary Science* 19: 183-192.

Dunnell, R.C. 1992. "The Notion Site," in J. Rossignol and L. Wandsnider, eds., *Space, Time, and Archaeological Landscapes*. New York: Plenum Press, 21-41.

Dunnell, R.C., and W.S. Dancey. 1983. "The Siteless Survey: A Regional Scale Data Collection Strategy," *Advances in Archaeological Method and Theory* 6: 267-287.

Dunning, N.P., S. Luzzadder-Beach, T. Beach, J.G. Jones, V. Scarborough, and T.P. Culbert. 2002. "Arising from the Bajos: The Evolution of a Neotropical Landscape and the Rise of Maya Civilization," *Annals of the Association of American Geographers* 92: 267-283.

Earle, T. 1997. *How Chiefs Come to Power: The Political Economy in Prehistory*. Stanford: Stanford University Press.

Edelman, D.V. 1995. "Edom: A Historical Geography," in D. V. Edelman, ed., *You Shall Not Abhor an Edomite for He Is Your Brother: Edom and Seir in History and Tradition*. Atlanta: Scholars Press, 1-11.

Eisenberg-Degen, D., and S. Rosen. 2013. "Chronological Trends in Negev Rock Art: The Har Michia Petroglyphs as a Test Case," *Arts* 2: 225-252.

el-Khouri, L. 2008. "The Roman Countryside in North-West Jordan (63 Bc - Ad 324)," *Levant* 40: 71-87.

el-Rishi, H., C. Hunt, D. Gilbertson, J. Grattan, S. McLaren, B. Pyatt, G. Duller, G. Gillmore, and P. Phillips. 2007. "The Past and Present Landscapes of the Wadi Faynan: Geoarchaeological Approaches and Frameworks," in G. Barker, D. D. Gilbertson and D. J. Mattingly, eds., *Archaeology and Desertification: The Wadi Faynan Landscape Survey, Southern Jordan*. Oxford: Oxbow Books; CBRL, 59-95.

Emberling, G. 1997. "Ethnicity in Complex Societies: Archaeological Perspectives," *Journal of Archaeological Research* 5: 295-344.

Erel, Y., and J. Torrent. 2010. "Contribution of Saharan Dust to Mediterranean Soils Assessed by Sequential Extraction and Pb and Sr Isotopes," *Chemical Geology* 275: 19-25.

Erickson, C.L. 2006. "Intensification, Political Economy, and the Farming Community: In Defense of a Bottom up Perspective of the Past," in J. Marcus and C. Stanish, eds., *Agricultural Strategies*. Los Angeles: Costin Institute of Archaeology, UCLA, 334-363.

Falconer, S.E., and S.H. Savage. 1995. "Heartlands and Hinterlands: Alternative Trajectories of Early Urbanization in Mesopotamia and the Southern Levant," *American Antiquity* 60: 37-58.

Fall, P.L., S.E. Falconer, and L. Lines. 2002. "Agricultural Intensification and the Secondary Products Revolution Along the Jordan Rift," *Human Ecology* 30: 445-482.

Fall, P.L., L. Lines, and S.E. Falconer. 1998. "Seeds of Civilization: Bronze Age Rural Economy and Ecology in the Southern Levant," *Annals of the Association of American Geographers* 88: 107-125.

Faust, A. 2006. *Israel's Ethnogenesis: Settlement, Interaction, Expansion and Resistance*. London: Equinox.

Feathers, J.K. 1996. "Luminescence Dating and Modern Human Origins," *Evolutionary Anthropology* 5: 25-36.

Feinman, G.M. 1991. "Demography, Surplus, and Inequality: Early Political Formations in Highland Mesoamerica," in T. Earle, ed., *Chiefdoms: Power, Economy, and Ideology*. Cambridge: Cambridge University Press, 229-262.

Feinman, G.M. 1994. "Social Boundaries and Political Change: A Comparative View from Ancient Mesoamerica," in G. J. Stein and M. S. Rothman, eds., *Chiefdoms and Early States in the near East: The Organizational Dynamics of Complexity*. Madison: Prehistory Press, 225-236.

Feinman, G.M., S.A. Kowalewski, L. Finsten, R.E. Blanton, and L. Nicholas. 1985. "Long-Term Demographic Change: A Perspective from the Valley of Oaxaca, Mexico," *Journal of Field Archaeology* 12: 333-362(30).

Feinman, G.M., and J. Marcus, eds. 1998. *Archaic States*. Santa Fe: School of American Research Press.

Feinman, G.M., and J. Neitzel. 1984. "Too Many Types: An Overview of Sedentary Prestate Societies in the Americas," *Advances in Archaeological Method and Theory* 7: 39-102.

Fiema, Z.T. 1991. "Economics, Administation, and Demography of Late Roman and Byzantine Southern Transjordan." The University of Utah. MI: UMI.

---. 2003. "Roman Petra (A.D. 106–363): A Neglected Subject," *Zeitschrift des Deutschen Palästina-Vereins*: 38-58.

Findlater, G., M. El-Najjar, A.-H. Al-Shiyab, M. O'Hea, and E. Easthaugh. 1998. "The Wadi Faynan Project: The South Cemetery Excavation, Jordan 1996: A Preliminary Report," *Levant* 30: 69-83.

Finkelstein, I. 1992. "Invisible Nomads: A Rejoinder," *Bulletin of the American School of Oriental Research* 287: 87-88.

Finkelstein, I., and A. Perevolotsky. 1990. "Processes of Sedentarization and Nomadization in the History of Sinai and the Negev," *Bulletin of the American Schools of Oriental Research* 279: 67-88.

Fish, S.K., and S.A. Kowalewski, eds. 2009. *The Archaeology of Regions: A Case for Full-Coverage Survey*. New York: Percheron.

Fisher, C.T. 2009. "Abandoning the Garden: The Population/Land Degradation Fallacy as Applied to the Lake Patzcuaro Basin in Mexico," in C. T. Fisher, J. B. Hill and G. M. Feinman, eds., *The Archaeology of Environmental Change: Socionatural Legacies of Degradation and Resilience*. Tucson: University of Arizona Press, 209-231.

Fisher, C.T., J.B. Hill, and G.M. Feinman, eds. 2009a. *The Archaeology of Environmental Change: Socionatural Legacies of Degradation and Resilience*. Tucson: University of Arizona Press.

---. 2009b. "Introduction: Environmental Studies for Twenty-First-Century Conservation," in C. T. Fisher, J. B. Hill and G. M. Feinman, eds., *The Archaeology of Environmental Change: Socionatural Legacies of Degradation and Resilience*. Tucson: University of Arizona Press, 1-12.

Fisher, C.T., H.P. Pollard, I. Israde-Alcántara, V.H. Garduño-Monroy, and S.K. Banerjee. 2003. "A Reexamination of Human-Induced Environmental Change within the Lake Pátzcuaro Basin, Michoacán, Mexico," *Proceedings of the National Academy of Sciences* 100: 4957-4962.

Forbes, H. 1998. "European Agriculture Viewed Bottom-Side Upwards: Fodder- and Forage-Provision in a Traditional Greek Community," *Environmental Archaeology* 1: 19-34.

---. 2007. *Meaning and Identity in a Greek Landscape: An Archaeological Ethnography*. Cambridge: Cambridge University Press.

Ford, A., and S. Fedick. 1992. "Prehistoric Maya Settlement Patterns in the Upper Belize River Area: Initial Results of the Belize River Archaeological Settlement Survey," *Journal of Field Archaeology* 19: 35-49.

Fowles, S.M. 2010. "A People's History of the American Southwest," in S. M. Alt, ed., *Ancient Complexities: New Perspectives in Precolumbian North America*. Salt Lake City: University of Utah Press, 183-204.

Frachetti, M.D. 2012. "Multiregional Emergence of Mobile Pastoralism and Nonuniform Institutional Complexity across Eurasia," *Current Anthropology* 53: 2-38.

Frachetti, M.D., and A.N. Mar'yashev. 2007. "Long-Term Occupation and Seasonal Settlement of Eastern Eurasian Pastoralists at Begash, Kazakhstan," *Journal of Field Archaeology* 32: 221-242.

Francovich , R., H. Patterson, and G. Barker, eds. 2000. *Extracting Meaning from Ploughsoil Assemblages*. Oxford: Oxbow Books.

Fried, M. 1967. *The Evolution of Political Society: An Essay in Political Anthropology*. New York: Random House.

Fritz, V. 1994. "Vorbericht Uber Die Grabungen in Barqa El-Hetiye Im Gebiet Von Fenan, Wadi El-'Araba (Jordanien) 1990," *Zeitschrift des Deutschen Palästina-Vereins* 110: 125-150.

Frösén, J., Z.T. Fiema, H. Haggrén, K. Koistinen, M. Lavento, and G.L. Peterman. 1998. "The Finnish Jabal Harun Project Report on the 1997 Season," *Annual of the Department of Antiquities of Jordan* 42: 483-502.

Frumkin, A. 1997. "The Holocene History of Dead Sea Levels," in T. M. Nieme, Z. Ben-Avraham and J. R. Gat, eds., *The Dead Sea: The Lake and Its Setting*. New York: Oxford University Press, 237-248.

Frumkin, A., I. Carmi, A. Gopher, D.C. Ford, H.P. Schwarcz, and T. Tsuk. 1999. "A Holocene Millennial-Scale Climatic Cycle from a Speleothem in Nahal Qanah Cave, Israel," *The Holocene* 9: 677-682.

Frumkin, A., I. Carmi, I. Zak, and M. Magaritz. 1994. "Middle Holocene Environmental Change Determined from the Salt Caves of Mount Sedom, Israel," in O. Bar-Yosef and R. S. Kra, eds., *Late Quaternary Chronology and Paleoclimates of the Eastern Mediterranean*. Tuscon: Radiocarbon, 315-332.

Frumkin, A., and Y. Elitzur. 2002. "Historic Dead Sea Level Fluctuations Calibrated with Geological and Archaeological Evidence," *Quaternary Research* 57: 334-342.

Frumkin, A., G. Kadan, Y. Enzel, and Y. Eyal. 2001. "Radiocarbon Chronology of the Holocene Dead Sea: Attempting a Regional Correlation," *Radiocarbon* 43: 1179-1189.

Frumkin, A., P. Karkanas, M. Bar-Matthews, R. Barkai, A. Gopher, R. Shahack-Gross, and A. Vaks. 2009. "Gravitational Deformations and Fillings of Aging Caves: The Example of Qesem Karst System, Israel," *Geomorphology* 106: 154-164.

Frumkin, A., M. Magaritz, I. Carmi, and I. Zak. 1991. "The Holocene Climatic Record of the Salt Caves of Mount Sedom Israel," *The Holocene* 1: 191-200.

Gallant, T.W. 1986. ""Background Noise" and Site Definition: A Contribution to Survey Methodology," *Journal of Field Archaeology* 13: 403-418.

Gellner, E. 1969. *Saints of the Atlas*. Chicago: The University of Chicago Press.

Georgakopoulou, M. 2014. "Metallurgical Remains from Regional Surveys of "Non-Industrial" Landscapes: The Case of the Kythera Island Project," *Journal of Field Archaeology* 39: 67-83.

Gibson, E. 2007. "The Archaeology of Movement in a Mediterranean Landscape," *Journal of Mediterranean Archaeology* 20: 61-87.

Given, M. 2004. *The Archaeology of the Colonized*. London: Routledge.

Given, M., A.B. Knapp, N. Meyer, T.E. Gregory, V. Kassianidou, J. Noller, L. Wells, N. Urwin, and H. Wright. 1999. "The Sydney Cyprus Survey Project: An Interdisciplinary Investigation of Long-Term Change in the North Central Troodos, Cyprus," *Journal of Field Archaeology* 26: 19-39(21).

Glueck, N. 1935. "Explorations in Eastern Palestine, Ii," *The Annual of the American Schools of Oriental Research* 15: ix-202.

---. 1939. "Explorations in Eastern Palestine, Iii," *The Annual of the American Schools of Oriental Research* 18: xi-288.

Graf, D.F. 1990. "The Origin of the Nabataeans," *ARAM* 2: 45-75.

---. 1992. "Nabataean Settlements and Roman Occupation in *Arabia Petraea*," in A. Hadidi, ed., *Studies in the History and Archaeology of Jordan Iv*. Amman: Department of Antiquities, Jordan, 253-260.

---. 2001. "Town and Countryside in Roman Arabia During Late Antiquity," in T. S. Burns and J. W. Eadie, eds., *Urban Centers and Rural Contexts in Late Antiquity*. East Lansing: Michigan State University Press, 219-240.

Grattan, J., S. Huxley, L. Abu Karaki, H. Toland, D. Gilbertson, B. Pyatt, and Z. Al-Saad. 2002. "'Death... More Desirable Than Life'? The Human Skeletal Record and Toxicological Implications of Ancient Copper Mining and Smelting in Wadi Faynan, Southwestern Jordan," *Toxicology and Industrial Health* 18: 297-307.

Grattan, J.P., D.D. Gilbertson, and C.O. Hunt. 2007. "The Local and Global Dimensions of Metalliferous Pollution Derived from a Reconstruction of an Eight Thousand Year Record of Copper Smelting and Mining at a Desert-Mountain Frontier in Southern Jordan," *Journal of Archaeological Science* 34: 83-110.

Grattan, J.P., D.D. Gilbertson, and M. Kent. 2013. "Sedimentary Metal-Pollution Signatures Adjacent to the Ancient Centre of Copper Metallurgy at Khirbet Faynan in the Desert of Southern Jordan," *Journal of Archaeological Science* 40: 3834-3853.

Greene, A., and I. Lindsay. 2013. "Mobility, Territorial Commitments, and Political Organization among Late Bronze Age Polities in Southern Caucasia," *Archeological Papers of the American Anthropological Association* 22: 54-71.

Gunderson, L.H., and C.S. Holling, eds. 2002. *Panarchy: Understanding Transformations in Human and Natural Systems*. Washington: Island Press.

Haiman, M. 1989. "Preliminary Report of the Western Negev Highlands Emergency Survey," *Israel Exploration Journal* 39: 173-191.

Hart, S. 1986. "Sela': The Rock of Edom?," *Palestine Exploration Quarterly* 118: 91-95.

---. 1989. "The Archaeology of the Land of Edom."Unpublished Ph.D. Thesis, Macquarie University. Sydney.

---. 1992. "Iron Age Settlement in the Land of Edom," in P. Bienkowski, ed., *Early Edom and Moab: The Beginning of the Iron Age in Southern Jordan*. Sheffield: J.R. Collis.

Hart, S., and R.K. Falkner. 1985. "Preliminary Report on a Survey in Edom, 1984," *Annual of the Department of Antiquities of Jordan* 29: 255-277.

Hastorf, C.A. 1990. "One Path to the Heights: Negotiating Political Inequality in the Sausa of Peru," in S. Upham, ed., *The Evolution of Political Systems: Sociopolitics in Small-Scale Sedentary Societies*. Cambridge: Cambridge University Press, 146-176.

Hauptmann, A. 2007. *The Archaeometallurgy of Copper - Evidence from Faynan, Jordan*. New York: Springer.

Hauptmann, A., and G. Weisgerber. 1992. "Periods of Ore Exploitation and Metal Production in the Area of Feinan, Wadi 'Arabah, Jordan," in A. Hadidi, ed., *Studies in the History and Archaeology of Jordan*. Amman: Department of Antiquities, Jordan, 61-66.

Hazan, N., M. Stein, A. Agnon, S. Marco, D. Nadel, J.F.W. Negendank, M.J. Schwab, and D. Neev. 2005. "The Late Quaternary Limnological History of Lake Kinneret (Sea of Galilee), Israel," *Quaternary Research* 63: 60-77.

Healy, P.F., C.G.B. Helmke, J.J. Awe, and K.S. Sunahara. 2007. "Survey, Settlement, and Population History at the Ancient Maya Site of Pacbitun, Belize," *Journal of Field Archaeology* 32: 17-39(23).

Henry, D.O. 1995. *Prehistoric Cultural Ecology and Evolution: Insights from Southern Jordan*. New York: Plenum Press.

Herr, L.G., and M. Najjar. 2001. "The Iron Age," in B. MacDonald, R. Adams and P. Bienkowski, eds., *The Archaeology of Jordan*. Sheffield: Sheffield Academic Press, 323-345.

Higham, T., J. van der Plicht, C.B. Ramsey, H.J. Bruins, M. Robinson, and T.E. Levy. 2005. "Radiocarbon Dating of the Khirbat En-Nahas Site (Jordan) and Bayesian Modeling of the Results," in T. E. Levy and T. Higham, eds., *The Bible and Radiocarbon Dating - Archaeology, Text and Science*. London: Equinox, 164-178.

Hill, J.B. 2004. "Land Use and an Archaeological Perspective on Socio-Natural Studies in the Wadi Al-Hasa, West-Central Jordan," *American Antiquity* 69: 389-412.

---. 2006. *Human Ecology in the Wadi Al-Hasa: Land Use and Abandonment through the Holocene*. Tucson: University of Arizona Press.

Høgestøl, M., and L. Prøsch-Danielsen. 2006. "Impulses of Agro-Pastoralism in the 4th and 3rd Millennia Bc on the South-Western Coastal Rim of Norway," *Environmental Archaeology* 11: 19-34.

Holl, A.F.C. 2013. "Grass, Water, Salt, Copper, and Others: Pastoralists' Territorial Strategies in Central Sudan," *Archeological Papers of the American Anthropological Association* 22: 39-53.

Holladay, J.S.J. 1998. "The Kingdoms of Israel and Judah: Political and Economic Centralization in the Iron Iia-B (Ca. 1000-750 Bce)," in T. E. Levy, ed., *The Archaeology of Society in the Holy Land*. London: Leicester University Press, 368-398.

Holling, C.S. 2001. "Understanding the Complexity of Economic, Ecological, and Social Systems," *Ecosystems* 4: 390-405.

Holling, C.S., and L.H. Gunderson. 2002. "Resilience and Adaptive Cycles," in L. H. Gunderson and C. S. Holling, eds., *Panarchy: Understanding Transformations in Human and Natural Systems*. Washington: Island Press, 25-62.

Honeychurch, W. 2013. "The Nomad as State Builder: Historical Theory and Material Evidence from Mongolia," *Journal of World Prehistory* 26: 283-321.

Honeychurch, W., J. Wright, and C. Amartuvshin. 2007. "A Nested Approach to Survey in the Egiin Gol Valley, Mongolia," *Journal of Field Archaeology* 32: 369-383.

Hong, S., J.-P. Candelone, C.C. Patterson, and C.F. Boutron. 1994. "Greenland Ice Evidence of Hemispheric Lead Pollution Two Millennia Ago by Greek and Roman Civilizations," *Science* 265: 1841-1843.

Hritz, C. 2013. "Urbanocentric Models and 'Rural Messiness': A Case Study in the Balikh River Valley, Syria," *American Journal of Archaeology* 117: 141-161.

Hübner, U. 2004. "Qurayyat El-Mansur Und Hirbet El-Faid in Sudjordanien," *Zeitschrift des Deutschen Palastinavereins* 120: 141-156.

Hunt, C., and H. El-Rishi. 2010. "Human Paleoecology in the Ancient Metal-Smelting and Farming Complex in the Wadi Faynan, Sw Jordan, at the Desert Margin in the Middle East," in I. P. Martini and W. Chesworth, eds., *Landscapes and Societies*. New York: Springer, 121-134.

Hunt, C.O., D.D. Gilbertson, and H.A. El-Rishi. 2007. "An 8000-Year History of Landscape, Climate, and Copper Exploitation in the Middle East: The Wadi Faynan and the Wadi Dana National Reserve in Southern Jordan," *Journal of Archaeological Science* 34: 1306-1338.

Ingold, T. 1993. "The Temporality of the Landscape," *World Archaeology* 25: 152-174.

Ireland, T. 2003. ""The Absence of Ghosts": Landscape and Identity in the Archaeology of Australia's Settler Culture," *Historical Archaeology* 37: 56-72.

Issar, A.S., H. Ginat, and M. Zohar. 2011. "Shifts from Deserted to Inhabited Terrain in the Arid Part of the Middle East, a Function of Climate Changes," *Journal of Arid Environments*: 1-7.

Issar, A.S., and M. Zohar. 2007. *Climate Change: Environment and History of the near East*. New York: Springer.

Joffe, A.H. 2002. "The Rise of Secondary States in the Iron Age Levant," *Journal of the Economic and Social History of the Orient* 45: 425-467.

Johnson, D.J. 1987. "Nabataean Trade: Intensification and Culture Change." Ph.D. dissertation, University of Utah. Ann Arbor: University Microfilms.

Joukowsky, M.S., ed. 1998. *Petra: The Great Temple, 1. Brown University Excavations 1993-1997*. Providence: Johnson.

Kennedy, D.L. 2000. *The Roman Army in Jordan*. London: Council for British Research in the Levant.

Khazanov, A.M. 1984. *Nomads and the Outside World*. Translated by J. Crookenden, *Cambridge Studies in Social Anthropology, 44*. Cambridge; New York: Cambridge University Press.

Killion, T., J. Sabloff, G. Tourtellot, and N. Dunning. 1989. "Intensive Surface Collection of Residential Clusters at Terminal Classic Sayil, Yucatan, Mexico," *Journal of Field Archaeology* 16: 273-294.

Kirch, P.V. 1994. *The Wet and the Dry: Irrigation and Agricultural Intensification in Polynesia*. Chicago: University of Chicago Press.

Kitchen, K.A. 1992. "The Egyptian Evidence on Ancient Jordan," in P. Bienkowski, ed., *Early Edom and Moab: The Beginning of the Iron Age in Southern Jordan*. Sheffield: J.R. Collis, 21-34.

Kitchener, H.H. 1884. "Major Kitchener's Report," *Palestine Exploration Quarterly* 16: 202-221.

Klinger, Y., J.P. Avouac, D. Bourles, and N. Tisnerat. 2003. "Alluvial Deposition and Lake-Level Fluctuations Forced by Late Quaternary Climate Change: The Dead Sea Case Example," *Sedimentary Geology* 162: 119-139.

Kloner, A., and C. Ben-David. 2003. "Mesillot on the Arnon: An Iron Age (Pre-Roman) Road in Moab," *Bulletin of the American School of Oriental Research* 330: 65-81.

Knabb, K.A., I.W.N. Jones, T.E. Levy, and M. Najjar. 2014. "Patterns of Iron Age Mining and Settlement in Jordan's Faynan District: The Wadi Al-Jariya Survey in Context," in T. E. Levy, M. Najjar and E. Ben-Yosef, eds., *New Insights into the Iron Age Archaeology of Edom, Southern Jordan: Surveys, Excavations and Research from the University of California, San Diego – Department of Antiquities of Jordan, Edom Lowlands Regional Archaeology Project (Elrap)*. Los Angeles: Cotsen Institute of Archaeology Press, 557-625.

Knapp, A.B. 2003. "The Archaeology of Community on Bronze Age Cyprus: Politiko "Phorades" in Context," *American Journal of Archaeology* 107: 559-580.

Knapp, A.B., and W. Ashmore. 1999. "Archaeological Landscapes: Constructed, Conceptualized, Ideational," in W. Ashmore and A. B. Knapp, eds., *Archaeologies of Landscape: Contemporary Perspectives*. Malden, MA: BLackwell Publishers, 1-30.

Knauf, E.A. 1992. "The Cultural Impact of Secondary State Formation: The Cases of the Edomites and Moabites," in P. Bienkowski, ed., *Early Edom and Moab: The Beginning of the Iron Age in Southern Jordan*. Sheffield: J.R. Collis, 47-54.

Knodell, A.R., and S.E. Alcock. 2011. "Brown University Petra Archaeological Project: The 2010 Petra Area and Wadi Sulaysil Survey," *Annual of the Department of Antiquities of Jordan* 55: 489-508.

Kohl, P.L. 1992. "The Transcaucasian "Periphery" in the Bronze Age: A Preliminary Formulation," in E. M. Shortman and P. A. Urban, eds., *Resources, Power, and Interregional Interaction*. New York: Plenum, 117-137.

Kohler, T.A., and S.E.v.d. Leeuw. 2007. *The Model-Based Archaeology of Socionatural Systems*. Santa Fe, N.M.: School for Advanced Research Press.

Kouki, P. 2009. "Archaeological Evidence of Land Tenure in the Petra Region, Jordan: Nabataean-Early Roman to Late Byzantine," *Journal of Mediterranean Archaeology* 22: 29-56.

---. 2012. "The Hinterland of a City: Rural Settlement and Land Use in the Petra Region from the Nabataean-Roman to the Early Islamic Period." Ph.D. Dissertation, Helsinki University. Helsinki: Helsinki University Print.

Kouki, P., and M. Lavento. 2013. *Petra – the Mountain of Aaron: The Finnish Archaeological Project in Jordan*. III vols. Vol. III. Helsinki: Societas Scientiarum Fennica.

Kowalewski, S.A. 2008. "Regional Settlement Pattern Studies," *Journal of Archaeological Research* 16: 225-285.

LaBianca, Ø.S., and R.W. Younker. 1998. "The Kingdoms of Ammon, Moab and Edom: The Archaeology of Society in Late Bronze/Iron Age Transjordan (Ca. 1400-500 Bce)," in T. E. Levy, ed., *The Archaeology of Society in the Holy Land*. London: Leicester University Press, 399-415.

Lavento, M., P. Kouki, A. Eklund, A. Erving, E. Hertell, H. Junnilainen, S. Silvonen, and H. Ynnilä. 2007. "The Finnish Jabal Harun Project Survey. Preliminary Report of the 2005 Season," *Annual of the Department of Antiquities of Jordan* 51.

Lefebvre, H. 1984. *The Production of Space*. Translated by D. Nicholson-Smith. Oxford: Blackwell.

Lev-Tov, J.S.E., B.W. Porter, and B. Routledge. 2011. "Measuring Local Diversity in Early Iron Age Animal Economies: A View from Khirbat Al-Mudayna Al-Aliya (Jordan)," *Bulletin of the American Schools of Oriental Research* 361: 67-93.

Levy, T.E. 2009. "Pastoral Nomads and Iron Age Metal Production in Ancient Edom," in J. Szuchman, ed., *Nomads, Tribes, and the State in the Ancient near East: Cross-Disciplinary Perspectives*. Chicago: The Oriental Institute, 147-177.

Levy, T.E., R.B. Adams, J.D. Anderson, M. Najjar, N.G. Smith, Y. Arbel, L. Soderbaum, and A. Muniz. 2003. "An Iron Age Landscape in the Edomite Lowlands: Archaeological Surveys Along the Wadi Al-Guwayb and Wadi Al-Jariya, Jabal Hamrat Fidan, Jordan, 2002," *Annual of the Department of Antiquities of Jordan* 47: 247-277.

Levy, T.E., R.B. Adams, A. Hauptmann, S. Schmitt-Strecker, and M. Najjar. 2002. "Early Bronze Age Metallurgy: A Newly Discovered Copper Manufactory in Southern Jordan," *Antiquity* 76: 425-437.

Levy, T.E., R.B. Adams, M. Najjar, A. Hauptmann, J.D. Anderson, B. Brandl, M.A. Robinson, and T. Higham. 2004. "Reassessing the Chronology of Biblical Edom: New Excavations and 14c Dates from Khirbat En-Nahas (Jordan)," *Antiquity* 78: 865-879.

Levy, T.E., R.B. Adams, and R. Shafiq. 1999. "The Jebel Hamrat Fidan Project: Excavations at the Wadi Fidan 40 Cemetery, Jordan (1997)," *Levant* 31: 293-308.

Levy, T.E., R.B. Adams, A.J. Witten, J.D. Anderson, Y. Arbel, S. Kuah, J. Moreno, A. Lo, and M. Wagonner. 2001. "Early Metallurgy, Interaction, and Social Change: The Jabal Hamrat Fidan (Jordan) Research Design and 1998 Archaeological Survey: Preliminary Report," *ADAJ* 45: 159-187.

Levy, T.E., and D. Alon. 1987. "Settlement Patterns Along the Nahal Beersheva-Lower Nahal Besor: Models of Subsistence in the Northern Negev," in T. E. Levy, ed., *Shiqmim I*. Bar International Series 356(I). Oxford: B.A.R.

Levy, T.E., E. Ben-Yosef, and M. Najjar. 2014a. "The Iron Age Edom Lowlands Regional Archaeology Project Research, Design, and Methodology," in T. E. Levy, M. Najjar and E. Ben-Yosef, eds., *New Insights into the Iron Age Archaeology of Edom, Southern Jordan: Surveys, Excavations and Research from the University of California, San Diego – Department of Antiquities of Jordan, Edom Lowlands Regional Archaeology Project (Elrap)*. Los Angeles: Cotsen Institute of Archaeology Press, 1-87.

Levy, T.E., T. Higham, C.B. Ramsey, N.G. Smith, E. Ben-Yosef, M. Robinson, S. Munger, K.A. Knabb, J.P. Schulze, M. Najjar, and L. Tauxe. 2008. "High-Precision Radiocarbon Dating and Historical Biblical Archaeology in Southern Jordan," *Proceedings of the National Academy of Sciences of the United States of America* 105: 16460-16465.

Levy, T.E., and A.F.C. Holl. 2002. "Migrations, Ethnogenesis, and Settlement Dynamics: Israelites in Iron Age Canaan and Shuwa-Arabs in the Chad Basin," *Journal of Anthropological Archaeology* 21: 83-118.

Levy, T.E., and M. Najjar. 2006. "Some Thoughts on Khirbat En-Nahas, Edom, Biblical History and Anthropology - a Response to Israel Finkelstein," *Tel Aviv* 33: 107-122.

Levy, T.E., M. Najjar, and E. Ben-Yosef, eds. 2014b. *New Insights into the Iron Age Archaeology of Edom, Southern Jordan: Surveys, Excavations and Research from the University of California, San Diego–Department of Natiquities of Jordan, Edom Lowlands Regional Archaeology Project (Elrap)*. 2 vols. Los Angeles: Cotsen Institute of Archaeology Press.

Levy, T.E., M. Najjar, A.D. Gidding, I.W.N. Jones, K.A. Knabb, K. Bennallack, M. Vincent, A.N. Lamosco, A.M. Richter, C. Smitheram, L.D. Hahn, and S. Balaswaminathan. 2012. "The 2011 Edom Lowlands Regional Archaeology Project (Elrap): Excavations and Surveys in the Faynan Copper Ore District, Jordan," *Annual of the Department of Antiquities of Jordan* 56: 423-445.

Levy, T.E., M. Najjar, T. Higham, Y. Arbel, A. Muniz, E. Ben-Yosef, N.G. Smith, M. Beherec, A. Gidding, I.W.N. Jones, D. Frese, C. Smitheram, and M.

Robinson. 2014c. "Excavations at Khirbat En-Nahas 2002-2009: An Iron Age Copper Production Center in the Lowlands of Edom," in T. E. Levy, M. Najjar and E. Ben-Yosef, eds., *New Insights into the Iron Age Archaeology of Edom, Southern Jordan: Surveys, Excavations and Research from the University of California, San Diego – Department of Antiquities of Jordan, Edom Lowlands Regional Archaeology Project (Elrap)*. Los Angeles: Cotsen Institute of Archaeology Press, 89-245.

Levy, T.E., M. Najjar, A. Muniz, S. Malena, E. Monroe, M. Beherec, N.G. Smith, T. Higham, S. Munger, and K. Maes. 2005a. "Iron Age Burial in the Lowlands of Edom: The 2004 Excavations at Wadi Fidan 40, Jordan," *Annual of the Department of Antiquities of Jordan* 49: 443-487.

Levy, T.E., M. Najjar, J.v.d. Plicht, T. Higham, and H.J. Bruins. 2005b. "Lowland Edom and the High and Low Chronologies: Edomite State Formation, the Bible and Recent Archaeological Research in Southern Jordan," in T. E. Levy and T. Higham, eds., *The Bible and Radiocarbon Dating - Archaeology, Text and Science*. London: Equinox, 129-163.

Levy, T.E., and E.C.M. van den Brink. 2002. "Interaction Models, Egypt and the Levantine Periphery," in E. C. M. van den Brink and T. E. Levy, eds., *Egypt and the Levant : Interrelations from the 4th through the Early 3rd Millennium B.C.E.* London: Leicester University Press, 3-38.

Lindner, M. 1992. "Edom Outside the Famous Excavations: Evidence from Surveys in the Greater Petra Area," in P. Bienkowski, ed., *Early Edom and Moab: The Beginning of the Iron Age in Southern Jordan*. Sheffield: J.R. Collis.

Lindner, M., and S. Farajat. 1987. "An Edomite Mountain Stronghold North of Petra (Ba'ja Iii)," *Annual of the Department of Antiquities of Jordan* 31: 175-185.

Lindner, M., and E.A. Knauf. 1997. "Between the Plateau and the Rocks Edomite: Economic and Social Structure," *Studies in the History and Archaeology of Jordan* 6: 261-264.

Lindner, M., E.A. Knauf, J. Hübl, and J.P. Zeitler. 1997. "An Iron Age (Edomite) Occupation of Jabal Al-Khubtha (Petra) and Other Discoveries on the "Mountain of Treachery and Deceit"," *Annual of the Department of Antiquities of Jordan* 41: 177-188.

Lindner, M., E.A. Knauf, U. Hübner, and J. Hübl. 1998. "From Edomite to Late Islamic: Jabal as-Suffaha North of Petra," *Annual of the Department of Antiquities of Jordan* 42: 225-240.

Lindner, M., E.A. Knauf, and J.P. Zeitler. 1996a. "An Edomite Fortress and a Late Islamic Village near Petra (Jordan): Khirbat Al-Mu'allaq," *Annual of the Department of Antiquities of Jordan* 40: 111-135.

Lindner, M., E.A. Knauf, J.P. Zeitler, and H. Hübl. 1996b. "Jabal Al-Qseir: A Fortified Iron Ii (Edomite) Mountain Stronghold in Sothern Jordan, Its Pottery and Its Historical Context," *Annual of the Department of Antiquities of Jordan* 40: 137-166.

Linduff, K.M., R.D. Drennan, and G. Shelach. 2002. "Early Complex Societies in Ne China: The Chifeng International Collaborative Archaeological Research Project," *Journal of Field Archaeology* 29: 45-73.

MacDonald, B. 1988. *The Wadi El-Hasa Archaeological Survey 1979-1983, West-Central Jordan*. Ontario, Canada: Wilfrid Laurier University Press.

---. 1992. *The Southern Ghors and Northeast 'Arabah Archaeological Survey*. Sheffield: J.R. Collins Publications.

MacDonald, B., L.G. Herr, M.P. Neely, T. Gagos, K. Moumani, and M. Rockman. 2004. *The Tafila-Busayra Archaeological Survey 1999-2001, West-Central Jordan*. Boston: American Schools of Oriental Research.

Marcus, J. 1998. "The Peaks and Valleys of Ancient States: An Extension of the Dynamic Model," in G. M. Feinman and J. Marcus, eds., *Archaic States*. Santa Fe: School of American Research Press, 59-94.

Marshall, R.C., ed. 2010. *Cooperation in Social and Economic Life*. Lanham: Altamira Press.

Marston, J.M. 2011. "Archaeological Markers of Agricultural Risk Management," *Journal of Anthropological Archaeology* 30: 190-205.

Marx, E. 1967. *Bedouin of the Negev*. New York: Praeger.

---. 2007. "Nomads and Cities: Changing Conceptions," in B. A. Saidel and E. van der Steen, eds., *On the Fringe of Society: Archaeological and Ethnoarchaeological Perspectives on Pastoral and Agricultural Societies*. Oxford: Archaeopress, 75-78.

---. 2013. *Bedouin of Mount Sinai : An Anthropological Study of Their Political Economy*. New York: Berghahn Books.

Master, D.M. 2001. "State Formation Theory and the Kingdom of Ancient Israel," *Journal of Near Eastern Studies* 60: 117-131.

Mattingly, D., P. Newson, J. Grattan, R. Tomber, G. Barker, D. Gilbertson, and C. Hunt. 2007. "The Making of Early States: The Iron Age and Nabatean Periods," in G. Barker, D. D. Gilbertson and D. J. Mattingly, eds., *Archaeology and Desertification: The Wadi Faynan Landscape Survey, Southern Jordan*. Oxford: Oxbow Books; CBRL, 272-303.

Mayerson, P. 1989. "Saracens and Romans: Micro-Macro Relationships," *Bulletin of the American Schools of Oriental Research*: 71-79.

McAnany, P.A., and N. Yoffee, eds. 2010. *Questioning Collapse: Human Resilience, Ecological Vulnerability, and the Aftermath of Empire*. Cambridge: Cambridge University Press.

McAndrews, T.L., J. Albarracin-Jordan, and M. Bermann. 1997. "Regional Settlement Patterns in the Tiwanaku Valley of Bolivia," *Journal of Field Archaeology* 24: 67-83.

McGuire, R.H. 1983. "Breaking Down Cultural Complexity: Inequality and Heterogeneity," *Advances in Archaeological Method and Theory* 6: 91-142.

McKenzie, J. 1990. *The Architecture of Petra*. Oxford: Oxford University Press.

McLaren, S. 2004. "Characteristics, Evolution and Distribution of Quarternary Channel Calcretes, Southern Jordan," *Earth Surface Processes and Landforms* 29: 1487-1507.

McLaren, S.J., D.D. Gilbertson, J.P. Grattan, C.O. Hunt, G.A.T. Duller, and G.A. Barker. 2004. "Quaternary Palaeogeomorphologic Evolution of the Wadi Faynan Area, Southern Jordan," *Palaeogeography, Palaeoclimatology, Palaeoecology* 205: 131-154.

McQuitty, A. 2005. "The Rural Landscape of Jordan in the Seventh-Nineteenth Centuries Ad: The Kerak Plateau," *Antiquity* 79: 327-338.

Migowski, C., M. Stein, S. Prasad, J.F.W. Negendank, and A. Agnon. 2006. "Holocene Climate Variability and Cultural Evolution in the near East from the Dead Sea Sedimentary Record," *Quaternary Research* 66: 421-431.

Millard, A. 1992. "Assyrian Involvement in Edom," in P. Bienkowski, ed., *Early Edom and Moab: The Beginning of the Iron Age in Southern Jordan*. Sheffield: J.R. Collis.

Miller, D., M. Rowlands, and C. Tilley, eds. 1995. *Domination and Resistance*. New York: Routledge.

Miller, J.M., ed. 1991. *Archaeological Survey of the Kerak Plateau*. Atlanta: Scholars Press.

Mithen, S., and E. Black, eds. 2011. *Water, Life and Civilisation: Climate, Environment and Society in the Jordan Valley*. Cambridge: Cambridge University Press.

Morrison, K.D. 2001. "Coercion, Resistance, and Hierarchy: Local Processes and Imperial Strategies in the Vijayanagara Empire," in S. E. Alcock, T. D'Altroy,

K. D. Morrison and C. M. Sinopoli, eds., *Empires: Perspectives from Archaeology and History*. Cambridge: Cambridge University Press, 252-278.

Muniz, A., and T.E. Levy. 2014. "Feeding the Iron Age Metalworkers at Khirbat En-Nahas: Zooarchaeological Data," in T. E. Levy, M. Najjar and E. Ben-Yosef, eds., *New Insights into the Iron Age Archaeology of Edom, Southern Jordan: Surveys, Excavations and Research from the University of California, San Diego – Department of Antiquities of Jordan, Edom Lowlands Regional Archaeology Project (Elrap)*. Los Angeles: Cotsen Institute of Archaeology Press, 627-663.

Muniz, A.A. 2007. "Feeding the Periphery: Modeling Early Bronze Age Economies and the Cultural Landscape of the Faynan District, Southern Jordan."Ph.D. Dissertation, University of California, San Diego.

Musil, A. 1907. *Arabia Petraea, Von Alois Musil; Ii. Edom: Topograhischere Reisebericht*. Wien: Alfred Holder.

Nelson, M.C., M. Hegmon, S. Kulow, and K.G. Schollmeyer. 2006. "Archaeological and Ecological Perspectives on Reorganization: A Case Study from the Mimbres Region of the U.S. Southwest," *American Antiquity* 71: 403-432.

Netting, R.M. 1990. "Population, Permanent Agriculture and Polities: Unpacking the Evolutionary Portmanteau," in S. Upham, ed., *The Evolution of Political Systems: Sociopolitics in Small-Scale Sedentary Societies*. Cambridge: Cambridge University Press, 21-61.

---. 1993. *Smallholders, Householders: Farm Families and the Ecology of Intensive, Sustainable Agriculture*. Stanford: Stanford University Press.

Newson, P., G. Barker, P. Daly, D. Mattingly, and D. Gilbertson. 2007. "The Wadi Faynan Field Systems," in G. Barker, D. Gilbertson and D. Mattingly, eds., *Archaeology and Desertification: The Wadi Faynan Landscape Survey, Southern Jordan*. Oxford: Oxbow Books; CBRL, 141-174.

Oleson, J.P. 2010. *Humayma Excavation Project, 1: Resources, History, and the Water-Supply System*. Boston: American Schools of Oriental Research.

Ortner, S.B. 1984. "Theory in Anthropology since the Sixties," *Comparative Studies in Society and History* 26: 126-166.

Palmer, C. 1998. "The Role of Fodder in the Farming System: A Case Study from Northern Jordan," *Environmental Archaeology* 1: 1-10.

Palmer, C., D. Gilbertson, H. el-Rishi, C. Hunt, J. Grattan, S. McLaren, and B. Pyatt. 2007. "The Wadi Faynan Today: Landscape, Environment, People," in G. Barker, D. D. Gilbertson and D. J. Mattingly, eds., *Archaeology and Desertification:*

The Wadi Faynan Landscape Survey, Southern Jordan. Oxford: Oxbow Books; CBRL, 25-57.

Parker, B.J. 2006a. "Toward an Understanding of Borderland Processes," *American Antiquity*: 1-25.

---. 2013. "Geographies of Power: Territoriality and Empire During the Mesopotamian Iron Age," *Archeological Papers of the American Anthropological Association* 22: 126-144.

Parker, S.T. 1986. *Romans and Saracens: A History of the Arabian Frontier*. Philadelphia: American Schools of Oriental Research.

---. 1987a. "Peasants, Pastoralists, and "Pax Romana": A Different View," *Bulletin of the American Schools of Oriental Research*: 35-51.

---. 1987b. *The Roman Frontier in Central Jordan : Interim Report on the Limes Arabicus Project, 1980-1985*. 2 vols. Vol. 1. Oxford, England: B.A.R.

---. 2006b. *The Roman Frontier in Central Jordan*. Vol. 1. Washington, D.C.: Dumbarton Oaks Research Library and Collection.

---. 2009. "The Roman Frontier in Southern Arabia: A Synthesis of Recent Research," *Journal of Roman Archaeology. Supplementary Series* 74: 143-152.

Parr, P. 2007. "The Urban Development of Petra," in K. D. Politis, ed., *The World of the Nabataeans. Volume 2 of the International Conference the World of Herods and the Nabataeans*. Stuttgart: Franz Steiner, 273-300.

Parsons, J.R. 1972. "Archaeological Settlement Patterns," *Annual Reviews in Anthropology*.

Pauketat, T.R. 2004. "The Economy of the Moment: Cultural Practices and Mississippian Cheifdoms," in G. M. Feinman and L. M. Nicholas, eds., *Archaeological Perspectives on Political Economies*. Salt Lake City: The University of Utah Press, 25-39.

Pearson, J.E. 2011. "Contextualizing the Nabataeans: A Critical Reassessment of Their History and Material Culture." PhD Dissertation PhD Dissertation, UC Berkeley. eScholarship: eScholarship.

Peregrine, P. 1991. "Some Political Aspects of Craft Specialization," *World Archaeology* 23: 1-11.

Peterson, C.E., and R.D. Drennan. 2005. "Communities, Settlements, Sites, and Surveys: Regional-Scale Analysis of Prehistoric Human Interaction," *American Antiquity* 70: 5-30.

Pike, A.W.G., and M.P. Richards. 2002. "Diagenetic Arsenic Uptake in Archaeological Bone. Can We Really Identify Copper Smelters?," *Journal of Archaeological Science* 29: 607-611.

Plog, F., and J. Hill. 1971. "Explaining Variability in the Distribution of Sites," in G. J. Gumerman, ed., *The Distribution of Prehistoric Population Aggregates*. Prescott, AZ: Prescott College Press, 7-36.

Plog, S., F. Plog, and W. Wait. 1978. "Decision Making in Modern Surveys," *Advances in Archaeological Method and Theory* 1: 383-421.

Porat, N., S.A. Rosen, E. Boaretto, and Y. Avni. 2006. "Dating the Ramat Saharonim Late Neolithic Desert Cult Site," *Journal of Archaeological Science* 33: 1341-1355.

Porter, A. 2012. *Mobile Pastoralism and the Formation of near Eastern Civilizations: Weaving Together Society*. Cambridge: Cambridge University Press.

Porter, B.W. 2004. "Authority, Polity, and Tenuous Elites in Iron Age Edom (Jordan)," *Oxford Journal of Archaeology* 23: 373-395.

---. 2011. "Feeding the Community: Objects, Scarcity and Commensality in the Early Iron Age Southern Levant," *Journal of Mediterranean Archaeology* 24: 27-54.

---. 2013. *Complex Communities: The Archaeology of Early Iron Age West-Central Jordan*. Tucson: University of Arizona Press.

Price, B. 1978. "Secondary State Formation: An Explanatory Model," in R. Cohen and R. I. Service, eds., *Origins of the State: The Anthropology of Political Evolution*. Philadelphia: Institute for the Study of Human Issues, 161-186.

Pyatt, F.B., D. Amos, J.P. Grattan, A.J. Pyatt, and C.E. Terrell-Nield. 2002a. "Invertebrates of Ancient Heavy Metal Spoil and Smelting Tip Sites in Southern Jordan: Their Distribution and Use as Bioindicators of Metalliferous Pollution Derived from Ancient Sources," *Journal of Arid Environments* 52: 53-62.

Pyatt, F.B., G.W. Barker, P. Birch, D.D. Gilbertson, J.P. Grattan, and D.J. Mattingly. 1999. "King Solomon's Miners—Starvation and Bioaccumulation? An Environmental Archaeological Investigation in Southern Jordan," *Ecotoxicology and Environmental Safety* 43: 305-308.

Pyatt, F.B., G. Gilmore, J.P. Grattan, C.O. Hunt, and S. McLaren. 2000. "An Imperial Legacy? An Exploration of the Environmental Impact of Ancient Metal Mining and Smelting in Southern Jordan," *Journal of Archaeological Science* 27: 771-778.

Pyatt, F.B., and J.P. Grattan. 2001. "Some Consequences of Ancient Mining Activities on the Health of Ancient and Modern Human Populations," *Journal of Public Health* 23: 235-236.

Pyatt, F.B., A.J. Pyatt, and J.P. Grattan. 2002b. "A Public Health Problem?: Aspects and Implications of the Ingestion of Copper and Lead Contaminated Food by Bedouin," *Environmental Management and Health* 13: 467-470.

Pyatt, F.B., A.J. Pyatt, C. Walker, T. Sheen, and J.P. Grattan. 2005. "The Heavy Metal Content of Skeletons from an Ancient Metalliferous Polluted Area in Southern Jordan with Particular Reference to Bioaccumulation and Human Health," *Ecotoxicology and Environmental Safety* 60: 295-300.

Rabb'a, I. 1994. The Geology of the Al Qurayqira (Jabal Hamra Fadan) Map Sheet No. 3051 Ii. Amman: Geology Directorate Geological Mapping Division Bulletin 28.

Redman, C., M.C. Nelson, and A.P. Kinzig. 2009. "The Resilience of Socioecological Landscapes: Lessons from the Hohokam," in C. T. Fisher, J. B. Hill and G. M. Feinman, eds., *The Archaeology of Environmental Change: Socionatural Legacies of Degradation and Resilience*. Tucson: University of Arizona Press, 15-39.

Redman, C.L. 1999. *Human Impact on Ancient Environments*. Tuscon: University of Arizona Press.

---. 2005. "Resilience Theory in Archaeology," *American Anthropologist* 107: 77-107.

Redman, C.L., S.R. James, P.R. Fish, and J.D. Rogers, eds. 2004. *The Archaeology of Global Change : The Impact of Humans on Their Environment*. Washington: Smithsonian Books.

Redman, C.L., and A.P. Kinzig. 2003. "Resilience of Past Landscapes: Resilience Theory, Society, and the Longue Duree," *Conservation ecology* 7: 14.

Rittenour, T.M. 2008. "Luminescence Dating of Fluvial Deposits: Applications to Geomorphic, Palaeoseismic and Archaeological Research," *Boreas* 37: 613-635.

Rodseth, L., and B.J. Parker. 2005. "Introduction: Theoretical Considerations in the Study of Frontiers," in B. J. Parker and L. Rodseth, eds., *Untaming the Frontier in Anthropology, Archaeology, and History*. Tucson: The University of Arizona Press, 3-21.

Roll, I. 2007. "Crossing the Negev in Late Roman Times: The Administrative Development of *Palaestina Tertia Salutaris* and of Its Imperial Road Network," in A. S. Lewin and P. Pellegrini, eds., *The Late Roman Army in the near East from*

Diocletian to the Arab Conquest. Bar International Series. Oxford: Archaeopress, 119-130.

Rollefson, G.O. 1996. "The Neolithic Devolution: Ecological Impact and Cultural Compensation at 'Ain Ghazal, Jordan," in J. D. Seger, ed., *Retrieving the Past: Essays on Archaeological Research and Methodology in Honor of Gus W. Van Beek*. Winona Lake, Indiana: Eisenbrauns.

Rollefson, G.O., and I. Köhler-Rollefson. 1992. "Early Neolithic Exploitation Patterns in the Levant: Cultural Impact on the Environment," *Population and Environment* 13: 243-254.

Roseberry, W. 1989. "Peasants and the World," in S. Plattner, ed., *Economic Anthropology*. Stanford: Stanford University Press, 108-126.

Rosen, A.M. 2007. *Civilizing Climate: Social Responses to Climate Change in the Ancient near East*. Lanham: Altamira Press.

Rosen, A.M., and I. Rivera-Collazo. 2012. "Climate Change, Adaptive Cycles, and the Persistence of Foraging Economies During the Late Pleistocene/Holocene Transition in the Levant," *Proceedings of the National Academy of Sciences*.

Rosen, S. 2000. "The Decline of Desert Agriculture: A View from the Classical Period Negev," in G. Barker and D. Gilbertson, eds., *The Archaeology of Drylands: Living at the Margins*. London: Routledge, 44-61.

---. 2008. "Desert Pastoral Nomadism in the Longue DuréE," in H. Barnard and W. Wendrich, eds., *The Archaeology of Mobility*. Los Angeles: Cotsen Institute of Archaeology, 115-140.

Rosen, S.A. 1987a. "Byzantine Nomadism in the Negev: Results from the Emergency Survey," *Journal of Field Archaeology* 14: 29-42.

Rosen, S.A. 1987b. "Demographic Trends in the Negev Highlands: Preliminary Results from the Emergency Survey," *Bulletin of the American Schools of Oriental Research*: 45-58.

---. 1992. "Nomads in Archaeology: A Response to Finkelstein and Perevolotsky," *Bulletin of the American Schools of Oriental Research*: 75-85.

Rothman, M.S. 1994. "Introduction Part I. Evolutionary Typologies and Cultural Complexity," in G. Stein and M. S. Rothman, eds., *Chiefdoms and Early States in the near East: The Organizational Dynamics of Complexity*. Madison: Prehistory Press, 1-10.

Routledge, B. 2000. "The Politics of Mesha: Segmented Identities and State Formation in Iron Age Moab," *Journal of the Economic and Social History of the Orient* 43: 221-256.

---. 2004. *Moab in the Iron Age: Hegemony, Polity, Archaeology*. Philadelphia: University of Pennsylvania Press.

Sanders, W.T., J.R. Parsons, and R.S. Santley. 1979. *The Basin of Mexico: Ecological Processes in the Evolution of a Civilization*. New York: Academic Press.

Sartre, M. 2005. *The Middle East under Rome*. Cambridge: Harvard University Press.

Scarborough, V. 2003a. "How to Interpret an Ancient Landscape," *Proceedings of the Natioanl Academy of Sciences* 100: 4366-4368.

Scarborough, V.L. 2003b. *The Flow of Power: Ancient Water Systems and Landscapes*. Santa Fe: SAR Press.

---. 2009. "Beyond Sustainability: Managed Wetlands and Water Harvesting in Ancient Mesoamerica," in C. T. Fisher, J. B. Hill and G. M. Feinman, eds., *The Archaeology of Environmental Change: Socionatural Legacies of Degradation and Resilience*. Tucson: University of Arizona Press, 62-82.

Schiffer, M.B., A.P. Sullivan, and T.C. Klinger. 1978. "The Design of Archaeological Surveys," *World Archaeology* 10: 1-28.

Schilman, B., M. Bar-Matthews, A. Almogi-Labin, and B. Luz. 2001. "Global Climate Instability Reflected by Eastern Mediterranean Marine Records During the Late Holocene," *Palaeogeography, Palaeoclimatology, Palaeoecology* 176: 157-176.

Schloen, J.D. 2001. *The House of the Father as Fact and Symbol: Patrimonialism in Ugarit and the Ancient near East*. Winona Lake: Eisenbrauns.

Schmid, S.G. 2001. "The Nabateans: Travellers between Lifestyles," in B. MacDonald, R. Adams and P. Bienkowski, eds., *The Archaeology of Jordan*. Sheffield: Sheffield Academic Press, 367-426.

---. 2005. "The Hellenistic Period and the Nabateans," in R. Adams, ed., *Jordan: An Archaeological Reader*. London: Equinox, 353-411.

Schmitt-Korte, K. 1990. "Nabataean Coinage—Part Ii. New Coin Types and Variants," *The Numismatic Chronicle* 150: 105-133.

Schmitt-Korte, K., and M. Price. 1994. "Nabataean Coinage—Part Iii. The Nabataean Monetary System," *The Numismatic Chronicle* 154: 67-131.

Schofield, A.J., ed. 1991. *Interpreting Artefact Scatters: Contributions to Ploughzone Archaeology*. Oxford: Oxbow Books.

Schortman, E., and S. Nakamura. 1991. "A Crisis of Identity: Late Classic Competition and Interaction on the Southeast Maya Periphery," *Latin American Antiquity* 2: 311-336.

Schwartz, G.M., and S.E. Falconer, eds. 1994a. *Archaeological Views from the Countryside: Village Communities in Early Complex Societies*. Washington: Smithsonian Institution Press.

---. 1994b. "Rural Approaches to Social Complexity," in G. M. Schwartz and S. E. Falconer, eds., *Archaeological Views from the Countryside: Village Communities in Early Complex Societies*. Washington: Smithsonian Institution Press, 1-9.

Scoones, I. 1999. "New Ecology and the Social Sciences: What Prospects for a Fruitful Engagement?," *Annual Review of Anthropology* 28: 479-507.

Scott, J.C. 1976. *The Moral Economy of the Peasant: Rebellion and Subsistence in Southeast Asia*. New Haven: Yale University Press.

---. 1985. *Weapons of the Weak: Everyday Forms of Peasant Resistance*. New Haven: Yale University Press.

---. 1990. *Domination and the Arts of Resistance: Hidden Transcrips*. New Haven: Yale University Press.

---. 2009. *The Art of Not Being Governed: An Anarchist History of Upland Southeast Asia*. New Haven: Yale University Press.

Service, E. 1962. *Primitive Social Organization: An Evolutionary Perspective*. New York: Random House.

---. 1975. *Origins of the State and Civilization: The Process of Cultural Evolution*. New York: Norton.

Singhvi, A.K., and N. Porat. 2008. "Impact of Luminescence Dating on Geomorphological and Palaeoclimate Research in Drylands," *Boreas* 37: 536-558.

Sinopoli, C. 1998. "Identity and Social Action among South Indian Craft Producers of the Vijayanagara Period," *Archeological Papers of the American Anthropological Association* 8: 161-172.

Smith, A.M., M. Stevens, and T.M. Niemi. 1997. "The Southeast Araba Archaeological Survey: A Preliminary Report of the 1994 Season," *Bulletin of the American Schools of Oriental Research* 305: 45-71.

Smith, A.T. 2003. *The Political Landscape: Constellations of Authority in Early Complex Polities*. Berkeley: University of California Press.

---. 2011. "Archaeologies of Sovereignty," *Annual Review of Anthropology* 40: 415-432.

Smith, M.L. 2005. "Networks, Territories, and the Cartography of Ancient States," *Annals of the Association of American Geographers* 95: 832-849.

Smith, N.G. 2009. "Social Boundaries and State Formation in Ancient Edom: A Comparative Ceramic Approach."Unpublished Ph.D. Dissertation, University of California, San Diego. La Jolla, CA.

Smith, N.G., and T.E. Levy. 2008. "The Iron Age Pottery from Khirbat En-Nahas, Jordan: A Preliminary Study," *Bulletin of the American Schools of Oriental Research* 352: 1-51.

---. 2014. "Iron Age Ceramics from Edom: A New Typology," in T. E. Levy, M. Najjar and E. Ben-Yosef, eds., *New Insights into the Iron Age Archaeology of Edom, Southern Jordan: Surveys, Excavations and Research from the University of California, San Diego – Department of Antiquities of Jordan, Edom Lowlands Regional Archaeology Project (Elrap)*. Los Angeles: Cotsen Institute of Archaeology Press, 297-459.

Smith, N.G., M. Najjar, and T.E. Levy. 2014a. "New Perspectives on the Iron Age Edom Steppe and Highlands: Khirbat Al-Malayqtah, Khirbat Al-Kur, Khirbat Al-Iraq Shmaliya, and Tawilan," in T. E. Levy, M. Najjar and E. Ben-Yosef, eds., *New Insights into the Iron Age Archaeology of Edom, Southern Jordan: Surveys, Excavations and Research from the University of California, San Diego – Department of Antiquities of Jordan, Edom Lowlands Regional Archaeology Project (Elrap)*. Los Angeles: Cotsen Institute of Archaeology Press, 247-295.

---. 2014b. "A Picture of the Early and Late Iron Age Ii in the Lowlands: Preliminary Soundings at Rujm Hamrat Ifdan," in T. E. Levy, M. Najjar and E. Ben-Yosef, eds., *New Insights into the Iron Age Archaeology of Edom, Southern Jordan: Surveys, Excavations and Research from the University of California, San Diego – Department of Antiquities of Jordan, Edom Lowlands Regional Archaeology Project (Elrap)*. Los Angeles: Cotsen Institute of Archaeology Press, 723-739.

Snead, J.E. 2011. "The 'Secret and Bloody War Path': Movement, Place and Conflict in the Archaeological Landscape of North America," *World Archaeology* 43: 478-492.

Snead, J.E., C.L. Erickson, and J.A. Darling, eds. 2006. *Landscapes of Movement: Trails, Paths, and Roads in Anthropological Perspective*. Philedelphia: University of Pennsylvania Museum of Archaeology and Anthropology.

Spielmann, K.A., M. Nelson, S. Ingram, and M.A. Peeples. 2011. "Sustainable Small-Scale Agriculture in Semi Arid Environments," *Ecology and Society* 16: 26.

Stanish, C. 1999. "Settlement Pattern Shifts and Political Ranking in the Lake Titicaca Basin, Peru," in B. R. Billman and G. M. Feinman, eds., *Settlement Pattern Studies in the Americas: Fifty Years since Virú*. Washington: Smithsonian Institution Press, 116-128.

---. 2006. "Prehispanic Agricultural Strategies of Intensification in the Titicaca Basin of Peru and Bolivia," in J. Marcus and C. Stanish, eds., *Agricultural Strategies*. Los Angeles: Cotsen Institute of Archaeology, 364-397.

Stein, G. 2001. "Understanding Ancient State Societies in the Old World," in G. M. Feinman and T. D. Price, eds., *Archaeology at the Millennium: A Sourcebook*. New York: Kluwer, 353-380.

Stein, G.J. 1994. "Segmentary States and Organizational Variation in Early Complex Societies: A Rural Perspective," in G. M. Schwartz and S. E. Falconer, eds., *Archaeological Views from the Countryside: Village Communities in Early Complex Societies*. Washington: Smithsonian Institution Press, 10-18.

---. 2002. "From Passive Periphery to Active Agents: Emerging Perspectives in the Archaeology of Interregional Interaction," *American Anthropologist* 104: 903-916.

Steward, J. 1955. *Theory of Culture Change*. Urbana, IL: University of Illinois Press.

---. 1968. "Cultural Ecology," in D. L. Sils, ed., *International Encyclopedia of the Social Sciences*. New York: Macmillan, 337-344.

Stone, A.E.C., Thomas, D.S.G. 2013. "Casting New Light on Late Quaternary Environmental and Palaeohydrological Change in the Namib Desert: A Review of the Application of Optically Stimulated Luminescence in the Region," *Journal of Arid Environments* 93: 40-58.

Tainter, J.A. 1988. *The Collapse of Complex Societies*. Cambridge: Cambridge University Press.

Tainter, J.A. 2006. "Social Complexity and Sustainability," *ecological complexity* 3: 91-103.

Thomas, D.H. 1975. "Nonsite Sampling in Archaeology: Up the Creek without a Site?," in J. W. Mueller, ed., *Sampling in Archaeology*. Tuscon: University of Arizona Press, 61-81.

Thompson, V.D., and J.A. Turck. 2009. "Adaptive Cycles of Coastal Hunter-Gatherers," *American Antiquity* 74: 255-278.

Tilley, C. 1994. *A Phenomenology of Landscape: Places, Paths and Monuments*, *Explorations in Anthropology*. Oxford, UK: Berg.

Trigger, B.G. 1990. "Maintaining Economic Equality in Opposition to Complexity: An Iroquoian Case Study," in S. Upham, ed., *The Evolution of Political Systems: Sociopolitics in Small-Scale Sedentary Societies*. Cambridge: Cambridge University Press, 119-145.

Turner, B.L., P.A. Matson, J.J. McCarthy, R.W. Corell, L. Christensen, N. Eckley, G.K. Hovelsrud-Broda, J.X. Kasperson, R.E. Kasperson, A. Luers, M.L. Martello, S. Mathiesen, R. Naylor, C. Polsky, A. Pulsipher, A. Schiller, H. Selin, and N. Tyler. 2003. "Illustrating the Coupled Human–Environment System for Vulnerability Analysis: Three Case Studies," *Proceedings of the National Academy of Sciences* 100: 8080-8085.

Twiss, K.C. 2007. "The Zooarchaeology of Tel Tif'dan (Wadi Fidan 001), Southern Jordan," *Paléorient* 33: 127-145.

---. 2008. "Transformations in an Early Agricultural Society: Feasting in the Southern Levantine Pre-Pottery Neolithic," *Journal of Anthropological Archaeology* 27: 418-442.

Underhill, A.P., G.M. Feinman, L. Nicholas, G. Bennett, F. Cai, H. Yu, F. Luan, and H. Fang. 1998. "Systematic, Regional Survey in Se Shandong Province, China," *Journal of Field Archaeology* 25: 453-474(22).

Upham, S. 1990. "Decoupling the Processes of Political Evolution," in S. Upham, ed., *The Evolution of Political Systems: Sociopolitics in Small-Scale Sedentary Societies*. Cambridge: Cambridge University Press, 1-17.

Ur, J.A., and E. Hammer. 2009. "Pastoral Nomads of the 2nd and 3rd Millennia Ad on the Upper Tigris River, Turkey: The Hirbemerdon Tepe Survey," *Journal of Field Archaeology* 34: 37-56.

Vafiadou, A., A.S. Murray, and I. Liritzis. 2007. "Optically Stimulated Luminescence (Osl) Dating Investigations of Rock and Underlying Soil from Three Case Studies," *Journal of Archaeological Science* 34: 1659-1669.

van der Leeuw, S., and C. Redman. 2002. "Placing Archaeology at the Center of Socio-Natural Studies," *American Antiquity* 67: 597-605.

van der Leeuw, S.E., ed. 1998. *The Archaeomedes Project: Understanding the Natural and Anthropogenic Causes of Land Degradation and Desertification in the Mediterranean Basin*. Luxemburg: Office for Official Publications of the European Union.

---. 2009. "What Is an "Environmental Crisis" to an Archaeologist?," in C. T. Fisher, J. B. Hill and G. M. Feinman, eds., *The Archaeology of Environmental Change: Socionatural Legacies of Degradation and Resilience*. Tucson: University of Arizona Press, 40-61.

van der Steen, E., and B.A. Saidel. 2007. "On the Fringe of Society: Archaeological and Ethnoarchaeological Perspectives on Pastoral and Agricultural Societies: Introduction," in B. A. Saidel and E. van der Steen, eds., *On the Fringe of Society: Archaeological and Ethnoarchaeological Perspectives on Pastoral and Agricultural Societies*. Oxford: Archaeopress, 1-8.

van der Veen, P. 2011. "The Seal Material," in P. Bienkowski, ed., *Umm Al-Biyara: Excavations by Crystal-M. Bennett in Petra*. Oxford: Oxbow Books, 79-84.

VanValkenburgh, P., and J.F. Osborne. 2013. "Home Turf: Archaeology, Territoriality, and Politics," *Archeological Papers of the American Anthropological Association* 22: 1-27.

Vayda, A.P., and B.J. McCay. 1975. "New Directions in Ecology and Ecological Anthropology," *Annual Review of Anthropology* 4: 293-306.

Weippert, M. 1987. "The Relatiosn of the States East of the Jordan with the Mesopotamian Powers During the First Millennium Bc," in A. Hadidi, ed., *Studies in the History and Archaeology of Jordan Iii*. Amman: Department of Antiquities, Jordan, 97-105.

Weisgerber, G. 2006. "The Mineral Wealth of Ancient Arabia and Its Use I: Copper Mining and Smelting at Feinan and Timna - Comparison and Evaluation of Techniques, Production and Strategies," *Arabian Archaeology and Epigraphy* 17: 1-30.

Whitcomb, D. 1992. "Reassessing the Archaeology of Jordan of the Abbasid Period," *Studies in the History and Archaeology of Jordan* 4: 385-390.

Whitmore, T.M., and B.L. Turner. 2001. *Cultivated Landscapes of Middle America on the Eve of Conquest*. New York: Oxford University Press.

Wilkinson, T.J. 2000. "Regional Approaches to Mesopotamian Archaeology: The Contribution of Archaeological Surveys," *Journal of Archaeological Research* 8: 219-267.

---. 2003. *Archaeological Landscapes of the near East*. Tucson: University of Arizona.

---. 2010. "Empire and Environment in the Northern Fertile Crescent," in I. P. Martini and W. Chesworth, eds., *Landscapes and Societies*. Dordrecht: Springer, 135-151.

Wilkinson, T.J., E. Peltenburg, A. McCarthy, E.B. Wilkinson, and M. Brown. 2007. "Archaeology in the Land of Carchemish: Landscape Surveys in the Area of Jerablus Tahtani, 2006," *Levant* 39: 213-247.

Willey, G.R. 1953. *Prehistoric Settlement Patterns in the Virú Valley, Perú*. Washington, D.C.: United States Government Printing Office.

Wilson, D.J. 2009. "Full-Coverage Survey in the Lower Santa Valley: Implications for Regional Settlement Studies on the Peruvian Coast," in S. K. Fish and S. A. Kowalewski, eds., *The Archaeology of Regions: A Case for Full-Coverage Survey*. New York: Percheron Press, 117-145.

Wintle, A.G. 2008a. "Fifty Years of Luminescence Dating," *Archaeometry* 50: 276-312.

---. 2008b. "Luminescence Dating: Where It Has Been and Where It Is Going," *Boreas* 37: 471-482.

Wittfogel, K. 1957. *Oriental Despotism*. New Haven: Yale University Press.

Yoffee, N. 2005. *Myths of the Archaic State: Evolution of the Earliest Cities, States, and Civilizations*. Cambridge: Cambridge University Press.

Zeder, M.A. 2012. "The Broad Spectrum Revolution at 40: Resource Diversity, Intensification, and an Alternative to Optimal Foraging Explanations," *Journal of Anthropological Archaeology* 31: 241-264.

Zeitler, J.P. 1992. "'Edomite' Pottery from the Petra Region," in P. Bienkowski, ed., *Early Edom and Moab: The Beginning of the Iron Age in Southern Jordan*. Sheffield: J.R. Collis.

Zimmerer, K.S. 1994. "Human Geography and the “New Ecology”: The Prospect and Promise of Integration," *Annals of the Association of American Geographers* 84: 108-125.

Zori, C., and E. Brant. 2012. "Managing the Risk of Climatic Variability in Late Prehistoric Northern Chile," *Journal of Anthropological Archaeology* 31: 403-421.

Appendix 1: Iron Age Fidan sites from 1998 and 2004 survey seasons

Site Number	North UTM	East UTM	Elev	Major Periods	Other Periods	Site Type	Site Type 2
WFD 1	396160	727310	-15	PPN		Settlement	
WFD 10	396355	727411	-18	IA II		Cairns	
WFD 100	395287	729162	48	Middle Paleolithic		Lithic Scatter	
WFD 101	395174	729123	50	EB I		Cemetery	
WFD 102	395336	729673	50	Modern?	Islamic	Campsite	
WFD 103	395364	729529	50	Middle Paleolithic		Lithic Scatter	
WFD 104a	395397	729486	46	Paleolithic		Cairns	
WFD 104b	395334	729482	47	Unknown		Cairns	
WFD 105	395248	729434	37	Islamic		Rectangular Features	
WFD 106	395229	729421	46	Roman		Cairns	
WFD 107	395321	729381	16	Roman/Byzantine	IA	Metallurgical	
WFD 108	395079	729329	24	Roman/Byzantine, Late Islamic		Rock Shelter	
WFD 109	395056	729350	32	Paleolithic	Modern?	Cave	
WFD 11	396227	727453	-23	Neolithic, EB I		Rectangular Features	Terraces
WFD 110	395024	729466	58	EB I		Rectangular Feature	Circular Features
WFD 111	394992	729480	57	Unknown		Circular Feature	
WFD 112	394939	729486	60	IA	Roman	Rectangular Feature	Cairns
WFD 113	395037	729424	50	Paleolithic		Lithic Scatter	
WFD 114	395050	729384	48	Paleolithic		Cairns	
WFD 115	394971	729111	46	Middle Paleolithic		Cairns	
WFD 116	394881	729036	56	Unknown		Cairns	

Site Number	North UTM	East UTM	Elev	Major Periods	Other Periods	Site Type	Site Type 2
WFD 117	394797	729073	55	EB I		Rectangular Features	
WFD 118	394721	729122	51	Roman/Byzantine		Cairns	
WFD 119	394744	729144	49	Middle Paleolithic		Lithic Scatter	
WFD 12	396222	727519	-22	Islamic		Campsite	
WFD 120	394776	729319	53	EB II-IV, IA	Roman/Byzantine?, Early Islamic	Metallurgical	Settlement
WFD 121	394651	729101	56	Roman/Byzantine		Rectangular Feature	
WFD 122	394522	729082	64	Roman/Byzantine		Cairn	
WFD 123	394508	729203	57	IA		Tumuli	
WFD 124	394460	729250	61	Islamic	Roman/Byzantine	Cemetery	
WFD 125	395381	729400	17	IA		Agricultural	
WFD 13	396238	727571	-19	EB I, IA		Circular Features	Standing Stones
WFD 14	396256	727628	-12	IA	Paleolithic	Cairn	
WFD 15a	396353	727547	1	IA		Cairn	Standing Stones
WFD 15b	396387	727527	-16	IA		Cairn	
WFD 16	396239	727720	-9	EB I		Cairn	
WFD 17	396303	727812	-6	Unknown		Tumuli	
WFD 18	396244	728000	26	Roman/Byzantine		Cairns	
WFD 19	396378	727595	-29	IA		Wall Lines	
WFD 2	396500	727393	-20	EB I		Architecture Fragment	
WFD 20	396320	727748	-3	IA		Sherd Scatter	Copper Ore Scatter
WFD 21	396333	728232	16	Islamic		Cemetery	
WFD 22	396352	728151	10	EB II-III	Modern?	Cemetery	

Site Number	North UTM	East UTM	Elev	Major Periods	Other Periods	Site Type	Site Type 2
WFD 23	396095	727689	-17	EB I-II	IA II, Roman	Agricultural	
WFD 24	396140	727700	-19	Late Islamic	Roman/Byzantine	Cemetery	
WFD 25	396166	727800	-14	Islamic		Cave	
WFD 26	396170	727906	-6	Byzantine		Cairn	Rectangular Features
WFD 27	396213	727864	-10	Unknown		Agricultural	
WFD 28	396166	727990	9	Unknown		Cairn	
WFD 29	396098	727910	2	Roman/Byzantine	EB I	Wall Lines	Rectangular Features
WFD 3	396531	727423	-33	EB I		Cairn	
WFD 30	396083	727899	2	Middle Paleolithic		Lithic Scatter	
WFD 31	396095	727789	-4	EB I, Byzantine		Wall Lines	Circular Features
WFD 32a	396029	727668	-11	Unknown		Tumulus	
WFD 32b	396009	727738	-8	Unknown		Tumulus	
WFD 33	396198	728163	7	Unknown		Cairns	Circular Feature
WFD 34	396202	728105	-3	Roman/Byzantine		Agricultural	
WFD 35	396089	727975	-7	Islamic, Modern		Rock Shelter	
WFD 36a	396033	727935	-11	Late Islamic, Modern		Cave	Wall Line
WFD 36b	396024	727967	-10	Late Islamic		Cave	Wall Line
WFD 37	396005	727922	-13	Roman/Byzantine		Wall Line	
WFD 38	395999	727843	-16	Roman/Byzantine		Rectangular Features	Wall Lines
WFD 39	395980	727698	-17	EB II-III	Roman/Byzantine	Agricultural	
WFD 4	3959840	728509	17	EB I	IA	Settlement	
WFD 40	396075	728144	13	IA II		Cemetery	

Site Number	North UTM	East UTM	Elev	Major Periods	Other Periods	Site Type	Site Type 2
WFD 41	396055	728163	14	Middle Paleolithic		Lithic Scatter	
WFD 42	396107	728409	41	Unknown		Circular Features	Rectangular Features
WFD 43	396148	728409	33	Late Islamic		Rock Shelter	
WFD 44	396026	728378	23	Roman/Byzantine	EB I	Cairns	
WFD 45	396022	728378	23	Unknown		Tumuli	
WFD 46	395363	726858	-32	PPN, Roman/Byzantine	EB I, IA	Circular Features	Wall Lines
WFD 47	395538	727064	-29	EB I, Roman/Byzantine	IA	Circular Features	Rectangular Feature
WFD 48	395559	727320	-23	EB II-III, Roman		Cairn	Circular Features
WFD 49	395447	727265	-21	Roman/Byzantine	EB I	Campsite	
WFD 5	396387	727526	-16	EB I		Circular Feature	
WFD 50	395694	727437	-22	Roman/Byzantine		Caravanserai	
WFD 50a	395764	727542	-17	Roman/Byzantine		Defensive	Well
WFD 51	395701	727205	-28	Chalcolithic/EB I		Settlement	
WFD 51a	395751	727134	-27	Chalcolithic/EB I		Agricultural	
WFD 52	395667	727709	-18	EB II-III, IA, Roman		Settlement	Metallurgical
WFD 52a	395703	727719	-17	EB II-III, IA, Roman		Metallurgical	
WFD 53	395672	727604	-17	Roman/Byzantine	EB I	Metallurgical	
WFD 54	395651	727527	-15	Islamic, Modern?	IA, Roman/Byzantine	Cemetery	
WFD 55	395642	727586	-18	Islamic		Cemetery	
WFD 56	395526	727601	-11	EB I, Roman/Byzantine		Cairns	
WFD 57	395606	727793	-9	Roman/Byzantine		Sherd Scatter	

Site Number	North UTM	East UTM	Elev	Major Periods	Other Periods	Site Type	Site Type 2
WFD 58	395228	727998	14	IA		Metallurgical	
WFD 59	395336	728054	10	EB I, Roman/Byzantine	IA, Modern?	Metallurgical	Cairns
WFD 6	396575	727419	-37	EB II-III		Rectangular Features	
WFD 60	395673	728178	-6	Roman	EB I	Settlement	
WFD 61	395693	727998	17	PPN		Settlement	
WFD 62	395768	728580	29	IA		Rectangular Feature	
WFD 63	395822	728628	3	EB I		Rectangular Features	Metallurgical
WFD 64	395998	728380	6			Metallurgical	
WFD 65	395698	727845	-12	Byzantine	Islamic	Cemetery	
WFD 66	395386	727676	0	Islamic		Cave	Wall Line
WFD 67	396322	728303	8	IA		Cairns	
WFD 68	396097	728489	0	Modern?		Cairns	
WFD 69	396096	728570	-2	Roman/Byzantine		Cairns	
WFD 7	396571	727472	-38	IA		Agricultural	
WFD 70	396103	728662	23	EB I		Cemetery	
WFD 71	396094	728700	22	Unknown		Cairns	
WFD 72	396128	728738	24	Unknown		Cemetery	
WFD 73	396085	728809	18	Unknown		Cairn	
WFD 74	396171	728888	25	Roman		Rock Shelter	
WFD 75	396244	729044	33	EB I		Cairns	
WFD 76	396084	728983	27	Unknown	Upper Paleolithic	Cairns	
WFD 77a	395950	729021	18	IA II		Watchtower	
WFD 77b	395987	728976	2	EB I		Rectangular Feature	
WFD 78	395771	728881	8	EB II-III, Roman/Byzantine	Islamic	Settlement	Metallurgical
WFD 79	395764	729078	10	EB I		Wall Lines	

Site Number	North UTM	East UTM	Elev	Major Periods	Other Periods	Site Type	Site Type 2
WFD 8	396501	727626	-23	EB I		Cairns	
WFD 80	395716	729182	10	Byzantine		Agricultural	
WFD 81	395708	729186	10	EB II-III, IA		Sherd Scatter	
WFD 82	395664	729212	12	Roman/Byzantine		Architecture Fragment	
WFD 83	395540	729256	17	Roman/Byzantine		Agricultural	
WFD 84	396316	729297	33	EB II-III		Sherd Scatter	
WFD 85	396046	729015	11	Roman		Cave	
WFD 86	395879	729281	38	Middle Paleolithic		Lithic Scatter	
WFD 87	395807	729330	41	IA II		Sherd Scatter	
WFD 88	395881	729343	42	Unknown		Cairns	
WFD 89	395914	729238	36	IA II		Cairns	
WFD 9	396510	727742	-16	Unknown		Cairn	
WFD 90	395558	729470	45	Unknown	Paleolithic	Cairns	
WFD 91	395552	729599	51	Unknown		Cairns	
WFD 92	395562	729532	49	Middle Paleolithic		Lithic Scatter	
WFD 93	395571	729443	40	Unknown		Cairns	Wall Line
WFD 94	395632	729653	54	Unknown		Cairns	
WFD 95	395645	729803	47	Unknown		Rectangular Feature	Cairns
WFD 96	395556	729754	53	IA		Sherd Scatter	
WFD 97	395745	729383	15	Roman/Byzantine		Defensive	
WFD 98	395632	729553	33	Roman/Byzantine	EB I	Cairn	
WFD 99	395354	729197	34	EB I		Rock Shelter	
WFD 600	3394869	729472	55	Unknown		Circular Features	Rectangular Feature
WFD 601	3394676	729576	65			Circular Features	Cairns
WFD 602	3394646	729542	58	Middle Paleolithic, IA		Architecture Fragment	Lithic Scatter

Site Number	North UTM	East UTM	Elev	Major Periods	Other Periods	Site Type	Site Type 2
WFD 603	3394632	729617	62	Unknown		Cairns	Wall Lines
WFD 604	3394548	729786	68	Middle Paleolithic, IA		Circular Features	Rectangular Features
WFD 605	3394543	729733	67	Modern?		Campsite	
WFD 606	3394394	729872	68	Paleolithic, EB	IA, Nabataean, Roman/Byzantine	Architecture Fragment	Cairns
WFD 607	3394367	729745	57	Unknown	Paleolithic	Rectangular Feature	
WFD 608	3394349	729913	64	Nabataean, Byzantine	Paleolithic, IA	Cairns	
WFD 609	3394398	729992	69	Roman/Byzantine	IA, Nabataean	Tumuli	
WFD 610	3394466	730061	71	Nabataean		Tumuli	
WFD 611	3394498	730029	69	Roman/Byzantine	Paleolithic	Tumulus	
WFD 612	3394280	729895	69	Nabataean		Tumuli	
WFD 613	3394253	729929	68	Roman/Byzantine, Late Islamic	IA?, Nabataean	Circular Features	
WFD 614	3394230	729929	69	Nabataean/Roman		Metallurgical	
WFD 615	3394266	730003	66	Nabataean/Roman		Campsite	
WFD 616	3394195	729870	71	Nabataean, Roman, Byzantine	EB, Late Islamic	Cemetery	
WFD 617	3394203	729896	67	Roman/Byzantine, Nabataean	Middle Islamic/Late Islamic	Defensive	Wall Lines
WFD 618	3394220	729868	64	EB, Nabataean, Roman/Byzantine, Late Islamic		Sherd Scatter	
WFD 619	3394168	729985	68	Roman/Byzantine	Islamic	Rectangular Features	Wall Lines
WFD 620	3394152	730024	72	Nabataean		Cairns	Wall Lines
WFD 621	3394041	730285	78	EB, Roman/Byzantine		Cemetery	

Site Number	North UTM	East UTM	Elev	Major Periods	Other Periods	Site Type	Site Type 2
WFD 622	3393880	730383	78	Unknown		Cairns	Wall Lines
WFD 623	3393764	730398	78	Paleolithic		Cairns	
WFD 624	3393733	730288	78	EB		Tumuli	
WFD 625	3394284	730121	73	Roman/Byzantine		Circular Features	Cairns
WFD 626	3393998	729742	68	Unknown		Cairns	
WFD 627	3393797	729737	71	Unknown		Wall Lines	
WFD 628	3393939	729673	67	Paleolithic, EB, IA, Roman/Byzantine		Sherd Scatter	Lithic Scatter
WFD 629	3394136	729681	63	Modern?		Campsite	
WFD 630	3394199	729621	63	IA		Cairns	
WFD 631	3394448	729465	55	IA, Roman/Byzantine		Cairns	Slag Scatter
WFD 632	3394352	729553	60	Unknown		Cairns	

Appendix 2: Iron Age Jariya/Ghuwayba sites from 2002 and 2007 survey seasons

Site Number	North UTM	East UTM	Elev	Major Periods	Other Periods	Site Type	Site Type 2
WAG 1	3396947	729645	21	Modern	Roman	Cemetery	
WAG 10	3397542	733533	88	Upper Paleolithic		Cairn	
WAG 101	3397745	733509	99	Modern		Campsite	
WAG 102	3397694	733609	87	Unknown	Modern	Cairns	Architecture Fragment
WAG 103	3397714	733688	95	Unknown		Cairns	
WAG 104	3397743	733584	96	Unknown		Rectangular Features	Cairns
WAG 11	3397558	733590	86	Unknown		Architecture Fragment	
WAG 12	3397522	733574	83	Modern?		Campsite	
WAG 13	3397575	733622	87	Unknown		Cairns	
WAG 14	3397513	733623	84	Unknown		Cairn	
WAG 15	3397530	733645	81	EB?		Architecture Fragment	
WAG 16	3397576	733648	81	Modern?		Campsite	
WAG 17	3397506	733710	82	Unknown		Cairns	
WAG 18	3397488	733788	80	Roman	EB I	Architecture Fragment	
WAG 19	3397449	733893	79	EB I		Campsite	Cairns
WAG 2	3396978	729702	43	Upper Paleolithic		Cairns	
WAG 20	3397571	733909	92	Upper Paleolithic		Circular Features	
WAG 21	3397422	733956	79	Modern?		Campsite	

Site Number	North UTM	East UTM	Elev	Major Periods	Other Periods	Site Type	Site Type 2
WAG 22	3397461	733825	80	Roman/Byzantine	Modern?, Upper Paleolithic?	Campsite	Cairns
WAG 23	3397489	733990	84	EB II-III	Modern?	Circular Features	Wall Lines
WAG 24	3397582	734173	94	IA IIA	EB I?	Cemetery	
WAG 25	3397509	734085	86	Modern?		Cemetery	
WAG 26	3397583	734096	87	IAIIB	EB?	Sherd Scatter	Lithic Scatter
WAG 27	3397465	734069	82	Modern?	IA II	Campsite	
WAG 28	3397561	734265	93	Upper Paleolithic		Circular Feature	
WAG 29	3397302	734807	146	Unknown		Cairn	
WAG 3	3397228	729570	42	Roman	EB I	Pastoral	
WAG 30	3397604	734368	96	Unknown		Circular Features	
WAG 31	3397570	734337	93	Unknown		Cairns	
WAG 32	3397566	734393	86	Unknown		Rectangular Features	
WAG 33	3397662	734418	94	Unknown		Circular Features	
WAG 34	3397199	734553	92	Modern?	Roman/Byzantine	Campsite	Wall Lines
WAG 35	3397290	734499	91	Modern?	IA II, Roman/Byzantine	Cemetery	
WAG 36	3396990	734504	99	Modern?		Campsite	
WAG 37	3396842	734536	103	Unknown		Circular Features	
WAG 38	3396942	734582	99	Unknown		Unknown	

Site Number	North UTM	East UTM	Elev	Major Periods	Other Periods	Site Type	Site Type 2
WAG 39	3396893	734587	98	Unknown		Circular Features	
WAG 4	3397121	729855	22	Upper Paleolithic		Architecture Fragment	
WAG 40	3396942	734557	95	Unknown		Cairn	
WAG 41	3397080	734427	101	Unknown		Circular Features	
WAG 42	3397474	734414	90	Late Islamic		Rectangular Features	Cairn
WAG 43	3397392	734391	90	Middle-Late Islamic		Circular Features	
WAG 44	3397057	734692	96	Modern		Campsite	Pastoral
WAG 45	3397254	734367	88	Late Islamic	Modern?	Campsite	
WAG 46	3397422	734853	104	Unknown		Cairns	
WAG 47	3397426	734744	98	Unknown		Architecture Fragment	
WAG 48	3397445	734554	94	Roman/Byzantine		Circular Features	Wall Lines
WAG 49	3397358	734214	84	Unknown		Wall Lines	
WAG 5	3396880	729943	119	Upper Paleolithic		Cairns	
WAG 50	3397359	734144	83	Unknown		Architecture Fragment	
WAG 51	3397318	733555	72	Modern?	Roman/Byzantine	Campsite	
WAG 52	3397333	733819	78	Modern		Campsite	Pastoral
WAG 53	3396420	734474	119	Middle Islamic 2		Metallurgical	
WAG 56	3396300	734655	115	Middle-Late Islamic		Cemetery	
WAG 57	3396659	734158	106	Middle Islamic 2		Mines	

Site Number	North UTM	East UTM	Elev	Major Periods	Other Periods	Site Type	Site Type 2
WAG 58	3396737	734242	135	IA II (Pre-Edomite)	Middle Islamic	Mines	
WAG 59	3397030	733805	136	IA II (Pre-Edomite)		Cairns	
WAG 6	3397453	733730	76	Modern		Campsite	
WAG 60	3396984	733579	86	IA II (Pre-Edomite)		Cemetery	
WAG 61	3396743	733813	153	IA II (Pre-Edomite)		Cemetery	
WAG 62	3396991	733464	83	IA II		Metallurgical	
WAG 7	3397429	733606	73	Modern		Campsite	
WAG 8	3397470	733491	73	Roman/Byzantine	Late Prehistoric?	Cairns	
WAG 9	3397564	733475	91	Modern	Prehistoric?	Pastoral	
WAJ 501	3397566	733759	88	Modern		Campsite	
WAJ 502	3397900	734081	96	Modern?		Campsite	
WAJ 503	3397870	734119	93	Unknown		Lithic Scatter	
WAJ 504	3397941	734160	101	Modern?		Circular Feature	
WAJ 505	3397888	734148	93	Paleolithic	Chalcolithic/EB I	Lithic Scatter	
WAJ 506	3398345	734290	137	EB I		Campsite	
WAJ 507	3398251	734231	143	Modern?		Cairns	
WAJ 508	3397743	734119	85	EB I?	Modern?	Campsite	
WAJ 509	3397881	734300	95	Modern?		Campsite	
WAJ 510	3397988	734309	99	Modern?		Circular Feature	Wall Line
WAJ 511	3398059	734289	100	EB, IA II, Roman/Byzantine		Metallurgical	

Site Number	North UTM	East UTM	Elev	Major Periods	Other Periods	Site Type	Site Type 2
WAJ 512	3398099	734425	105	Roman/Byzantine	Modern?, EB I?	Architecture Fragment	Cairn
WAJ 513	3398495	734585	132	EB I	Modern?	Campsite	
WAJ 514	3398640	734532	136	IA II	Modern?, EB I?	Circular Feature	Cairn
WAJ 515	3398919	734427	125	IA IIA	EB I	Cairns	
WAJ 516	3398807	734240	132	IA IIA		Rectangular Feature	Cairns
WAJ 517	3398634	734442	120	Modern?		Cemetery	
WAJ 518	3398982	734328	134	IA IIA	EB I	Rock Shelters	Architecture Fragment
WAJ 519	3398936	734264	154	Unknown		Cairn	
WAJ 520	3398627	734436	120	IA II	EB I?	Cemetery	
WAJ 521	3398783	734417	125	IA IIA		Campsite	
WAJ 522	3399040	734335	138	IA IIA		Cairns	
WAJ 523	3399126	734345	137	IA IIA		Cairns	
WAJ 524	3399066	734418	130	Modern?	IA II	Cemetery	
WAJ 525	3399149	734398	127	Late Islamic	EB I?	Campsite	Cairn
WAJ 526	3399115	734520	126	Roman	Modern?	Campsite	
WAJ 527	3398890	734625	127	IA IIA		Cairns	Circular Features
WAJ 528	3398844	734561	121	Late Islamic	IA II, Modern?	Campsite	
WAJ 529	3399250	734518	131	Modern		Circular Features	
WAJ 530	3399326	734394	131	IA II	EB I, Modern?	Campsite	
WAJ 531	3399622	734113	151	Roman	Upper Paleolithic, IA IIA	Cairns	
WAJ 532	3399644	734383	138	Roman		Campsite	

Site Number	North UTM	East UTM	Elev	Major Periods	Other Periods	Site Type	Site Type 2
WAJ 533	3399660	734596	142	Roman/Byzantine	EB I?	Campsite	
WAJ 534	3399592	734463	137	EB I		Cairns	
WAJ 535	3399606	734668	143	IA II	EB I?	Circular Features	Wall Line
WAJ 536	3399740	734492	151	Unknown		Cairn	
WAJ 537	3399542	734390	133	EB I, IA II		Campsite	
WAJ 538	3399487	734570	160	Unknown		Campsite	
WAJ 539	3399519	734444	144	Unknown		Cairns	
WAJ 540	3399885	734880	154	IA II		Metallurgical	
WAJ 542	3399555	735126	163	IA II		Mine	
WAJ 543	3399428	735336	194	IA II		Mine	
WAJ 544	3399419	735351	196	IA II		Mine	
WAJ 545	3399402	735396	206	IA II		Mine	
WAJ 546	3399403	735527	224	IA II		Mine	
WAJ 547	3399397	735581	223	IA II		Mine	
WAJ 548	3399264	735616	236	EB II, EB III, IA II	Byzantine	Mine	
WAJ 549	3399223	735666	238	IA II		Mine	
WAJ 550	3399194	735758	247	IA II		Mine	
WAJ 551	3399121	735898	263	Roman/Byzantine		Mine	Metallurgica l
WAJ 552	3399191	735921	271	Modern	IA II	Mine	
WAJ 553	3399217	736036	289	IA II		Mine	
WAJ 554	3399228	736051	293	Unknown		Mine	
WAJ 555	3399287	735382	187	IA II	Modern?	Metallurgical	
WAJ 556	3399648	735333	234	Modern?		Campsite	
WAJ 557	3399608	735402	237	Modern?		Campsite	
WAJ 558	3399557	735437	244	Modern?		Campsite	
WAJ 559	3399518	735554	258	Unknown		Cairn	
WAJ 560	3399672	735661	0	IA		Mine	

Site Number	North UTM	East UTM	Elev	Major Periods	Other Periods	Site Type	Site Type 2
WAJ 561	3399672	735453	244	IA	Paleolithic	Circular Feature	
WAJ 562	3399606	735008	184	IA	Islamic	Cemetery	
WAJ 563	3399608	735134	239	Nabatean		Cairn	
WAJ 564	3399653	735203	193	IA, Roman/Byzantine		Circular Features	
WAJ 565	3399678	735218	194	IA		Rectangular Feature	
WAJ 566	3399616	735232	191	Roman/Byzantine		Cemetery	
WAJ 567	3399588	735226	194	Unknown		Circular Features	
WAJ 568	3399362	735574	251	Unknown		Campsite	
WAJ 569	3399219	735638	253	Modern?		Campsite	
WAJ 570	3399241	735664	261	Modern?		Campsite	
WAJ 571	3399276	735695	257	Modern?		Campsite	
WAJ 572	3399390	735685	257	Unknown		Mine	
WAJ 573	3399401	735603	240	Modern?		Campsite	
WAJ 574	3399577	735658	254	IA	Modern?	Rectangular Feature	
WAJ 575	3401097	735867	221	IA	EB, Modern?	Circular Features	Campsite
WAJ 576	3401275	736013	224	Islamic		Agricultural	
WAJ 577	3399660	735926	278	EB		Mine	
WAJ 578	3399654	736011	277	Roman/Byzantine		Mine	
WAJ 579	3399614	736049	279	Unknown		Agricultural	
WAJ 580	3399462	736053	294	Unknown		Cairns	
WAJ 581	3399549	735947	270	Unknown		Rectangular Feature	

Site Number	North UTM	East UTM	Elev	Major Periods	Other Periods	Site Type	Site Type 2
WAJ 582	3399592	735908	273	IA		Circular Features	
WAJ 583	3399599	735624	257	Roman		Sherd Scatter	
WAJ 584	3399623	735542	249	Modern	IA	Campsite	
WAJ 585	3399673	735552	246	Unknown		Cairn	
WAJ 586	3399918	735455	227	IA, Roman/Byzantine		Architecture Fragment	
WAJ 587	3399913	735511	227	IA		Mine	
WAJ 588	3399964	735116	182	IA		Campsite	Rectangular Features
WAJ 589	3399852	735328	217	Unknown		Cairns	
WAJ 590	3400014	735456	205	IA	Paleolithic?	Cairns	
WAJ 591	3400204	735405	192	IA, Roman/Byzantine		Campsite	
WAJ 592	3400141	735347	185	Roman/Byzantine	EB?	Circular Features	Cairn
WAJ 593	3400184	735251	191	IA, Modern	Paleolithic?, Roman/Byzantine	Campsite	
WAJ 594	3399844	734775	192	Modern?	Paleolithic?, IA	Campsite	
WAJ 595	3399986	734529	252	IA, Roman/Byzantine	EB	Defensive	
WAJ 596	3399993	734908	209	IA, Nabataean/Roman, Islamic		Cairns	Campsite
WAJ 597	3400136	735214	195	Unknown		Cairns	
WAJ 598	3400199	735058	204	Neolithic?		Lithic Scatter	

Site Number	North UTM	East UTM	Elev	Major Periods	Other Periods	Site Type	Site Type 2
WAJ 599	3399810	734925	173	Unknown		Cairn	Circular Features
WAJ 600	3400477	735717	201	IA?		Mine	
WAJ 601	3400461	735686	201	IA, Nabataean		Mine	
WAJ 602	3400425	735653	199	IA	EB	Mine	
WAJ 603	3400388	735652	201	EB, IA?		Mine	
WAJ 604	3400345	735653	201	IA		Mine	
WAJ 605	3400324	735660	201	IA	Paleolithic?, EB	Mine	
WAJ 606	3400206	735696	210	IA, Nabataean/Roman	Middle Paleolithic	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	Roman/Byzantine	Mine	
WAJ 611	3400233	735485	189	IA, Roman	Paleolithic	Mine	
WAJ 612	3400178	735536	199	IA		Mine	
WAJ 613	3400157	735484	198	IA	Late Islamic	Mine	
WAJ 614	3400102	735440	199	IA	Middle Paleolithic?	Mine	
WAJ 615	3399962	735496	206	EB, IA?		Mine	
WAJ 616	3400217	735587	223	Unknown		Cairn	
WAJ 617	3400214	735790	225	Unknown		Mine	
WAJ 618	3400190	735811	227	Unknown		Mine	
WAJ 619	3400384	735534	189	EB?		Cemetery	
WAJ 620	3400593	735768	200	EB		Mine	

Site Number	North UTM	East UTM	Elev	Major Periods	Other Periods	Site Type	Site Type 2
WAJ 621	3400625	735767	198	IA?	Middle Paleolithic	Mine	
WAJ 622	3400627	735798	201	EB, IA, Roman/Byzantine		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	
WAJ 628	3400533	736144	229	Unknown		Mine	
WAJ 629	3400501	736169	235	Unknown		Mine	
WAJ 630	3400574	736220	218	EB	Modern	Cemetery	
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, Nabataean		Mine	
WAJ 635	3400244	736645	248	Unknown		Sherd Scatter	
WAJ 636	3400672	736030	213	IA		Mine	
WAJ 637	3400651	736128	218	IA		Mine	
WAJ 638	3400494	736392	227	Unknown		Cemetery	
WAJ 639	3400319	735130	194	IA		Cemetery	
WAJ 640	3400577	735470	217	IA	Middle Paleolithic?, PPNB, PPNC, EB, Nabataean	Cemetery	Architecture Fragment
WAJ 641	3400795	735693	216	IA	Roman/Byzantine	Cairns	
WAJ 642	3401493	736215	242	EB	Modern?	Cairn	
WAJ 643	3401693	736291	263	IA	Paleolithic?, Modern?	Rectangular Features	

Site Number	North UTM	East UTM	Elev	Major Periods	Other Periods	Site Type	Site Type 2
WAJ 644	3401014	735670	221	Unknown		Circular Feature	
WAJ 645	3401025	735766	223	Roman	Byzantine?	Campsite	
WAJ 646	3401169	735896	228	Paleolithic?		Lithic Scatter	
WAJ 647	3401244	735896	240	Unknown		Wall Line	
WAJ 648	3401493	736053	242	Unknown		Cairn	Wall Lines
WAJ 649	3401550	736183	240	Nabataen/Roman		Sherd Scatter	
WAJ 650	3401594	736240	249	Unknown		Cairns	
WAJ 651	3401918	736536	296	Unknown		Cairn	