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Long-Distance Trade and Social Complexity in Iron Age Faynan, Jordan

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

in

Anthropology

by

Matthew David Howland

Committee in charge:

Professor Thomas E. Levy, Chair
Professor Geoffrey E. Braswell
Professor James Day
Professor Paul Goldstein
Professor Falko Kuester

2021

The dissertation of Matthew David Howland is approved, and it is acceptable in quality and form for publication on microfilm and electronically.

University of California San Diego

2021

EPIGRAPH

Everything is related to everything else, but near things are more related than distant things.

Waldo Tobler

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LIST OF ABBREVIATIONS

ELRAP – Edom Lowlands Regional Archaeology Project (UCSD)
KAG – Khirbat al-Ghuwayba
KAJ – Khirbat al-Jariya
KEN – Khirbat en-Nahas
RHI – Rujm Hamra Ifdan
RHI-A – Sounding A at Rujm Hamra Ifdan
RHI-B – Sounding B at Rujm Hamra Ifdan
SGNAS – The Southern Ghors and Northeast ʿArabah Archaeological Survey (MacDonald 1992)
UCSD – University of California San Diego

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ABSTRACT OF THE DISSERTATION

Long-Distance Trade and Social Complexity in Iron Age Faynan, Jordan

by

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Doctor of Philosophy

in

Anthropology

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Professor Thomas E. Levy, Chair

Tens of thousands of tons of copper were produced in Southern Jordan's Faynan region during the Iron Age (ca. 1200 - 600 BCE). Despite this, the long-distance exchange of copper and its effect on the development of social complexity in the region are not well-understood, due to a limited corpus of copper artifacts sourced to the Iron Age mines of Faynan, recycling of metal objects, and a lack of research specifically focused on the exchange of copper. However, trade and social complexity can be explored through examination of material culture beyond metallurgical evidence. This work applies a range of methods in order to study whether elites at the Iron Age copper producing site Khirbat al-Jariya exploited trade networks in which copper and ceramics were exchanged in order to develop and reinforce their own power. The approaches used here to address these issues are aerial regional survey, excavation at Khirbat al-Jariya, and comprehensive ceramic analysis. The aerial survey, consisting of low-altitude aerial photography and three-dimensional image-based modeling, facilitated the remapping of important Iron Age sites such as Khirbat en-Nahas and Khirbat al-Jariya, among others, providing an updated understanding of the distribution of material remains and scale of copper production at these sites. Excavation at Khirbat al-Jariya in 2014 provided data allowing for the study of the social organization of the site and its role in a regional network, as well as a refinement of chronology of the site. This excavation also recovered the ceramics, studied through 3D modeling, typological analysis, and ceramic petrography, that allow for the examination of technology and provenance. This ceramic study demonstrates the presence of elites at Khirbat al-Jariya and illustrates their participation in Iron Age regional exchange networks. This analysis also shows that social complexity at Khirbat al-Jariya was driven by elites' exploitation of long-distance exchange networks.

Introduction

Research Goals and Methods

This work investigates social complexity and trade at the Iron Age copper production site Khirbat al-Jariya (KAJ) through aerial survey, excavation, and ceramic analysis. The central objective of the project is to understand the role that exchange—particularly of copper—played in the development of inequality in the Faynan region of Southern Jordan during the Iron Age. This work complements prior studies, which have largely focused on the role of technology and production in social evolution (Ben-Yosef et al. 2019; Hauptmann 2007; Levy 2006; Levy et al. 2014). The exchange of copper produced in Faynan during the Iron Age is still poorly understood, due to a limited corpus of copper artifacts sourced to the Iron Age mines of Faynan, recycling of metal objects (Bray et al. 2015), and a lack of research specifically focused on exchange of copper. In general, the study of ceramics is not limited by issues of scarcity or recycling and can be an excellent basis for the study of exchange networks and political centralization (Costin 2002). Thus, the study of ceramics can provide insight into trade relationships active in the Early Iron Age in which copper was exchanged and related issues of social complexity. The examination of ceramics allows for the study of international exchange networks and whether or not elites were able to exploit these patterns to develop and reinforce their own power. Four hypotheses are tested in this work, presented in detail with their archaeological correlates below. First, the conjecture that elites occupied Area B at KAJ is tested. Second, the idea that society in Faynan was locally organized, rather than controlled by an external entity, is examined. The final two hypotheses narrow in on the role of trade and its impact. The third tests the supposition that copper produced in Faynan and at KAJ was primarily traded westward through the Negev Desert. Finally, the fourth hypothesis investigates whether or not elites at KAJ exploited the copper trade for their own benefit and if this exchange was a key driver of social complexity in the region. These hypotheses and their archaeological correlates are discussed more fully in Chapter 5.

Several methods are applied to test these hypotheses. A systematic campaign of aerial survey provides highly accurate context for other analyses. Low-altitude aerial photography, image-based modeling, and GIS-based mapping methods resulted in the comprehensive remapping of key Iron Age sites such as Khirbat en-Nahas and Khirbat al-Jariya, as well as providing a basis for intra-site spatial analysis and digital public archaeology. This survey also helped to inform decisions during 2014 excavations at KAJ. The objectives and outcomes of this survey are more fully discussed in Chapter 6. The excavation of Areas B and C at KAJ also provides data toward the goals of understanding trade and social complexity at the site. Area B was chosen for investigation as it represents the largest extant structure at the site and a possible elite context, allowing for the examination of social organization and complexity at the site. Meanwhile, Area C was probed in order to further study the industrial trajectory of the site. These excavations uncovered the ceramics that serve as a central focus of the analysis discussed here. As such, these excavations, discussed in Chapter 7, provide important detail about a wide range of activity at the site, allowing for the testing of the central hypotheses of this work. The main methods applied to study trade and social complexity are multiple approaches toward ceramic analysis. The recording of key diagnostic sherds in three dimensions using image-based modeling provides a record of sherds and allows for automatic illustration that facilitates comparative study. The models produced through these techniques also provide the basis for 3D Open Data sharing. These methods are detailed in Chapter 8. The second method of ceramic investigation is form analysis and classification. The study of parallels to the ceramics recovered from KAJ in 2014 allows for comparison with the assemblages of other sites in the Faynan region such as the important site of Khirbat en-Nahas as well as sites in regions such as the Negev Highlands, providing insight into both social organization and trade connections. These ceramic forms are discussed in Chapter 9. The final analytical method applied here, presented in Chapter 10, is petrographic examination of ceramic fabrics through optical mineralogy. This approach allows for the examination of the chaîne opératoire of ceramic production, which, in turn, has relevance to social groups active in ceramic manufacture. Moreover, the provenancing of ceramics through comparison to geologic units in the Southern Levant provides concrete evidence for trade connections and networks in which inhabitants of KAJ were engaged. The last approach used, providing outreach and context to the analysis done in the study and discussed in Chapter 11, is the publishing of digital archaeological data on online platforms such as Sketchfab and ArcGIS StoryMaps. Though these are not necessarily analytical tools, the use of 3D and spatial data collection methods for other objectives in this study provides a wealth of digital data that can be published in contextualized ways online. These platforms can be oriented toward Open Data publishing for the scholarly community or for storytelling for the general public.

Outline

Following this introduction chapter, Chapter 1: Theoretical Framework provides a review of the anthropological and archaeological theory that provides structure to the analysis conducted. The theory discussed can largely be divided into three categories. First, a discussion of craft production, ideology, and social stratification provides context for the presence of elites at Iron Age copper smelting sites, who were likely engaged in craft production. Archaeological correlates for a stratified society in which elites are present are discussed. It is argued that the spatial distribution of serving and food preparation wares and fine imported ceramics is indicative of social complexity. Second, literature providing context for the role of long-distance exchange in social complexity is reviewed, and possibilities for the ways in which elites exploited trade for their own advantage are discussed. Finally, the concept of the chaîne opératoire is discussed and it is proposed that examination of ceramic technology can provide information about the social groups and communities of practice manufacturing ceramic vessels.

Chapter 2: Temporal Context and Historical Evidence sets the scene for discussion of the Iron Age polity of Edom. The chapter gives background on the Late Bronze Age collapse, which created the preconditions for the rise of social complexity in the Wadi Arabah. The chapter also briefly summarizes the historical debates regarding the chronology and control of Iron Age copper production in Faynan. Finally, the historical evidence relevant to the early Edomite polity and its development is reviewed, suggesting that caution must be applied when using this evidence to interpret the archaeological past.

Chapter 3: Geographic, Geologic, and Environmental Context similarly provides important background to discussion of settlement at Khirbat al-Jariya. The geography of the Faynan region is presented, as is the geology, which provides important background information for the petrographic analysis presented later. Finally, the major sources of paleoclimatic evidence for the Iron Age Southern Levant are discussed, illustrating that conditions in the Iron Age may have been more favorable to settlement in marginal areas. However, local variation in environmental conditions and especially social, political, and economic factors were of primary importance.

Chapter 4: Evidence for Iron Age Trade and Social Complexity offers an extensive review of both previous research on the Iron Age copper producing sites of Faynan and many contemporaneous sites in the Wadi Arabah, Negev Desert, and Beersheba Valley. The ceramics of these sites are valuable for comparison to the ceramics of Khirbat al-Jariya. This chapter discusses the general trends observed in the Iron Age ceramics at regional scale as well as within individual sites. Ultimately, discussion of the evidence from these sites reveals similarities between sites in the Wadi Arabah and those in the Negev, suggesting a possible trade connection between the two regions. Chapter 5 also casts doubt on the premise that copper production and society in Faynan was externally controlled.

Chapter 5: Hypotheses and Correlates draws on the discussion of the previous chapters in order to lend support to four hypotheses that serve as the central foci of the analyses conducted in this work. Each hypothesis is presented and discussed along with their archaeological correlates. The four hypotheses presented are the premise that elites occupied Building 2 at Khirbat al-Jariya (KAJ), that society in Faynan was locally organized and controlled, that copper produced in the region was primarily exchanged through the Negev Desert, and that this trade served as a primary catalyst of social complexity in the region.

Chapter 6: Aerial Survey opens the second part of the dissertation, which focuses on the new contributions of this study. This chapter describes a campaign of low-altitude aerial photography and image-based modeling used to record many archaeological sites in Faynan in three-dimensions. The datasets produced through this analysis allowed for the high-resolution mapping of these sites. This chapter describes the re-mapping of important Iron Age sites Khirbat en-Nahas and Khirbat al-Jariya and details the improvements made vis-à-vis older maps. These new maps help illustrate the scale and scope of copper production in the region.

Chapter 7: Excavation at Khirbat al-Jariya 2014 explains the investigation of Areas B and C at KAJ. These areas were excavated and radiocarbon dated in 2014. These excavations showed that the site was occupied from the mid-11th century BCE to the mid-late-10th century BCE and was likely occupied as part of an organized and coordinated effort. These excavations also produced the ceramic assemblage studied in greater detail in the subsequent chapters.

Chapter 8: Ceramic Analysis — 3D Modeling is the first of three chapters describing the ceramic analysis conducted for this dissertation. This chapter focuses on the collection of 3D models of the diagnostic ceramic sherds from KAJ through image-based modeling. This chapter argues for the utility of 3D sherd models for automated illustration and analysis. The chapter also describes an Open Data project involving publishing contextualized 3D sherd models on platforms such as Sketchfab and ArcGIS StoryMaps.

Chapter 9: Ceramic Analysis — Classification and Typology presents a new classification of the ceramic assemblage recovered from KAJ in 2014 excavations. This classification builds on the discussion of Chapter 4 as the classification in this chapter is built based on parallels to contemporaneous sites, especially the nearby site of Khirbat en-Nahas. Overall, this chapter argues that the KAJ assemblage is typical of Iron Age copper producing sites, suggesting that potters producing the ceramics of the site operated in a shared social network as those of KEN and other nearby sites. The presence of imported and decorated fine-wares also suggests the presence of elites at KAJ who exploited trade networks for their own gain.

In Chapter 10: Ceramic Analysis — Petrography, the analysis of a sample of diagnostic ceramics from KAJ through optical mineralogy is presented. This work divides the ceramics of KAJ into three main ware groups representative of geologic origins, building on previous petrographic studies discussed in Chapter 4 and the geology of the region discussed in Chapter 3. The fabric characterization presented in this chapter classifies the majority of ceramics at KAJ as local, representing a homogeneous assemblage and shared chaîne opératoire. Two ware groups, however, are identified as consisting of imported ceramics, representing the ability of elites at KAJ to exploit interregional exchange networks.

Chapter 11: Public Archaeology, Open Data, and Digital Engagement discusses the online publishing of digital datasets collected through the analyses described in other chapters. These digital publications serve two purposes: providing contextualized Open Data for scholars and engaging the general public through informative and entertaining spatial storytelling. Digital public archaeology also facilitates community engagement, as argued in this chapter.

Finally, Chapter 12: Summary of the Main Argument of this Dissertation provides a brief review of how the evidence presented in the above chapters addresses the main hypotheses introduced in Chapter 6. In short, this chapter reiterates the argument that elites were present at KAJ, that copper production and society at the site and region was locally organized and controlled, that copper produced in the region was exported through the Negev, and that elites at KAJ exploited the copper exchange and leveraged it to reinforce their own power.

Dates and Terminology

The relative chronology of the Southern Levant during the 12th to 8th centuries BCE is famously contested. This period is divided into periods (e.g. Bronze Age, Iron Age), which are subdivided (e.g. Iron I, Iron II), subdivided again (e.g. Iron IIA, Iron IIB), and in some cases subdivided again (e.g. Early Iron IIA, Late Iron IIA). These chronological divisions represent cultural eras, largely based on ceramic typologies, into which strata at various archaeological sites are slotted. These archaeological periods also correlate with historical phenomena in the Southern Levant, which are often considered to be "chronological anchors," tying this relative dating scheme to absolute chronology. For example, the Biblically-attested Assyrian conquest of the Southern Levant in the Iron IIB period is linked to archaeologically-attested destruction layers at many sites (e.g. Lachish Stratum III), and pottery from these layers is thus characteristic of the Iron IIB period (Mazar 2005). In turn, archaeological sites with ceramics similar to the assemblages from these sites on the basis of established ceramic typologies are, in turn, dated to the Iron IIB through relative dating. The extent to which ceramic analysis in the Southern Levant relies on comparison to chronological and cultural typologies is discussed in greater detail in Chapter 9.

The association of this relative dating scheme to absolute dates, which relies on chronological anchors that are sparse and subject to reinterpretation, has resulted in an ongoing controversy. The origins of this debate came when Finkelstein (1995, 1996) challenged the traditional chronological sequence of historical periods. Finkelstein, by challenging the circular logic of pottery dated based on association with architecture and sites dated based on similarity of ceramics, argued that the Iron Age IIA began at the end of the 10th century (the Low Chronology) rather than the traditional date of 1000 BCE (the High Chronology). Subsequent development in the debate has tightened the gap between the two schools of thought. Advocates of a higher chronology now adhere to the Modified Conventional Chronology (Mazar 2005, 2011; Table 1.1), which holds that the Iron IIA period began ca. 980 BCE and continued until ca. 830 BCE. Finkelstein's current iteration of the Low Chronology holds that the

Iron IIA began ca. 920-880 BCE and ended ca. 800 BCE (Finkelstein and Piasetzky 2009, 2010, 2011). Despite the overall proximity of these two dating schemes, the separation still provides challenges in associating archaeological remains with historical events. However, surveying the wealth of evidence relevant to these chronological debates is well beyond the scope of this discussion. This dissertation will generally follow the Modified Conventional Chronology (Table 1.1) when associating relative to absolute dates.

Table 1.1: The Modified Conventional Chronology generally used in this dissertation (after Mazar 2011).

Period	**Dates BCE**
Iron IA	1200 - 1140/30
Iron IB	1140/30 - ca. 980
Iron IIA	ca. 980 - ca. 830
Iron IIB	ca. 830 - ca. 600

Choosing a chronological scheme, unfortunately, does not resolve confusion over analysis and interpretation of remains from many sites. The debate over linking relative to absolute chronologies has resulted in a state of play in which many—if not most—sites in the Southern Levant are dated solely based on ceramic associations to accepted typologies. Ceramic studies typically publish assemblages in coordination with the relative dating of archaeological periods (i.e. Iron I, Early Iron IIA, Late Iron IIA, etc.) without reference to absolute dates. Thus, these sites have a relatively clear relative date with a debated association to absolute chronology. Thus, comparing the contemporaneity of two sites' ceramic assemblages is challenging unless one avoids absolute dating entirely. To mitigate this problem, when discussing ceramic parallels, primacy is given to the excavators' interpretations of relative dates. No attempt is made here to unify these disparate dates into a single scheme (e.g. Finkelstein's Iron IIA ceramics are treated as contemporaneous with Mazar's Iron IIA ceramics, though each scholar would argue that these ceramics feature differing absolute dates). This solution allows for some flexibility of relative dating periods, as well as allowing for the likelihood that ceramic forms.do not map neatly onto relative dating periods. This approach also allows for the direct comparison of the ceramics of Khirbat al-Jariya with the assemblages of many other sites, a critical task in studying exchange networks featuring these sites across the Southern Levant.

Chapter 1: Theoretical Framework

1.1 Introduction

Ancient ceramics are some of the most useful lines of evidence of the past for archaeologists. Ceramics are widespread, nonperishable, often representative of all classes of society, and provide a physical representation of intentional human action (Rice 1986: 24-25). As such, the study of archaeological ceramics is a fruitful avenue for studying many aspects of the past. These include the ancient economy and its interrelation with social status and complexity. These issues are of central importance for the examination of the archaeology of Faynan, the source of tens of thousands of tons of copper and the locus of related social and political development during the Early Iron Age. A discussion of the role of copper as a commodity and the form and ideological significance of craft production can help set the stage for the identification of ceramic correlates for social complexity. More specifically, the examination of ceramics vis-à-vis foodways and exchange can provide evidence of the presence of elites in the archaeological record and their participation in long-distance exchange networks. Finally, the concept of chaîne opératoire provides a lens through which social groups can be identified through the technological choices made during potting, identifiable in archaeological ceramics. Thus, the study of Iron Age ceramics from Faynan can provide insight into three related issues, as discussed here: the presence of copper-smelting elites, their engagement in interregional trade networks, and the social groups in which ceramic production knowledge was shared.

1.2 Craft Production, Ideology, and Social Stratification

The concept of the commodity is central to economic relations within and between societies. This is especially relevant in the context of a study of the long-distance exchange of copper. However, the extent to which this idea is applicable to ancient societies is debated. Marx, in his seminal work on the subject, defined the commodity as dependent on its *use-value* and *exchange value* (Marx 1887).

Use-value is understood as the utility of an object, tied to an individual's ability to use or consume the item. The use-value of the object is only realized in a practical sense when the object passes into the hands of an individual who will use it, usually through exchange. Exchange-value, on the other hand, is both inherent to the object and external from it. It relates to the proportion to which an object can be swapped for others, defined in terms of a third value factor separate from the two objects being exchanged. Marx ultimately ties this third factor to the amount of labor used to create the product (Marx 1887). Though objects may have use-value and exchange-value, an object only becomes a commodity when it is subject to exchange and becomes a use-value for another party (Appadurai 1988; Marx 1887). Based on this definition, Marx took the view that in ancient societies (his *Asiatic* and *Classical* modes of production), commodities did not exist, as small-scale societies did not exchange goods within social groups and alienation of labor was necessary for this to occur (Baron and Millhauser 2021: 3; Marx 1887; 1911: 51). Rather, Marx argued that commodities only came into existence in exchange between ancient societies when they interacted with each other (Baron and Millhauser 2021: 3; Marx 1887; 1911: 51). However, this is a relatively simplistic picture, ignoring the complex economic relations occurring within ancient societies (Morris 1986). The analysis conducted by Gregory (1982) and Sahlins (1974) allows for a more sophisticated view of exchange by considering the role of an alternative mode—gift exchange. In modes of gift exchange (cf. Levi-Strauss 1969; Mauss 1954), individuals are incentivized to maximize their generosity to avoid indebtedness. In total, Gregory and Sahlins propose that societies range from clan societies based on gift modes of exchange to class societies based on commodity exchange. However, his view also fails to capture the complex organizational structures of ancient societies (Morris 1986). To the overall picture we can add barter exchange, which lacks the use of money in traditional commodity exchange but still features the lack of social obligation and indebtedness of gift exchange (Appadurai 1988). Barter exchange has been theorized as a precursor to market exchange (Garraty 2010; Stark and Garraty 2010). However, the impracticalities of large scale barter seem to indicate that it is unlikely to have been a major form of economic exchange (Dalton 1982; Graeber 2011: 29). In addition, such an economic system would be difficult, if not impossible, to find archaeologically (Graeber 2011: 29). Moreover, to even categorize commodity exchange, gift exchange, and barter exchange as three clearly differentiable forms of exchange may miss the complexity naturally at play in the matter. Forms and ways of exchange were often mixed in ancient societies (Bohannan 1955; Simmel 1978; Stark and Garraty 2010; Appadurai 1988). As such, the search for pure systems of one or the other type may be misguided.

Returning to the subject of the commodity, Appadurai (1988) attempts to add nuance to the picture by defining commodities as those objects whose "exchangeability (past, present, and future) for some other thing is its socially relevant feature." In this conception, an item need not actually be exchanged, have its exchange-value realized, and its use-value realized for the second party, to become a commodity. Rather, Appadurai argues, three aspects make up an object's status as a commodity: the phase of its life cycle in which it is a commodity, the possibility of it becoming a commodity, and its context as a commodity. The first refers to the idea that objects can be commodities in some parts of their life cycle but not in others, the second depends on situations that cause objects to become commodities or not, and the third refers to the social and cultural context in which objects are considered commodities. In the context of Iron Age copper production, it is important to understand both the economic and symbolic role played by copper within society in the Arabah during the period. Economically, copper was surely manufactured with the ultimate objective of being exchanged since the amount of copper produced during the Iron Age far exceeded needs for local consumption. As such, we can understand copper during the Iron Age to be a commodity, in at least some stages of its life cycle. However, two caveats should be considered. First, Appadurai's broadening of the commodity concept means identifying an object as a commodity does not help us to understand through what form of exchange it was traded. This is contra previous understandings of commodities, which would necessarily be exchanged between social groups and not through gift or barter exchange or within societies. As such, understanding that copper was a commodity in the Iron Age Arabah helps us to contextualize the object as playing an important role in intentionally-organized systems of exchange, but understanding the processes of this exchange (as taking the form of gift, barter, or market or commodity exchange) requires further study. Secondly, the development of copper into a commodity must also be considered alongside parts of the object's life cycle in which it is not a commodity, as it is given other socially and ideologically relevant meaning beyond its exchangeability through its social and cultural context. To address this, we need to focus on the role of ideology in craft production.

Craft production of commodity goods in preindustrial societies is often tightly linked to ideology (Childs 1998, Clark and Houston 1998, Lass 1998, Spielmann 1998; Inomata 2001). This can be seen as an extension of the tendency for humans to give a higher meaning to material goods beyond their usefulness for subsistence (Renfrew 1972). In fact, crafting can often be associated with supernatural or magical power, exercised through ritual practice (Arnold 1987; Helms 1993; Inomata 2001). This holds true in the case of craft metallurgy as well (Budd and Taylor 1995). Importantly, ideology not only serves to help individuals in a society understand their world, but also conditions individuals to accept and perform their roles in society. Ideology can function in service of the ideological state apparatus, which brings individuals into the state system as subjects through *interpellation* (i.e. a process of internalizing ideals or values, cf. Althusser 1971). In other words, ideology indoctrinates individuals in such a way that they participate in the state-dominated system without resistance. These state apparatuses serve to reproduce the means of production, which includes the people who are part of these means (Althusser 1971). Through interpellation, elites continue to control the material means of production and are also able to reproduce the conditions of production, which include appropriately indoctrinated workers. Moreover, an individual's subjugation to the elite class arguably depends on three things: their belief in the legitimacy of the elites' power, a fear of reprisal from the elites, and a lack of belief in his own ability to overturn the system (Habermas 1975:

96). In the context of craft production, the successful performance of ideologically significant rituals and procedures can serve to increase the perceived legitimacy of elites. This process of interpellation of subjects results in their acceptance of their roles. The production of objects seen to represent magical power provides a self-explanatory justification of elite power (Inomata 2001). A discussion of elites and power also opens the door to a definition of elite status. Elites here are defined by the power they hold in society. This power can be identified as either the "power to," referring to having influence over others without being able to command them to act, or "power over," which includes the ability to coerce others (Miller and Tilley 1984). The form that this power takes depends on the complexity of the society in question (Cobb 1993: 50-52). Discussion of whether the copper-producing polity based in Faynan was a coercive state is the subject of ongoing debate (Levy et al. 2014a). Thus, the question of whether elites in Faynan wielded power over organization rather than simply the power to organize (cf. Hastorf 1990) to difficult to address here. Still, we will define elites here as having power of some sort in the realms of production and exchange—for recognizing them in the archaeological record, we can turn to the archaeological correlates discussed below. Returning to the ideological and social significance of craft production, in the Iron Age Wadi Arabah the smelting of copper was likely ritually significant (Sapir-Hen et al. 2018). Consequently, smelters likely occupied higher status positions in society (Sapir-Hen and Ben-Yosef 2014; Sapir-Hen et al. 2018; Sukenik et al. 2017, 2021). This is evidenced by, among other lines of evidence, the presence of high-quality dyed textiles, traditionally the exclusive domain of elites in the ancient Near East, in copper smelting contexts at Timna (Sukenik et al. 2017, 2021). The high status of smelters in the Iron Age Wadi Arabah status is also reflected in the quality of their diets, consisting of diverse and high-quality foodstuffs including fruits, nuts, imported fish, and quality cuts of meat (Ben-Yosef et al. 2017; Muniz and Levy 2014; Sapir-Hen and Ben-Yosef 2014; Sapir-Hen et al. 2018).

Though crafting can reify status through its ideological importance, anthropologists have not always recognized the potential for craft specialists to occupy social positions of high status. Studies of craft specialization (e.g. Brumfiel and Earle 1987; Costin 1991; Earle 1981; Sinopoli 1988) have considered the forms of craft specialization to fall along a continuum from independent production (typically producing "for an unspecified market of nonelites"; Earle 1981: 230) to attached or administered production (in which crafting is done to meet the need of an elite patron or political institution). This continuum model fails to consider forms of specialization in which craft producers are in fact are elites themselves whose structural power derives from their production of elite goods—these can be referred to as *embedded specialists* (Ames 1995: 158; cf. Inomata 2001 for an argument that the independent/embedded continuum does not imply low status of producers). This model of craft production more fully factors in the social and ideological significance of skilled production than independent or attached production modes, which are hypothesized largely based on political or economic factors (Janusek 1999: 126). In other words, the ritual significance of production reinforces elite power; the mechanisms through which this process occurs are discussed above. Embedded production may be identified in the archaeological record when "evidence of craft manufacture is recovered from high-status domestic contexts" (Costin 2005:1071). Such a finding is consistent with the possibility that elites were in fact the craft specialists—though it is also consistent with attached production by non-elites in elite contexts (Costin 2005: 1071). At Iron Age copper production sites in the Wadi Arabah, elite contexts often coincide with evidence of copper production. For example, Area R at Khirbat en-Nahas, an elite residence at the site (discussed in greater detail below), features many metallurgical remains and a largely intact base of a furnace used for smelting copper (Levy et al. 2014b: 202-222). Other evidence of high-quality food and textiles found in industrial contexts also suggests a close relationship between elite status and craft production of copper (Ben-Yosef et al. 2017; Muniz and Levy 2014; Sapir-Hen and Ben-Yosef 2014; Sapir-Hen et al. 2018; Sukenik et al. 2017, 2021). As such, copper metallurgists in the Iron Age Wadi Arabah may best be considered embedded specialists, whose knowledge of ritually significant and technically complex metallurgical practices functioned as justification for their elevated social statuses.

Foodways are an important avenue toward gaining a fuller understanding of the social organization of Iron Age society in Faynan. As discussed above, Iron Age smelters had access to high quality foods; this evidence aids in the identification of elites in the archaeological record. This is significant as evidence of food preparation can shed light on identity (Bill and Braswell 2005; Braswell and Prufer 2009; Braswell et al. 2008; Goldstein 2003). The interpretation of domestic activities and diet also allows for a more nuanced and sophisticated understanding—and identification—of social status than traditional metrics such as the presence of imported valuable goods or monumental architecture (Turkon 2004). Indeed, food can be a "pervasive and critical element in the articulation and manipulation of social relations" (Dietler 1996: 88). Food is an important symbol that carries a strong emotional message (Appadurai 1981). Food "can serve to sustain relations characterized by rank, distance, or segmentation" (Appadurai 1981). Like craft production, diet can reify the social order by legitimizing elites' power as specific foods come to symbolize status (Hastorf 2003). Examples include maize in the Mazatan region (Clark and Blake 1994: 28), Mediterranean wine in the lower Rhône basin (Dietler 1996), fresh, large fish among the Massa people (de Garine 1996: 203), and beef in 20th century France (Bourdieu 1979: 209-10). Access to a diversity of food can also serve a similar purpose in demonstrating elite status (Lentz 1991) Certain modes of feasting, such as the "diacritical feast," in which rare, expensive, or specially-prepared foods are consumed can serve a similar function of naturalizing hierarchy (Dietler 1996). In general, foods that function to strengthen the legitimacy of elites in a society are often rare, imported, or require high effort to produce or obtain (Turkon 2004: 227 and references therein). Thus, the identification of these foods in certain contexts can serve as archaeological correlates for the presence of elites. At Timna, fish imported from the Mediterranean (ca. 250-300 km away) and quality cuts of meat in smelting contexts evidence the role that elite access to special foods may have played in perpetuation of the social order alongside the ritual significance of copper production (Ben-Yosef et al. 2017; Sapir-Hen and Ben-Yosef 2014; Sapir-Hen et al. 2018).

The identification of elites based on foodways goes beyond the identification of imported foods, as the distribution of evidence of food preparation and serving can also shed light on subsistence and its relationship to power. Food preparation was a time-consuming, potentially difficult process in prehistoric societies, requiring specific skills and equipment (Hendon 1996). As such, elite members of a society may look to outsource food preparation labor, potentially even spatially-differentiating food preparation from other household activities. This separation serves to differentiate elites from the rest of society (Turkon 2004). One result of this would be a comparative lack of evidence of food preparation in elite contexts, providing another archaeological correlate for the presence of elites (Gumerman 1997). This type of analysis has been done at Tikal, for example, where food preparation areas are separate from elite residential areas (Haviland and Moholy-Nagy 1992). Food preparation, consumption, and disposal contexts can be identified based on the ratios of various animal parts, though caution should be taken given the possible complexities of disposal practices (Grantham 2000; Gumerman 1997; Zeder 1988, 1991). In the Southern Levant, at the site of Qasrin in the Golan Heights, researchers applied this faunal approach to differentiate elite from non-elite contexts based on ethnographic analogy (Grantham 2000). In the Iron Age Wadi Arabah, the distribution of quality cuts of meat in industrial contexts has been interpreted as evidence for the social status of smelters (Sapir-Hen and Ben-Yosef 2014; Sapir-Hen et al. 2018). However, the link between abundance of edible meat or the ratio of meat-to-bone and social status may not be straightforward given that it is culturally contingent (Grantham 2000). At Khirbat en-Nahas, elite context Area R is differentiated from non-elite contexts by the presence of gazelle remains—possibly representing an elite food—and a lack of other taxa common across the site, such as hare, possibly suggesting its function as a non-elite food (Muniz and Levy 2014).

The role of food in social complexity can be studied through means beyond direct faunal evidence, as the distribution of domestic pottery can also illustrate the presence of elites at a site. Of particular significance are vessels used in the serving of food, which takes on particular significance as the consumption of food is highly-visible and may take on ceremonial importance (Turkon 2004; Costin and Earle 1989; Garraty 2000). Through this conspicuous consumption from fine or ideologically-significant ceramics, elites can demonstrate or reinforce their own political and economic power (Clark and Blake 1994; Garraty 2000). Thus elite consumption contrasts sharply with food preparation, which may be sequestered away as discussed above. Taking this into account, elite contexts are likely to have a high proportion of serving vessels, which are comparatively likely to be decorated, compared to non-elite residences or food preparation areas (Brumfiel 1987; Garraty 2000; Hirth 1993; Turkon 2004). In addition to decoration, serving vessels are also likely to be open, fine-ware forms with flat bases and may be burnished or slipped as these characteristics limit the possibility of porosity in addition to being decorative (Smith 1983; Rice 1987:236-240; Singer-Avitz 2016: 508). As such, the predominance of these types of vessel can be a clear correlate for the presence of elites in a particular context. The size of serving vessels can be used to understand the size of the social group (Blitz 1993; Hendrickson and McDonald 1983). Cooking vessels, by contrast, tend to be coarse and tempered and are likely to be larger than those used for consumption though their form varies drastically according to the type of cooking (Rice 1987: 237). The presence of these vessels, in turn, would suggest that elites are not likely to be present in the context. Overall, the study of the distribution of cooking and serving vessels can be useful for the identification of elites in an archaeological context given the important role conspicuous consumption plays in reinforcing social hierarchy. This is one important aspect of ancient society that the study of ancient ceramics can provide insight into.

1.3 Trade and the Development of Social Complexity

Beyond identifying the presence of elites, the study of archaeological ceramics can also provide insight into exchange and its relationship to the political economy. The study of political economy in the ancient world, in turn, has great potential for understanding the development, maintenance, and collapse of social and political complexity in the past. Addressing the generation of wealth and inequality through the structure of labor relationships is not a new approach; Karl Marx applied his economic approach to social evolution to ancient times in *The German Ideology* (Marx and Engels 1947: 9-12). Since Marx, discussions of political economy in anthropology and archaeology have moved beyond a specific focus on control of the means of production from a strict Marxist perspective and have expanded to include, more broadly, study of the linkages between social relationships and wealth/power differentials (Hirth 1996: 205). Nevertheless, Marxist and materialist approaches remain relevant to this topic thanks to updates to Marxist perspectives (e.g., the rejection of unilineal evolutionary approaches, Godelier 1978; Bloch 1983: 150; Kristiansen 1984: 72), and support for the concept that elite control of production is a main driver of social evolution has remained popular. Earle (1991), for example, has contended that the ability of chiefs to control agricultural production allowed them to consolidate power. Cultural ecology approaches also serve as an example of this type of research (e.g., Sanders and Price 1968). Study of ancient production necessarily addresses the scale, intensity, and degree of elite control and sponsorship of craft specialization, all of which exists on a spectrum (Costin 1991). Studies of craft specialization have occurred in the Iron Age Wadi Arabah, where analysis has focused largely on the role of technological developments in social complexity (Ben-Yosef et al. 2019; Levy 2006; Levy et al. 2014).

An opposing perspective—also influenced by Marxist ideas—developed within the lens of political economy, holding that long-distance trade and exclusive control of or access to wealth goods via exchange networks are the catalyst behind the development of social inequality (Hirth 1996: 207). This approach draws on the ideas emphasized by Karl Polanyi (et al. 1957). The importance of trade relations in this regard can be seen in the application of world-systems theory (Wallerstein 1974; Chase-Dunn and Hall 1994) to archaeology as well as in the Peer-Polity Interaction model (Renfrew and Cherry 2009). Approaches emphasizing the importance of trade in the development of social complexity take different approaches to the economic bases of complex societies—some models prioritize the exchange of prestige goods (Blanton et al. 1996; Brumfiel and Earle 1987; Friedman and Rowlands 1977); others focus on staple goods (d'Altroy and Earle 1985; Halstead and O'Shea 1989). Examining trade's role in the development of social complexity, however, requires an understanding of different modes of exchange. Smith (1976) lays out three types. First, *dyadic exchange* refers to direct trade between individuals of equal status (Braswell 2010; Smith 1976). Second, *polyadic exchange* occurs when a higher-status individual trades or redistributes to lower-status recipients (Braswell 2010; Smith 1976). The third form, *market exchange*, is the most complex and was argued by Polanyi (1957), incorrectly, to not have existed in ancient state-level societies (Smith 2004). Market exchange can be further subdivided into various types (Smith 1976), each of which has archaeological correlates (Hirth 1998), which can be the basis for detailed studies of economic systems and their interrelationships with social structures (Braswell 2010). When studying and understanding economies, the distribution of fine, imported ceramics can serve a double function. First, the availability of these wares across social classes suggests the operation of a market economy, as even fine ceramics are available for purchase by all (Hirth 1998). In this context, the rates of fine or decorated wares can be straightforwardly applied as a measure of the wealth of a household as elite households could afford more and better wares than non-elites (Garraty 2000; Smith 1987). The ability to own, use, and display fine ceramics has the effect of reinforcing social status and therefore political power (Smith 1987), as discussed above. However, when the distribution of fine imported wares is limited to elite contexts, this can either imply the high cost of such ceramics in a market economy or the operation of other economic forms (Hirth 1998: 459). In non-market economies, exclusive access to fine, imported ceramics among certain households can still be a correlate for elite status (Upham 1982). In the context of Iron Age Faynan, imported fine-wares (from the Negev and beyond, see below for further discussion) are rare (Smith et al. 2014b: 164). At KEN, these are primarily found in well-constructed elite contexts such as Areas R and T (Smith and Levy 2014: 448). The lack of widespread availability of these types of ceramics hints at their high cost and likely at the lack of a market economy operating in the region at the time. Thus, imported finewares are likely a correlate for the presence of elites in Iron Age Faynan.

The models of craft production and exchange are both clearly operational in the context of Iron Age copper-production sites in Faynan. As such, the false dichotomy between the primacy of one of the two drivers of complexity should be rejected in favor of a more nuanced approach in which production and exchange are both controlled by elites to acquire status and apply ideology to legitimate their power (Hirth 1996). The movement of luxury goods, controlled by elites, facilitates the development of social and economic networks that elites can take advantage of to entrench themselves in societal power structures (Hirth 1996). The control of production and exchange of luxury items can also be used to acquire food to mitigate subsistence risk (Arnold 1992). This idea opens the door to a third model of elite aggrandizement, essentially functional and ecosystems-based, that argues both production and exclusive control over exchange are used by elites as a society-wide level strategy to mitigate subsistence risk (Halstead and O'Shea 1989). In addition to catalyzing the development of inequality, exchange can be seen as a buffering mechanism against variability, due to climate or other instability (Halstead and O'Shea 1989). In some cases this strategy can be seen through the exchange of staple goods within a single society in a simple buffering system. However, more complex systems can develop, with multiple social groups participating in the exchange (O'Shea 1989). In such a system, some varieties of which can be called "specialised complex systems," (O'Shea 1989) exchange occurs between groups with different subsistence strategies and in different ecological zones, each producing surpluses with the intent of exchanging for other forms of staple goods. One example of this is the interaction between nomadic foraging groups and those practicing sedentary agriculture, with each group systematically overproducing and regularly exchanging surplus to diversify their subsistence bases (Spielmann 1982). Sedentary populations also engage in mutualistic subsistence exchange with pastoral nomadic groups (Avni 1996; Bar-Yosef and Khazanov 1992; Barker 2012), another example of a complex exchange-based risk buffering mechanism (O'Shea

1989). This type of subsistence strategy has been observed ethnographically in Jordan (Palmer 2002) and can more specifically be termed semi-nomadic or semi-sedentary pastoralism (Khazanov 1994). In the Iron Age Wadi Arabah, the societies engaged in copper production practiced pastoral nomadism as a subsistence strategy (Levy et al 2014), in combination with potential limited agriculture (Ben-Yosef 2019; Knabb 2015; Mattingly et al. 2007). The extent to which elites in Faynan manipulated exchange networks for complementing subsistence strategies practiced in the region is unknown, though this is likely based on the context of copper production during the Iron Age and subject to further testing. An exchange network operating in exactly such a way during the Early Iron Age has been proposed by Ben-Yosef and Sergi (2018), who suggested that agricultural produce from the vicinity of Gath may have been exchanged for copper from the Wadi Arabah. These hypotheses regarding the trade networks in which copper producing societies in the Wadi Arabah were engaged can be evaluated through analysis of ancient pottery, as compositional analysis of archaeological ceramics can demonstrate the origins of vessels, while stylistic and compositional analysis can also illustrate social and economic relationships in the past.

1.4 Ceramics and the Chaîne Opératoire

A third approach toward the study of ancient ceramics applies the chaîne opératoire approach, as developed by Leroi-Gourhan (1964), which can shed light on the social groups producing ceramic wares. This method assumes that the production of ceramics should be seen as a learned technique, passed down from tutors to potters (Roux 2016; Shennan 2013). This teaching process involves the transmission of intangible “know-how” to learning potters, which archaeologists can only hope to reconstruct as a recipe for action (Schiffer and Skibo 1987). Thus, archaeologists’ understanding of the production process is *etic* in the sense that it does not necessarily reflect ancient potters’ understanding of their craft (Albero 2014: 55; Vidal and García Rosselló 2009), which in turn may not represent the “techno-science” that explains the relative effectiveness of an approach (Schiffer and Skibo 1987).

However, a fundamentally etic approach does not preclude archaeologists from understanding social relations through study of the production process. The main stages of ceramic production, and therefore various chaînes opératoires, are generally known and apply to all ceramic manufacture. These are "collecting and preparing the raw materials, fashioning, finishing, surface treatment, decoration, and firing" (Roux 2016). However, each one of these stages has its own chaîne opératoire as well, in which socially-dependent variation is expressed (Roux 2016). From a different perspective, the loci of choice can be seen as the selection of raw materials, the tools, energy sources, and techniques used, and the sequence and rate of production (Sillar and Tite 2000: 4). The choices made in each of these contexts can be assumed to have an impact on the final product, and thus the ceramic vessel can provide information about the choices made during production (Albero 2014: 53). Each choice made in the process of producing ceramics influences other choices in the process (Sillar and Tite 2000). Moreover, each decision is socially and possibly ideologically meaningful (Albero 2014: 57; Sillar and Tite 2000). Archaeologists can therefore investigate each step of the process to understand what choices were made and their significance (van der Leeuw 1984). Taken together, the aggregate of these interrelated choices (i.e., the chaîne opératoire) form a system that is unique to a society and forms a "bridge" between the techniques employed and the society itself (Albero 2014; Lemonnier 1986). In general, the technological skills that one potter teaches another are passed down within a social group (Roux 2016, 2019). However, the size of the social group in which a particular technique is used and taught can vary widely (Roux 2016). The social groups in which a particular chaîne opératoire is applied can be considered a "community of practice," in which learning and production are related activities (Lave and Wenger 1991; Wenger 1998).

Studying the chaîne opératoire of ceramic vessels requires both macroscopic and microscopic analysis (Roux 2019). The analysis and description of archaeological ceramics through these methods can shed light on various stages of the chaîne opératoire. Perhaps most significantly, fabric descriptions can identify potters' selection of raw materials and their processing (Whitbread 2016).

The acquisition of clay is not straightforward, but rather is the subject of often-complex and ritually significant processes (Rice 1987: 115). Generally, potters prefer to acquire their base clay within 1 km of a settlement, and the vast majority acquire it within 7 km (Arnold 1980). The acquisition of temper is even more likely to occur at a local level, almost always within 5 km (Arnold 1980). Clays for slips, on the other hand, are more likely to be acquired from great distances, including via interregional trade (Arnold 1980). Thus, the identification of a geologic association for a base clay provides strong evidence for the provenance of production of the ceramic vessel (Whitbread 2016). However, the identification of base clays also provides insight into choices made by potters in terms of which clays were selected, with different clays providing different functional advantages (Whitbread 2016). The same holds true for the selection of tempers, which have a wide variety of technical characteristics that impact other choices in the ceramic production process (Sillar and Tite 2000; Whitbread 2016). These characteristics of a ceramic vessel, as well as forming and firing techniques, can all be identified through the macroscopic and microscopic analysis of ceramics (Whitbread 2016). Ultimately, these types of analysis can be applied in a systematic way to understand the chaîne opératoire and how it relates to choices made by social groups. By applying a multi-stage analytical process in which ceramics are sorted into groups on the basis of their fabrics, features, and style, the intention of the potter can be compared to the results of the ceramic assemblage (Roux 2016). This process allows for the categorization of ceramic assemblages as either homogeneous or heterogeneous (Roux 2016). Homogeneous assemblages feature primarily local clay sources and reflect one tradition of ceramic manufacture—reflecting a community of practice—while heterogeneous assemblages consist of a higher degree of variability of fabrics and technical traditions, thus indicating a wider range of consumers (Roux 2016). The classification of an assemblage in this way can relate to the composition of social groups in an area featuring a given assemblage. Thus, the classification of an assemblage as homogeneous is a correlate for the presence of a shared community in which ceramic traditions are passed down. In the context of Iron Age Faynan, study of the chaîne opératoire has been used to argue for continuity in practice and thus social organization between Early Iron Age copper production sites in Faynan and Late Iron Age sites in the traditional highlands of Edom. This approach also has significance for the examination of assemblages within the Faynan region as the occupation and use of different sites in the region has been argued to compose a regional network of copper production—this network would likely also reflect in shared ceramic traditions.

1.5 Summary

Overall, ancient ceramics can provide great insight into the related topics of the ancient economy and social complexity. This type of analysis is especially apt to the study of Iron Age Faynan, a major copper producing region where—for various reasons—the direct examination of copper artifacts is not sufficient to understand the organization of society. Still, the importance of metallurgy in the region allows us to make certain conclusions. First, copper was a commodity as its exchangeability was its socially relevant feature in certain contexts, especially as it was traded away from Faynan (Appadurai 1988). Beyond economic incentives, however, copper also played a hugely important role with regard to ideology. Crafting, including metallurgy, can be associated with supernatural power (Arnold 1987; Budd and Taylor 1995; Helms 1993; Inomata 2001). It is likely that the ideologically significant, perhaps almost magical, act of copper smelting served to legitimize the power of smelters and caused subjects to accept their roles, reproducing the means of production through interpellation (Althusser 1971; Habermas 1975:96). Thus, they were likely embedded specialists, elites whose craft specialization justified their own power (cf. Ames 1995).

These interpretations, however, depend on our ability to identify elites in the archaeological record of Faynan. Fortunately, foodways and ceramics provide archaeological correlates for this assertion. Elites consume specific rare or imported foods that symbolize and reinforce their status (Hastorf 2003; Turkon 2004); the identification of these foods evidences the presence of elites. Prior studies in the region have demonstrated that smelters had access to high-quality imported foodstuffs

(Ben-Yosef et al. 2017; Muniz and Levy 2014; Sapir-Hen and Ben-Yosef 2014; Sapir-Hen et al. 2018; Sukenik et al. 2017, 2021). With regard to possible routes of identifying elites through examination of ceramics, a lack of evidence of food preparation, including cooking pots, would be expected in apparently elite contexts as a key correlate (Gumerman 1997; Turkon 2004). Conversely, a high proportion of serving vessels, especially decorated serving vessels, would be expected in elite contexts, as conspicuous consumption from fine-wares or ideologically-significant ceramics reinforces elite status (Clark and Blake 1994; Garraty 2000). Similarly, in non-market economies, exclusive access to fine, imported ceramics in certain contexts can indicate elite status (Upham 1982), suggesting elites can be identified by differential rates of these wares as compared to presumably non-elite contexts. The presence of fine imported wares may also indicate that elites had exclusive control of and access to exchange networks, a strategy used by elites to gain and maintain power (Hirth 1996). More specific understanding of these exchange networks and whether they operated to mitigate subsistence risk requires further study (cf. Halstead and O'Shea 1989; Khazanov 1994; O'Shea 1989). However, these correlates provide a course of action for identifying elites and trade routes and their relationship to social complexity in Iron Age Faynan.

Beyond the identification of elites, the study of ceramics can also help in understanding social groups through detailed study and understanding of the technology and choices (i.e. chaîne opératoire; Leroi-Gourhan 1964) used by ancient potters. All the steps of producing ceramics are of relevance, including raw material choice, and each stage of production is embedded with social and potentially ideological meaning (Albero 2014; Roux 2016; Sillar and Tite 2000). Ultimately, the sum total of these choices is unique to a "community of practice" (Lave and Wenger 1991; Wenger 1998) in which these traditions are passed down. Thus, the identification of sites and communities in which these practices are shared can also indicate shared social identity. These approaches can be applied to the ceramics of Iron Age Faynan, providing insight into the social organization of production in Faynan.

Thus, the examination of ceramics can be an important tool for the investigation of the ancient economy and social complexity in the region.

Chapter 2: Temporal Context and Historical Evidence

2.1 Introduction

The interregional dynamics of the end of the Late Bronze Age and the Early Iron Age set the stage for the rise in social complexity and copper production in Faynan and at Khirbat al-Jariya. As such, it is important to examine the developments of these periods and their relationship to society in Faynan to provide context for the analysis conducted here. In general, the decline in sociopolitical complexity at the end of the Late Bronze Age resulted in a power vacuum in the Southern Levant that facilitated the rise of locally-organized complex societies in the subsequent Early Iron Age. It is against this backdrop that the study of elites and social complexity at Khirbat al-Jariya discussed in the chapters below should be considered.

2.2 The End of the Late Bronze Age

The Late Bronze Age (LBA; ca. 1550-1200 BCE) represents a period of great change across the Eastern Mediterranean. The LBA is traditionally considered to be one of collapse, as sites across the region were destroyed, empires lost influence or collapsed entirely, and mass migrations drastically changed the social dynamics in the southern Levant (Ward and Joukowsky 1992; Drews 1993; Knapp and Manning 2016). The Southern Levant in particular experienced destructions at many sites around 1200 BCE, though the dates and perpetrators of these destructions are not clear (Knapp and Manning 2016). Looking at the influence of empires over the region, Egypt had expanded influence, military activity, and administration in the Southern Levant over the course of the 19th Dynasty (Martin 2011). Notably, Egypt had a hand in copper production in the Timna Valley during the LBA (Rothenberg 1972; Rotheberg and Bachmann 1988; Ventura 1974; Sapir-Hen and Ben-Yosef 2014; Yagel et al. 2016), though not in Faynan (Levy et al. 2014). However, in the 20th Dynasty, coinciding with the LBA, Egypt began to lose control and influence over Levantine territory, especially in the area that would become Philistia (Bietak 1991, 2007; Stager 1995; Martin 2011). Egypt also lost control of the copper industry at Timna during this period as Iron Age production would represent a new, differently organized phase (Ben-Yosef et al. 2012). The Hittite Kingdom of the Northern Levant also suffered destructions and ultimately collapse in the decades around the turn of the 12th century BCE (Yakar 2006; Drews 1993). Meanwhile, Cyprus had been an important trade partner with the Levant in the LBA, in part due to the large-scale production and export of copper (Knapp and Stech 1985; Karageorghis and Kassianidou 1999). While Cyprus experienced some continuity of settlement and production, interregional trade suffered from the instability of the period and the movement of Cypriot copper to the Levant seems to have declined sharply (Fantalkin and Finkelstein 2006; Hauptmann 2007; Knauf 1991, 1995; Levy et al. 2008). Ultimately, the disruptions of the LBA left a political and economic vacuum in the Southern Levant as the influence of Egypt, the Hittites, and Mediterranean exchange waned. The relative stability of the ensuing Iron Age provided opportunity for local political and economic development free from foreign imperial hegemony.

2.3 The Iron Age

The Iron Age (ca. 1200-500 BCE) in the Southern Levant was a period of remarkable local social and political development on the edges of Mesopotamian and Egyptian Civilization. In the wake of the dramatic changes of the LBA, the Iron Age provided fertile ground for the development of new ethnicities and polities. Ultimately, these processes culminated in the rise of “tribal kingdoms" in the southern Levant (LaBianca and Younker 1998). The earliest part of the Iron Age is often seen as a sustained period of ethnogenesis in which ethnicities such as the Israelites, Philistines, and others came about (Killebrew 2005). The development of Israelite ethnicity, in particular, has been extensively debated and discussed in the literature (Finkelstein 1988; Levy and Holl 2002; Bloch-Smith 2003; Killebrew 2005; Faust 2006a). Beyond the development of new ethnic identities is the question of understanding the process of transition from ethnicity to polity. Dating the rise of the Israelite polity (which relates to the transition from Iron I to Iron IIA) is equally contentious as the development of Israelite ethnicity, though recent years have brought opposing sides on the debate to something resembling a consensus at either ca. 970 (Mazar 2011) or ca. 940 (Finkelstein and Piasetzky 2011). Studies of the ethnogenesis and related eventual state formation of the Trans-Jordanian polities were also undertaken, though anthropological perspectives were historically lacking (LaBianca and Younker 1998: 402).

In particular, studies of the development of the Edomite polity undertaken in the 20th century relied primarily on Biblical accounts and excavations at sites in the highlands of southern Jordan. Evidence from the Bible, in general, suggests that Edomite political organization has a date early in the Iron Age. Genesis 36:31 alludes to the kings of Edom ruling before any king of Israel, suggesting a date in the Iron I (ca. 1200-970 BCE (Mazar 2011) or ca. 1130-940 BCE (Finkelstein and Piasetzky 2011)). Despite the apparent significance of this evidence for determining the date of Edomite state formation, it is important to note that the texts describing events prior to the Iron Age are by no means contemporaneous with the events they describe. Rather, they seem to date to later periods (Bartlett 1989: 84). However, initial archaeological investigation, undertaken by Nelson Glueck, supported the Biblical narrative with regard to the origins of Edom. Glueck (1934; 1935; Avishur 2007) suggested that a “highly developed Edomite civilization” existed between the 13th and 8th centuries BCE, battling Judah over control of the Wadi Arabah and access to the Red Sea and Arabian trade from the 10th century onwards. Archaeological excavation of the Edomite sites Umm el-Biyara (Bienkowski 1990), Tawilan (Bennett and Bienkowski 1995), and Buseirah (Bienkowski 1990) caused researchers to conclude that there was no significant polity in Edom at any point during the Iron I or the Iron IIA, at which point these sites were not significantly occupied (Bartlett 1972: 32; Bienkowski 2001). The presence of Assyrianizing architecture at these sites, including a temple and a palace at Buseirah, provided evidence that the rise of the Edomite state was due in part to Assyrian influence beginning in the 8th century BCE (Bienkowski 1990). Various Assyrian texts referencing Edom and dating to 800 BCE and later were seen as further corroboration of a later date for Edomite complexity (Pritchard 1969: 281-2, 287, 291, 294, 297, 301; Bennett 1966). Suggestions of an early date for significant Edomite settlement in the highlands (Finkelstein 1992a; Sauer 1986) were dismissed or ignored (Bartlett 1989; Bienkowski 1992). Thus, prior to substantial archaeological investigation into lowland sites in the Wadi Arabah, scholarly consensus posited a date in the 7th century BCE (after the Iron I and IIA periods) for the origin of an Edomite polity.

The late date for the development of an Edomite polity was challenged by Levy and Najjar of ELRAP through their excavations of copper-producing sites in Faynan. These scholars argued that the dating of Iron Age sites in the region, especially Khirbat en-Nahas, along with arguments regarding the scale of copper production in Faynan and monumental architecture such as the fortress at KEN, imply a date for Edomite social complexity in the early Iron Age (Levy et al. 2005, 2007; Levy and Najjar 2006b; Levy et al. 2014; Smith and Levy 2008) . This assertion was challenged and the subject of some debate in the literature (Finkelstein 2005; Finkelstein and Singer-Avitz 2008, 2009; Finkelstein and Piasetzky 2008; Kefafi 2014; Van der Steen and Bienkowski 2006). Resolving part of this debate, the publication of 108 high-precision radiocarbon dates (Higham et al. 2005; Levy et al. 2005, 2014b) along with a full report on the archaeological remains and results from other Iron Age sites in Faynan have largely put the matter of the dating of copper production in Faynan to the 12th to 9th centuries BCE beyond doubt (cf. Finkelstein et al. 2018). However, the political "affiliation" of the early Iron Age polity is still under debate.

There are two schools of thought as to the location of the center of political and economic control of an Iron Age desert polity based around production and exchange of copper. One of these models, proposed by Israel Finkelstein (2005), links control of Faynan copper production to the site of Tel Masos in the Beersheba Valley. Finkelstein's argument centered on a few key lines of evidence: temporal coincidence, artifacts suggestive of a copper industry at Tel Masos, a large number of copper and bronze items found there, Negebite pottery, and site type. Finkelstein (1984, 1995; 2003, 2005; Fantalkin and Finkelstein 2006; Finkelstein and Piasetzky 2008) argues that the ca. six ha. Stratum II site at Tel Masos was the center of a "desert chiefdom," the political development of which was catalyzed by economic factors associated with copper production and exchange. Finkelstein suggests that the Iron Age settlement at Tel Masos, dated to the early Iron IIA, overlaps perfectly with the peak of copper production in Faynan (2012), indicating a connection between the copper produced in the Wadi Arabah and the suddenly flourishing settlement at Tel Masos. Finkelstein (1995: 103-26, 2005: 121, 2012, 2018) also has linked the "Negev Fortress" sites (for background: Faust 2006b; Meshel 1974; Finkelstein 1984) to the hypothetical Tel Masos-centered late Iron I/Iron IIA desert chiefdom based on their contemporaneity to the late 10th century/Iron IIA period (Boaretto et al. 2010; Finkelstein 2014; Shahack-Gross et al. 2014). This polity, Finkelstein argues, matches up well chronologically with Iron Age activity in Faynan.

Finkelstein's (2005: 121) second line of evidence for his assertion that a desert chiefdom centered at Tel Masos that political control source comes from excavations at Tel Masos that uncovered unrefined copper ore in addition to three crucibles, which may have been used for smelting (Kempinski and Fritz 1977: 158; Kempinski et al. 1983: 21). The excavators of the site themselves suggest that this evidence could mean that the copper trade played a strong factor in the increased settlement size and prosperity seen at the site in Stratum II. Finkelstein (2005: 121) takes this evidence in tandem with the presence of what he calls an "exceptionally large number of copper/bronze items" (Crüsemann 1983; Lupu 1983: 202-203) as evidence of a significant copper industry at the site, linking it with Faynan. Finkelstein (2005: 122) further suggests that the presence of Negebite pottery at Tel Masos, the Negev sites, and Faynan as well as Midianite pottery at Tel Masos and Khirbet en-Nahas provides evidence of a connection between the lowlands of the Wadi Arabah and the Negev Highlands/Beersheba Valley. As a last source of data, Finkelstein (2005: 122) argues that the prosperity of Tel Masos Stratum II should be contrasted with the lacking evidence from the Edomite highlands in the Iron I. These lines of evidence, Finkelstein (2005: 122), suggests in his 2005 article, reveal that Tel Masos would have prospered as a trade intermediary between Transjordan and the Philistine coast. Not content with this explanation of the Tel Masos Chiefdom as an intermediary, Finkelstein would suggest that this desert polity, created by sedentarization of pastoral nomads, controlled copper production and trade (Fantalkin and Finkelstein 2006: 25; Finkelstein and Piasetzky 2008: 89). This desert polity, their view, would have extended from Faynan to the Negev Highlands and the Beersheba Valley, and dominated the desert trade of copper and other goods westward across the Negev to the Mediterranean coast.

The second model for how copper production in Faynan was controlled was offered by Levy and colleagues, who countered Finkelstein in proposing an alternative hypothesis of local organization and control of copper production. Levy et al. (2004) were the first to make such a proposal, arguing that the development of a complex polity in the lowlands of the Wadi Arabah should be viewed within the context of surrounding Iron Age polities (i.e. Israel, Judah, Moab, etc.), and that local processes of social interaction were the primary catalyst behind the development of large-scale copper industry and social complexity. This argument was expanded on by Levy et al. (2005: 157-8), who went on to assert that copper production at Khirbet en-Nahas may in fact be representative of an earlier-than-assumed development of the Biblical kingdom of Edom and that local control over production and trade of copper would have provided a major catalyst to social evolution and social inequality. This view came contra previous suggestions that the Edomite polity first developed in the 7th century BCE at highland sites due to Assyrian influence, as discussed above. Levy and Najjar (2006) compare Finkelstein's case to that of Knauf-Belleri (1995), especially with regards to control of Faynan production by a non-local entity in the Beersheba valley, and suggest that these arguments miss the significance of recently-uncovered evidence from Faynan. This argument was carried forward by Levy (2009), who put forward an anthropological approach to ethnogenesis in Edom.

Smith (2009:329-330) also put forward criticism of Finkelstein's idea that a desert chiefdom centered at Tel Masos controlled copper production at Faynan, arguing that the simple fact that Khirbet en-Nahas is larger than Tel Masos makes it unlikely that the smaller site would have controlled the larger-scale production at Khirbet en-Nahas. In fact, Smith (2009: 319) argues that the more reasonable suggestion would be that Khirbet en-Nahas oversaw copper production in Faynan and its trade across the Negev among a number of smaller sites. Smith also takes chronological issue with Finkelstein's case for the primacy of Tel Masos over copper production and trade. Smith (2009: 319-20), through analysis of radiocarbon dates, notes that Tel Masos Stratum II came to an end before the end of industrial-scale production at Khirbet en-Nahas. This difference in chronology, Smith (2009: 320) argues, shows that industry at Faynan was never dependent on Tel Masos, since it was able to continue after the end of prosperity at the Beersheba Valley site. Furthermore, Ben-Yosef (2010: 946-7), citing Yahalom-Mack (2010: 272-3), put together an argument that the evidence from Tel Masos for possible metallurgical activity has been overstated. Yahalom-Mack (2010: 272-3), dissecting the data, argued that no smelting occurred at Tel Masos Straum II, only remelting or reworking, and that in one of the two rooms identified by the excavators of the site as containing metallurgical activity, no such activity took place. Ben-Yosef (2010: 946-7) builds on Yahalom-Mack's interpretation to assert that the Tel Masos metallurgical evidence is "weak, and represents at most a small bronze workshop similar to many others in the Iron Age southern Levant." It does seem clear that Finkelstein's argument for a large Tel Masos-centered desert chiefdom are ultimately based on historical coincidence, general similarity of material culture (e.g. Negebite ware), and specific evidence of copper working at Tel Masos. Given the interpretation of the metallurgical evidence from Tel Masos of Yahalom-Mack (2010) and Ben-Yosef (2010), one must realize that the only solid pillars of Finkelstein's Tel Masos-centered argument are similar historical timelines and similar pottery in a similar ecological environment with trade interactions. These lines of evidence, it must be said, are nowhere near enough to validate the hypothesis that Tel Masos controlled production at Khirbet en-

Nahas. A more likely hypothesis was proposed by Tebes (2003), who suggested that Tel Masos served as a waypoint on the copper trade between production sites in the Arabah coastal destinations for the copper. Tebes hypothesized that the settlement at Tel Masos Stratum II was able to flourish based on importing, collecting, taxing, refining, and exporting copper, and in exchange, importing refined products to the desert regions from the Mediterranean coast (Tebes 2003). This proposal was somewhat refined by Fantalkin and Finkelstein (2006) and Ben-Dor Evian (2017), who suggested that Tel Masos Stratum II reached importance in the Iron I as an important checkpoint in the copper trade, but lost significance in this exchange network in the Iron IIA as routes toward Egypt gained prominence. During this period, Ben-Dor Evian (2017) argues, Tell el-Qudeirat thrived as an important destination along the Darb el-Ghazza route from the Arabah and Negev to Egypt.

In recent years, excavations at the copper producing sites in the Wadi Arabah at Faynan and Timna have shed additional light as to the control and organization of copper production in the Wadi Arabah. Investigations into sites in the Timna Valley have established the chronology of copper-producing sites from that region and demonstrated an overall similarity of material culture with that of Faynan (Ben-Yosef et al. 2012, Ben-Yosef 2016). Notably, the similarity extends to the technology of copper-smelting, which underwent development along identical trajectories in Faynan and Timna over the course of the Early Iron Age (Ben-Yosef et al. 2019). Analyses of ceramics in Faynan and the Negev have also indicated the importance of the Wadi Arabah for the center of a political entity controlling the production and exchange of copper (Martin et al. 2013; Martin and Finkelstein 2013; Smith and Levy 2014). In total, evidence suggests that copper production sites in the Wadi Arabah and sites in the Negev involved in copper exchange may have all been part of one tribal political entity based in Faynan, perhaps at Khirbat en-Nahas (Ben-Yosef 2009, 2016; et al. 2019). Evidence for this hypothesis from each of the relevant sites is presented in further detail below. Overall, Finkelstein's model is opposed by Levy, Smith, and Ben-Yosef, who make the case for locally-controlled production in Faynan with copper production as a catalyst for this evolution. The control and organization of copper production and exchange as seen through evidence from Khirbat al-Jariya is the focus of the analysis described in the chapters below.

2.4 Historical Evidence

Beyond the archaeological evidence, historical evidence can also shed light on the development of Iron Age society in the Southern Levant (cf. Albright 1938; Avishur 2007; Friedman 2017; Halpern 1988, 2005, 2010; Handy 1997; Hendel 2010; Hess 2007; Lemaire et al. 2010; McCarter 1996; Na'aman 2004, among others). As discussed above, scholars have contested that settlement in Faynan during the Early Iron Age should be affiliated with early origins of the Biblically-referenced polity of Edom. As such, the earliest historical evidence of Edom, much of which comes from Egyptian sources, is highly-relevant to understanding the historicity of the Edomites from the Late Bronze Age to the Early Iron Age. The earliest record that can be associated with Edom comes in the Egyptian Execration Texts from ca. 1800 BCE, in which the "chiefs" of "Kushu" are described, with Kushu representing Edom (Bienkowski 1992; Kitchen 1992). These chiefs can be contrasted in these texts with the "rulers" of "Shutu," which is associated with Ammon and Moab, possibly indicating that residents of Edom practiced pastoral nomadism within a tribal political structure (Bienkowski 1992; Kitchen 1992). The first explicit appearance of Edom in the historical record is in the 13th century BCE Egyptian Papyrus Anastasi VI, which states "[We] have finished letting the Bedouin tribes of Edom pass the Fortress [of] Mer-ne-Ptah Hotep-hir-Maat [...] to keep them alive and to keep their cattle alive" (Pritchard 1969). This reference is also significant due to its use of the term "Shasu," translated as "Bedouin" above. Shasu is an Egyptian word referring to a certain social class bearing similarities to Bedouin or pastoral nomadic people (Ward 1992; Levy 2008). The Shasu term also appears in other Egyptian texts from 1500-1100 BCE, sometimes in association with the term "Seir," which is a geographical term that may refer to the region that would later become Edom (Kitchen 1992; Levy 2008; Levy and Najjar 2006a). Interestingly, the term Seir may have included areas of the Negev desert in addition to the region east of the Wadi Arabah (Bartlett 1989; Edelman 1995; Zucconi 2007), providing some circumstantial evidence of a more widespread Edomite tribal polity as has been suggested in recent analysis of Edom in the Early Iron Age (Ben-Yosef 2009; et al. 2019). In total, these early Egyptian references seem to indicate that the predecessors of the Edomite polity were practicing a type of pastoral nomadism prior to the political developments of the Iron Age.

Despite the existence of historical records from Egypt from the LBA, there are no texts from Edom itself until the development of an Edomite script in the seventh-sixth centuries BCE. There is, however, a fair amount of Biblical evidence that describes the Edomite polity in the Early Iron Age. However, one cannot take these references at face value as the dating of particular verses has been subject to a good deal of debate and guesswork (Bartlett 1992). Many of the references appear applicable to Edom in the Early Iron Age but in fact date to later periods. As such, a critical analysis of the Biblical text is necessary.

Genesis 36:31 alludes to the kings of Edom ruling before any king of Israel, which taken at face value would suggest a date in the Iron I (ca. 1200-970 BCE (Mazar 2011) or ca. 1130-940 BCE (Finkelstein and Piasetzky 2011)). Ths would seem to be compelling evidence for early development of social complexity in Edom, and it has been interpreted as such (Eissfeldt 1966; Von Rad 1961; Westermann 1986). However, historical analysis of the text reveals that these lines of evidence likely date to centuries later than the period in question and may not accurately reflect the timeline of Edomite political development (Bartlett 1989, 1992; Knauf 1985). It may in fact refer to Aram due to a common linguistic error (Lemaire 2010). However, Genesis 36 also refers to the "Benê Esau, that is Edom" who apparently occupy the Negev desert, but this text seems to also have a later date to which it refers (Lemaire 2010).

More Biblical evidence that purportedly relates to early Edom comes from a few other sources that illustrate conflict between Edom and Israel. First, Numbers 20:14-21 mentions Kadesh (Barnea) as on the edge of Edomite territory and describes the Edomites refusing passage to Moses and the Israelites through Edom. Similarly, Judges 11:19-26 indicates that Israelites were not able to pass through the land of Edom. However, Deuteronomy 2:1-8 indicates that Moses and the Israelites were able to pass through Edom without trouble. The conflict between these verses is not easily resolved. However, in any case, these verses all seem to date to later periods and reflect later antagonism between Israelites and Edomites (Bartlett 1992).

Due to the later date of many of these sources, finding a reliable source that illustrates early Edomite political complexity is difficult. The first such Biblical reference may be 1 Samuel 14:47-48, which describes Saul, the first king of the 10th century BCE United Monarchy of Israel, fighting against and defeating Edom, among others. This verse suggests that Edom is a political entity, while not providing much more detail (Bartlett 1992).

Another important Biblical line of evidence discussing Edom in the time of the United Monarchy focuses on King David's military campaign against Edom. In 2 Samuel 8:13-14, David is described as "striking down eighteen thousand Edomites in the Valley of Salt" and subsequently, "He put garrisons throughout Edom, and all the Edomites became subject to David." Similarly, 1 Kings 11:15-16 describes the subjugation of Edom by Israelites, as does 1 Chronicles 18:13. These Biblical sources would seem to indicate an Edomite polity in the Iron I and IIA, competing with David and Israelites, though the traditional highland Edomite polity did not exist until later in the Iron Age (Bennett 1966; Bennett and Bienkowski 1995; Bienkowski 2002; Pratico 1993). Ultimately, this Biblical evidence provides some evidence for Edomite political development earlier in the Iron Age. However, great caution should be taken in applying Biblical evidence to the archaeological record. Of primary importance in understanding the archaeological reality of the complexity of Edom in the Early Iron Age is evidence from the archaeological record, discussed in detail below.

Chapter 3: Geographic, Geologic, and Environmental Context

3.1 Geographic Context of Research Area

The Southern Levant, loosely defined as the area consisting of modern-day Israel, Palestine, Jordan, and the southern parts of Lebanon and Syria, occupies a key strategic location as a land bridge between the African and Asian continents (Cleave 1999; Markaz al-Jughrafi al-Malaki, al-Urduni 2001). Generally, the geography of the region can be interpreted in a number of bands running north-south, which share many of the same characteristics along their lengths. Starting in the east, the Jordanian plateau forms a high, relatively flat plain, extending well to the east into present-day Saudi Arabia and bordered in the north by the mountains of Lebanon and Syria. In the Iron II period, this plateau became significant as the homeland of the Biblical Kingdoms of Edom, Moab, and Ammon. In the Iron II, the Edomite polity in the highlands was centered at the sites of Busayra, Tawilan, and Umm al-Biyara. Edom is geographically differentiated from the Iron Age polity of Moab by the Wadi al-Hasa. Meanwhile, Moab featured the important site of Dhiban, while the ancient polity of Ammon developed north of the Wadi Mujib. Proceeding west, the Jordanian highlands drop fairly steeply into the Wadi Arabah and Jordan Valley, one continuous north-south depression in the landscape. These valleys are part of the Great Rift Valley, extending into East Africa (Hauptmann 2007; Klinger 2000). In the southern Levant, this depression starts at the Sea of Galilee at its northern end and runs south including the Jordan River and the Dead Sea. Further south, the depression is dry and referred to as the Wadi Arabah, which extends until the Gulf of Aqaba on the Red Sea. The Wadi Arabah features the region of Faynan, ca. 30 km southeast of the Dead Sea. West of the rift valley, the elevation rises again, though more slowly than on the east side of the Wadi Arabah/Jordan Valley. In the south, the rise in elevation leads to the highlands of the Negev Desert in present-day Israel. Further north, the rise in elevation leads to the hills of Palestine/the West Bank before ultimately dipping into the Jezreel

Valley. Continuing west, these hills descend into foothills, known as the Shephelah, before ultimately flattening out into the coastal plain, which stretches from Gaza in the south to Mount Carmel in the north, which divides the coastal plain of present-day Israel from the Akko Plain north of the mountain.

As mentioned above, the Wadi Arabah is part of a large north-south rift system that differentiates the area from its surroundings in the wider southern Levant. The Wadi Arabah rift is a large depression running north-south from the Dead Sea to the Red Sea, a distance of ca. 175 km. The wadi ranges in width from 10 to 25 km over its length (5-15 km on its floor), and in elevation from 406 m below sea level (the lowest point on earth) to sea level at the Gulf of Aqaba on the Red Sea (Hauptmann 2007). The Wadi Arabah was a critical crossroads in the Iron Age between the north-south Arabian trade that Egypt had lost influence over (Finkelstein 1988; Jasmin 2006) and east-west trade routes from the Jordan Highlands and Busayra to the Wadi Arabah, Ain Hazeva, and westward to the Mediterranean coast and Egypt (Ben-Yosef, Najjar, and Levy 2014). In the Iron Age, the Wadi Arabah was home to two main centers of copper production: Faynan and Timna, located 105 km to the south near the Red Sea.

The Faynan region is located ca. 50 km south of the Dead Sea on the eastern edge of the Wadi Arabah. Broadly speaking, Faynan is defined by the presence of two main wadi basins along which the main Iron Age Sites in the region are located (Figure 3.1). The southernmost of these wadi basins consists of the Wadi Dana and the Wadi Ghuweir, which combine to flow into the Wadi Faynan and subsequently the Wadi Fidan (Levy et al. 2014). These wadis are the home to Khirbat Faynan, after which the Faynan region is named, and Khirbat Hamra Ifdan, both of which were occupied during the Iron Age. The northern wadi basin is centered around the Wadi al-Ghuwayba. The Wadi Ghuwayba al-Ghani and Wadi Ghuwayba al-'Atshana combine to form the Wadi al-Ghuwayba, which is joined by the Wadi al-Jariya from the north. The Wadi al-Ghuwayba features the crown jewel of Iron Age copper production, Khirbat en-Nahas, while the important Iron Age sites Khirbat al-Ghuwayba and Khirbat al-Jariya are located on the Wadi Ghuwayba al-Ghani and the Wadi al-Jariya, respectively

(Levy et al. 2014; Ben-Yosef et al. 2014). Khirbat al-Ghuwayba is located ca. 3 km east of KEN, straddling the former wadi and a perennial spring that sustains orchards to this day. Khirbat al-Jariya, the focus of excavation and analysis described below, straddles the Wadi al-Jariya, ca. 3 km northeast of KEN. These sites, located in proximity to each other and to the copper ore available in the geologic makeup of Faynan, make up the Iron Age industrial landscape of Faynan.

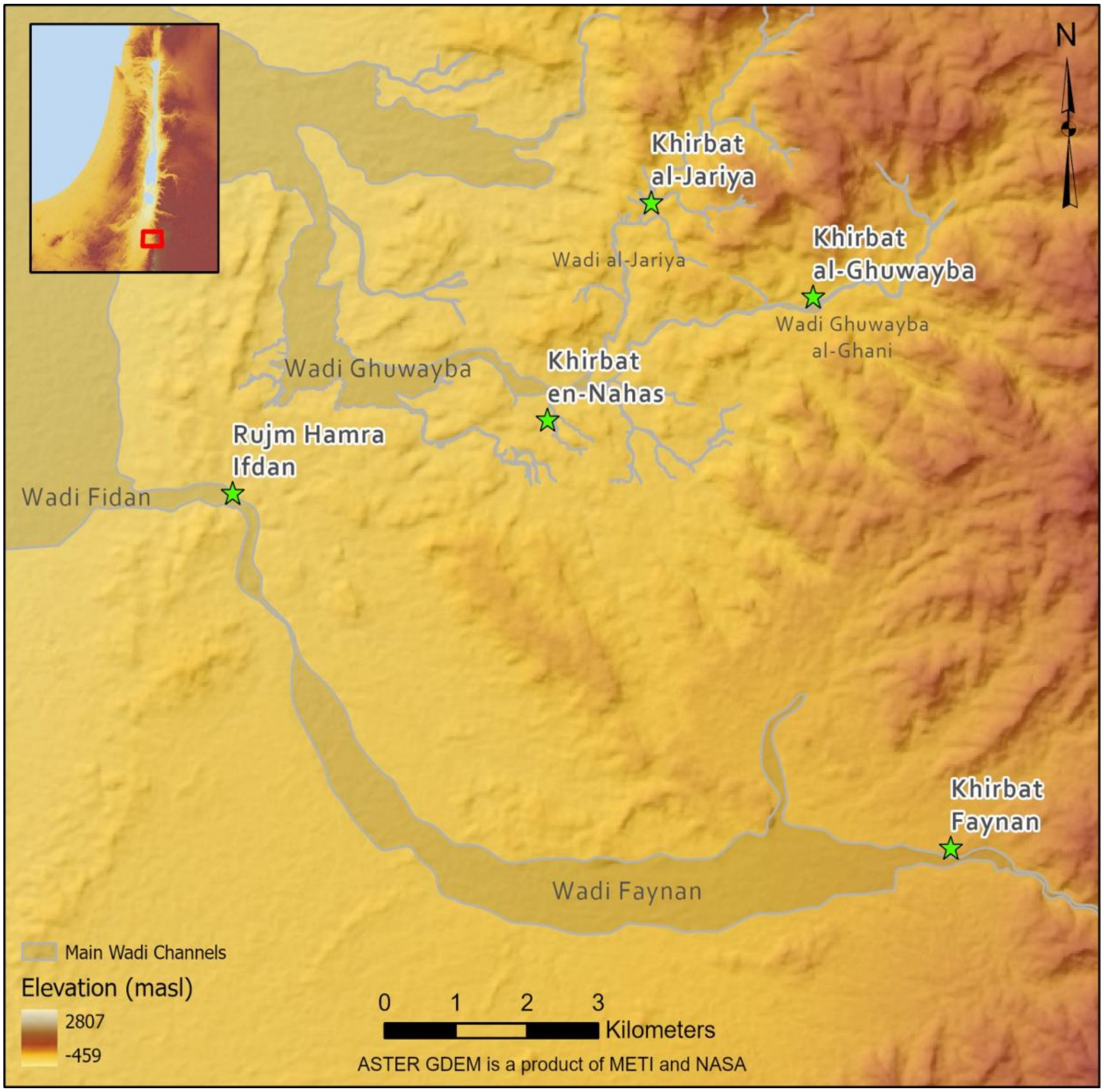

Figure 3.1: The major Iron Age sites and wadis in the Faynan region.

3.2 Geologic Context of Research Area

The geology of the Faynan region is perhaps the most important element of the region's environmental context with regard to how and why ancient society was able to flourish in the region. The defining geological feature of the Faynan region and its location in the Wadi Arabah is the rift valley in which it is located. While the Wadi Arabah represents the localized section of the rift, the a continuous stretch of the rift extends 1,200 km from the Red Sea to the Zagros-Tauros subduction zone at the northern end of the Levant (Bender 1974; Hauptmann 2007). Moreover, the entire rift feature extends approximately 6,000 km into the African continent and represents the separation of the African Plate from the Arabian Plate (Hauptmann 2007). Along the main, north-south fault,a number of faults running east-west, one of which (the Wadi Dana-Zakimat el-Hassa Fault) created the geological "niche" in which Faynan sits. Significantly, the strike-slip fault systems in the rift valley have resulted in the Arabian Plate moving ca. 105 km northward and these movements continue at ca. 0.5-1cm per year (Garfunkel 1981; Hauptmann 2007). The relative shift in these plates explains the presence of copper ore-bearing geologic units on either side of the Wadi Arabah at Faynan and Timna at widely varying latitudes.

The geologic makeup of the Faynan area itself is particularly important when it comes to the presence of copper resources in the region (Figure 3.2). Overall, the geology can be considered in three parts. Oldest are the Precambrian, crystalline basement rocks which are represented in Faynan in an uplifted block, also known as a horst. This horst, visible in a 50 km long strip on the eastern side of the Wadi Arabah, including in Faynan, features primarily andesites (Rabba' 1991, 1994; Hauptmann 2007). In general, the basement rocks of the region feature latitic-basaltic and andesitic-rhyolitic dikes, which represent volcanic eruption channels (Burgath et al. 1984; Hauptmann 2007). These volcanic rock channels contain copper-featuring minerals and are likely the origin of the copper ore deposits that can be found in abundance in the sedimentary layers above. The second geological sequence, younger than the metamorphic basement, is composed of sedimentary rock from the Cambrian to the Quaternary and ranging up to 1,900 m in thickness (Hauptmann 2007; Bender 1974). The lowest layer of these sedimentary rock layers are sandstones ranging in age from the Cambro-Ordovician to the Early Cretaceous and are generally grouped together as the "Nubian Sandstones" (Bender 1968). These Nubian Sandstones, especially those of the Cambrian era, are particularly significant because they include the copper ore deposits that were so critical to ancient exploitation and settlement in the region (Hauptmann 2007). Interestingly, Hauptmann (2007) suggests that a change in the regional flow regime in the 3rd millennium BCE may have resulted in the erosion and exposure of the copper ores in the region and facilitating their exploitation. Taking a closer look at the important Nubian Sandstones, they can be subdivided into four separate units present in Faynan (Bender 1965, 1974; Van den Boom 1969; Bigot 1975; Heitkemper 1988; Hauptmann 2007). The oldest unit is an arkosic sandstone of ca. 60 m thickness, known as the Salib Arkosic Sandstone (Hauptmann 2007; Rabba' 1991). The second oldest unit is a Dolomite-Limestone-Shale (DLS) unit, referred to locally as the Burj formation (Burj Limestone or Burj Dolomite-Shale, Abu-Ajameieh et al. 1988). This Dolomite-Limestone-Shale is ca. 20 to 40 m thick in the Faynan area. This geological unit can again be divided into multiple layers, including a lower sandstone layer, a middle layer of sandy dolostones, and a shale layer on top. The upper part of the dolostone layer features the copper ore, which is present primarily in matrix mineralizations and vein fillings (Bender 1965; Hauptmann 2007). Above the DLS in the Nubian Sandstones are a layer of Sandstones/Claystones that are ca. 50 m, which themselves underlie a massive brown sandstone layer of up to 250 m thick, the Umm Ishrin Sandstone. The Disi Sandstone, reaching 30m at its maximum in the area of Petra, southeast of Faynan, lies above, separated by an unconformity from the Kurnub Sandstone group above (Smith et al. 2014a; Rabba' 1991). Finally, the uppermost unit in Faynan consists of conglomerates, sandstones, and claystones dating as far back as the Neogene (Levy, Ben-Yosef, and Najjar 2014).

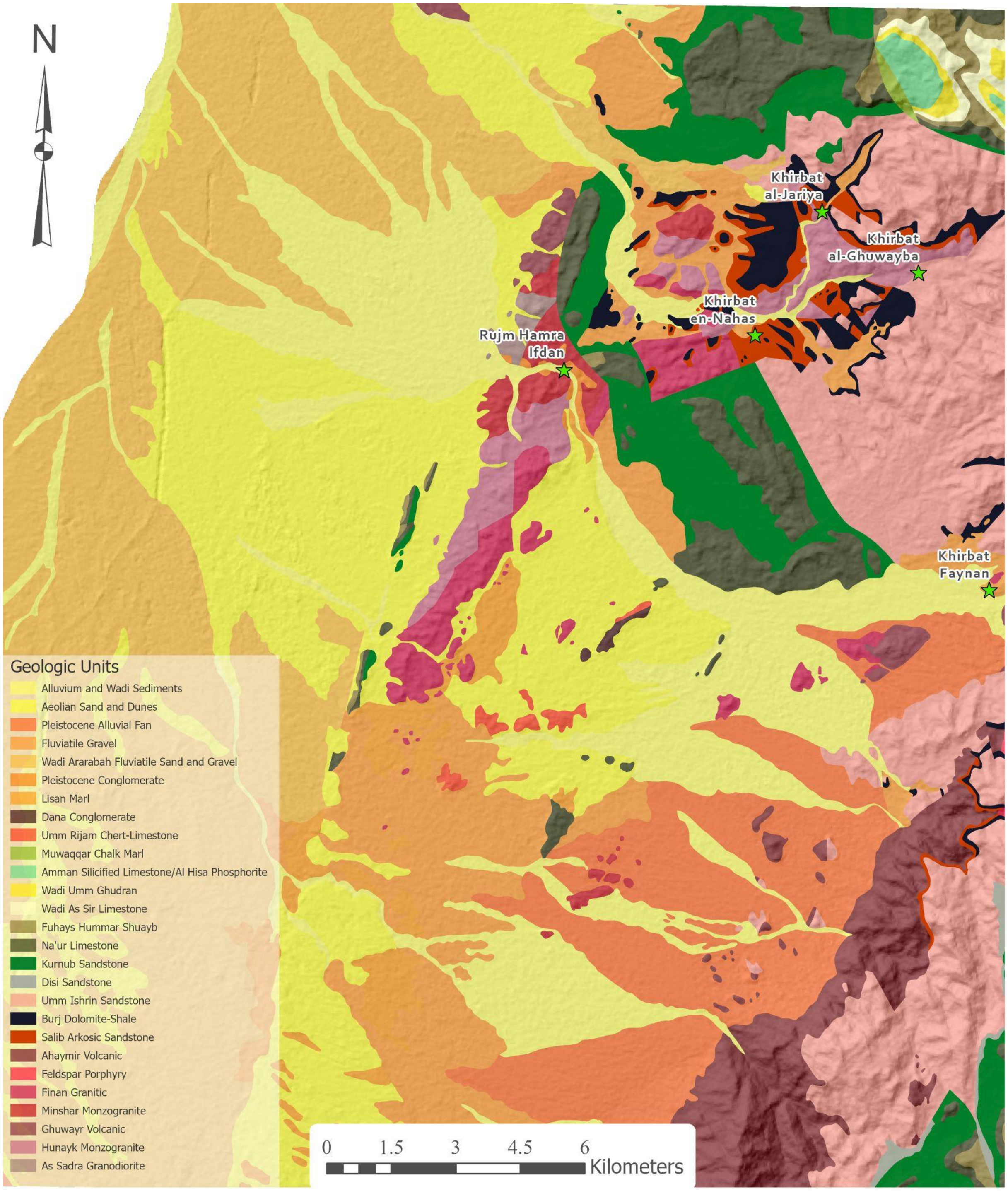

Figure 3.2: Geology of Faynan illustrating selected geologic formations (after Rabba' 1991).

A few geologic formations and soil types in the region are also particularly significant for the sourcing of raw material for ceramic manufacture. First, a group referred to as the Lower Cretaceous Shales has significance. These shales are present in Faynan as part of the Kurnub Sandstone layer (Figure 3.2), and are exposed throughout Faynan and the Jordanian highlands (Smith et al. 2014a). Lower Cretaceous Shales are also present elsewhere in the Southern Levant, though their presence in ceramics found in Faynan likely suggests manufacture in either the lowlands or highlands of Edom (Smith et al. 2014a). The Salib Arkosic Sandstone, mentioned above, features fluviatile sandstones with some interbedding, including rhyolite (Hauptmann 2007) and are also present in the Faynan area, especially in and around the Wadi al-Jariya (Rabba' 1991). Again, the presence of clay derived from this formation likely also is indicative of local manufacture of ceramics (Smith et al. 2014a). The Disi Sandstone, on the other hand, is not widely exposed in the Faynan area, but rather to the southeast in the region of Petra (Rabba' 1991; Smith et al. 2014a). Given the relative proximity of this area, ceramics using clay originating in the Disi Sandstone can be considered relatively local as well. Finally, one important soil type not local to the Faynan region bears discussion — Loess soil. Loess soil refers to aeolian sediments with primarily silt texture. Loess can accumulate on top of other sediments at levels from centimeters to hundreds of meters (Crouvi et al. 2017). These soils are found in the northern part of the Negev Desert and the southern part of the Shephelah region (Crouvi et al. 2017; Goren et al. 2004). Loess, due to its variable mineralogy, is not easily associated with a particular geologic unit, but the presence or absence of various mineral grains may provide insight into its specific provenience (Goren et al. 2004). Each of these geologic units or origins plays an important role in the manufacture of Iron Age ceramics and will be discussed in further detail below.

3.3 Paleoclimatic Context of Research Area

The environment is an important issue to consider here, especially as the paleoenvironment provides a backdrop to the historical issues and debates (cf. Butzer 2012; Cordova 2007a, 2007b;

Rosen 2007) . Generally, present-day Faynan is an arid region, receiving only ca. 50mm of rain per year, which can result in seasonal flash flooding (Bruins 2006). For more reliable water sources, inhabitants must turn to perennial springs such as the ʻAin al-Ghuwayba that are able to support orchards to this day (Levy et al. 2014). Today, the region features average annual rainfall of about 50 mm, as well as mean annual temperatures of ca. 23-24°C (Bruins 2006), serving as a baseline for comparison. The study of the ancient environment is challenging and requires the use of proxy data from various sources. These proxies include analysis of pollen from sediment cores (Kaniewski et al. 2013; Langgut et al. 2013, 2015), study of oxygen and carbon isotope ratios (Bar-Matthews et al. 2017; Schilman et al. 2001; Verheyden et al. 2008), and examination of water levels (Kaniewski et al. 2013, 2017; Litt et al. 2012; Migowski et al. 2006; Stein et al. 2010; Torfstein and Enzel 2017). These analyses provide an interesting framework for understanding the paleoenvironment. Evidence from the Levant seems to suggest a dry period at the end of the Late Bronze Age (Kaniewski et al. 2015; Langgut et al. 2015). However, during the earliest part of the Iron Age, the environment seems to have been relatively moist, more so than during the Late Bronze Age (Langgut et al. 2015). This may have been a factor in increased settlement during the later period (Finkelstein 2003). The increased moisture may have resulted especially in increased settlement in marginal areas during the Iron I period (Langgut et al. 2015). This is particularly significant given that the Iron Age copper industry began to flourish in the early Iron Age in especially marginal areas like Faynan and Timna. However, care should be taken to avoid environmental determinism when analyzing this period and its climate (Levy et al. 2014). Moreover, the relationship between climate and population might not be as direct as some evidence suggests (Palmisano et al. 2019). Speleothem evidence from Soreq cave in Israel suggests the presence of slightly more precipitation during the early Iron Age, though the period as a whole is drier than prior periods (Bar-Matthews et al 1998). Oxygen isotopes from Lake Van in Turkey also show a dry period around 3000 BP (Wick et al 2003), as does evidence from Upper Mesopotamia for the same period (Neuman and Parpola 1987). As such, local variation probably remained of primary importance over global climate change, with climate change likely not serving as the main factor in social change in any case. This supposition is supported by settlement patterns in the Negev over time, showing that political and economic factors held stronger sway over settlement activity in the area than did variance in climate conditions (Finkelstein et al. 2018). Overall, the suggestion of a wetter Iron Age facilitating increased settlement in more marginal areas bears significance to the occupation of Faynan, a generally dry area. However, social, political, and economic factors should retain their primacy in our understanding of ancient society, especially given the extent of local variations in climatic conditions. In Iron Age Faynan, the production and exchange of copper is of primary importance.

Chapter 4: Evidence for Iron Age Trade and Social Complexity

4.1 Introduction

Interpreting the role inhabitants of Khirbat al-Jariya (KAJ) played in interregional exchange networks during the Early Iron Age based on the analysis of ceramic evidence largely depends on comparative study with the ceramics of other sites and regions. Similarly, understanding KAJ's involvement in long-distance trade patterns requires an understanding of the social, economic, and political situation of the Early Iron Age Southern Levant. For these reasons, a review of archaeological evidence from contemporaneous sites in the region is warranted, with a focus on both Early Iron Age settlement patterns and the ceramic evidence at each site discussed. The examination of these lines of evidence provides a valuable basis of comparison for the study of material culture at KAJ.

In addition to briefly covering the history of research in the Wadi Arabah and Faynan in particular, the discussion below focuses on four regions that are essential to the study of Early Iron Age copper production and trade before addressing selected other relevant sites (Figure 4.1). First, the main Iron Age sites in Faynan are discussed. These sites are most directly relevant to occupation at KAJ, which likely operated in a regional network of settlement and copper production in the region during the Early Iron Age. Smith's comprehensive study of the typology (Smith and Levy 2014) and petrography (Smith et al. 2014b) of ceramics from Khirbat en-Nahas and other sites in the region is of particular importance for the study of ceramics from KAJ. Second, the contemporaneous copper producing region Timna is discussed. Though Timna is surely not the destination of copper smelted at KAJ, the sites in the region were likely occupied by members of the same social group and political structure as inhabitants of sites in Faynan (Ben-Yosef 2016; et al. 2019). Thus, comparison between the ceramics and technology of KAJ and Timna can shed additional light on the social dynamics at play at KAJ. The third region discussed, the Negev Highlands, were the locus of a relatively intensive process of sedentarization during the Early Iron Age. Occupation at sites in this region has been linked through ceramic analysis and historical coincidence to copper production in Faynan (Finkelstein 1984, 2005; Fantalkin and Finkelstein 2006; Martin and Finkelstein 2013). However, the premise—hypothesized here—that copper was largely traded westward from Faynan through the Negev has not yet been tested from the perspective of the Wadi Arabah copper producing region. Thus examination of the Early Iron Age settlement and ceramic evidence will help contextualize the analysis conducted here. The final region discussed in some detail below is the traditional highland heartland of Edom. The excavation (largely by Crystal-M. Bennett of sites in this region largely helped to establish a narrative that the polity of Edom was not established until the Late Iron Age (Bennett 1966; Bennett and Bienkowski 1995; Bienkowski 2002; Pratico 1993). However, this framework has been challenged by results from excavations in the lowlands of Faynan, including through analysis of ceramics demonstrating a continuous local tradition of ceramic manufacture (Levy et al. 2004; Smith and Levy 2008, 2014). Though a full examination of the relationship between KAJ and highland Edomite sites is beyond the scope of the present study, a brief discussion of this topic is necessary to provide a holistic understanding of the social milieu in which inhabitants of KAJ in the Early Iron Age operated. Finally, selected other sites are discussed as well on the basis of their apparent involvement in Early Iron Age copper exchange or the significance of their ceramic assemblages for comparative purposes. Overall, the discussion below situates settlement and production at KAJ within the complex social and political framework of the Early Iron Age, which is necessary to contextualize the analysis described below.

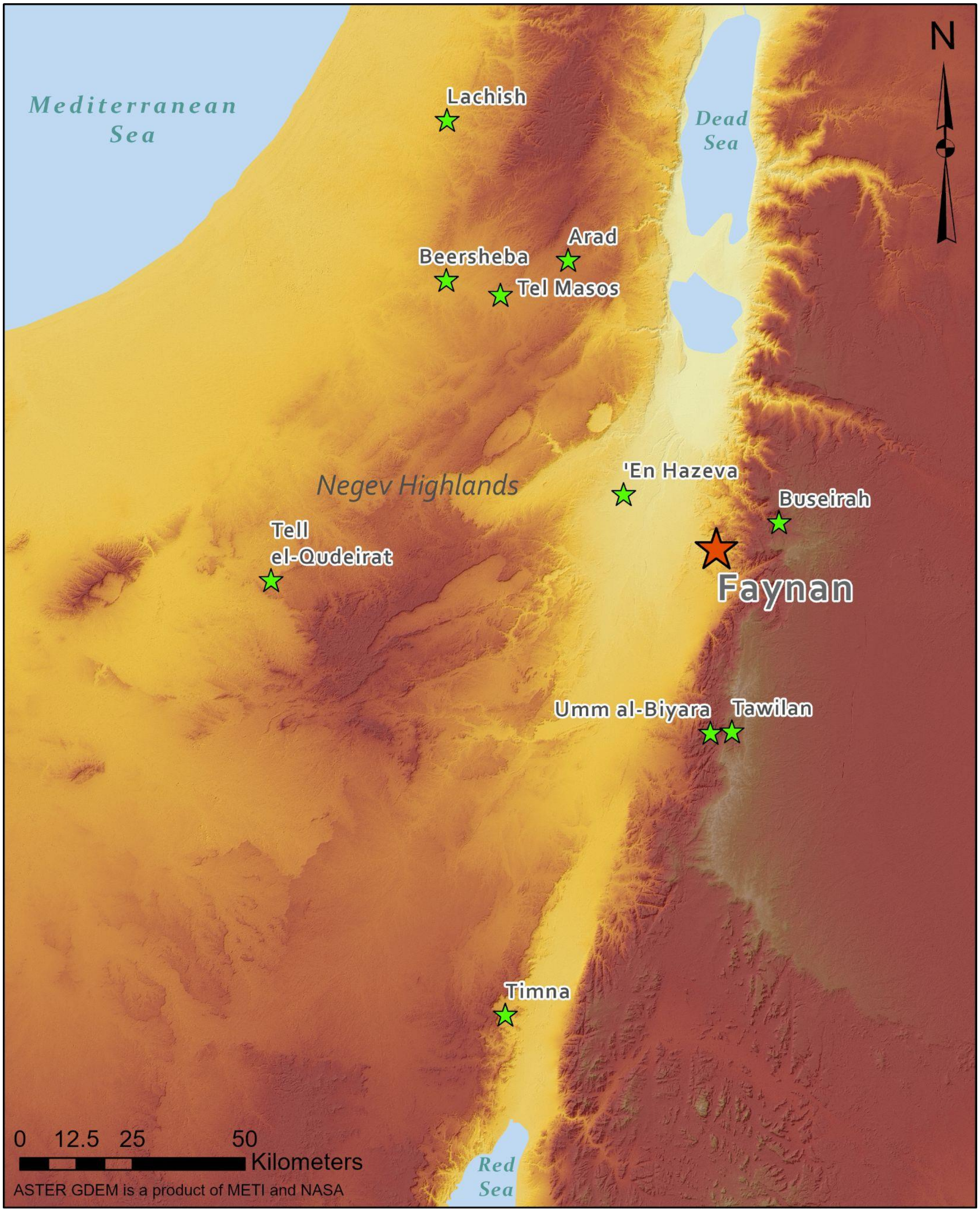

Figure 4.1: The major Iron Age sites from the Southern Levant discussed in this chapter.

4.2 History of Research in the Wadi Arabah

4.2.1 Pre-ELRAP Investigations

The Iron Age copper production sites in Faynan have a long history of being the subject of archaeological investigations (Ben-Yosef 2010). Mapping Iron Age sites in the region dates back as far as 1732, when the site Khirbat Faynan (*Phenon*) was featured along with the phrase *Aeris Fodinae*, indicating the presence of copper production in the area, on a map by Bourguignon d'Anville (1897). Faynan was also mapped as a region of archaeological significance by Major Horatio H. Kitchener of the Palestine Exploration Fund (PEF). Kitchener's report on his 1883 expedition to the region mapped a copper production site, most likely Khirbat al-Jariya (Kitchener 1884; Ben-Yosef and Levy 2014b). Faynan was also visited by Czech explorer Alois Musil, who specifically visited Khirbat en-Nahas and reported on the region's archaeological remains (Musil 1908). Another significant explorer to the Iron Age sites in the Wadi Arabah was the German Templar Fritz Frank, who lived in the region and surveyed the Wadi Arabah (Hadas 2006). Frank explored Timna and Tell el-Kheleifeh and later shared his findings with Beno Rothenberg, in addition to publishing his own reports (Frank 1934a, 1934b, 1935; Hadas 2006). Nelson Glueck, an American archaeologist, visited the Wadi Arabah within a year of Frank and was the first to systematically explore the Wadi Arabah and date sites using ceramics found on site surfaces. Glueck explored both Faynan and Timna and his interpretations of the copper producing sites in Faynan and Timna were significant in establishing a paradigm for many years of these Arabah sites being part of the Solomonic United Monarchy of the Iron Age (Glueck 1934, 1935; Ben-Yosef 2010). Glueck, after visiting Khirbat en-Nahas, Khirbat al-Jariya, and Khirbat al-Ghuwayba, argued that the sherds present at these sites were Edomite sherds dating to the Early Iron Age, in particular Iron I and Iron II periods (Glueck 1935). He also made the case, largely based on comparing archaeological remains to Biblical evidence, that the laborers working the mines and smelting furnaces would have been slaves, taken either as captives from Judea or later on from the local Edomite population after David's conquest of Judah (Glueck 1935). These assertions were widely accepted until they were called into question by later excavations in the Edomite highlands, which caused a reevaluation of the chronology of the Biblical Edomite kingdom (Ben-Yosef 2010; Levy et al. 2005a, 2005b).

After the early investigations into the archaeological remains of the Wadi Arabah, some of the first systematic excavation of the archaeological remains in the Wadi Arabah was conducted by Beno Rothenberg's Arabah Expedition, which adopted an archaeometallurgical approach to the remains at Timna beginning in 1959. Rothenberg led surveys of the Timna Valley, along with excavations at many of the sites in the valley (Rothenberg and Bachmann 1988). The metallurgical approach to the remains at Timna were crucial for developing an increased understanding of how ancient people were able to produce copper from ore (Ben-Yosef 2010; Bamberger et al. 1986, 1988; Bamberger and Wincierz 1990; Merkel 1990).

As discussed above, excavations in the Edomite highlands to the east of the Wadi Arabah also had a big impact on contemporary understanding of the chronology of the Edomite polity. In particular, archaeological excavation of the Edomite sites Umm el-Biyara (Bienkowski 1990), Tawilan (Bennett and Bienkowski 1995), and Buseirah (Bienkowski 1990) by Crystal-M. Bennett caused researchers to conclude that there was no significant polity in Edom at any point during the Iron I or the Iron IIA, at which point these sites were not significantly occupied (Bartlett 1972: 32). The presence of Assyrianizing architecture at these sites, including a temple and a palace at Buseirah, provided evidence that the rise of the Edomite state was due in part to Assyrian influence beginning in the 8th century BCE (Bienkowski 1990). Various Assyrian texts referencing Edom and dating to 800 BCE and later were seen as further corroboration of a later date for Edomite complexity (Pritchard 1969: 281-2, 287, 291, 294, 297, 301; Bennett 1966). Suggestions of an early date for significant Edomite settlement in the highlands (Finkelstein 1992a; Sauer 1986) were dismissed or ignored (Bartlett 1989; Bienkowski 1992). Thus, prior to substantial archaeological investigation into lowland sites in the Wadi Arabah, scholarly consensus posited a date in the 7th century BCE (after the Iron I and IIA periods) for the beginnings of Edomite statehood.

In the 1980s, investigation into the archaeological sites in the Faynan region intensified, beginning with the work of the German Mining Museum, led by Andreas Hauptmann. This work, spanning 1983-1992, culminated in the publication of an extensive survey of metallurgical sites in the region, including the Iron Age sites KEN, KAG, and KAJ, among many other sites (Hauptmann 2007). Hauptmann's (2007) dating of these sites through the excavation of small geologic probes limited radiocarbon dating, and typologic dating at other sites put activity at KEN in the 11th-9th centuries BCE and KAJ and KAG in the Iron I and II. Hauptmann (2007) also published important estimates of slag tonnage at these sites, approximating that between 100,000 and 130,000 t of slag was produced at the various Iron Age sites. These dates and estimates established an important baseline for understanding Faynan as a major center of Iron Age copper production.

The work of the Council of British Research in the Levant (CBRL) during this time period also played an important role in revealing the history of the region through a number of surveys and excavations, including the Wadi Faynan Landscape Survey (Barker et al. 2007), the Southern Ghor and Northern Arabah Survey (McDonald 1992), the Tafila-Busayra Archaeological Survey (MacDonald 2004), and others (Barker et al. 2007; Barnes et al. 1995; Ruben et al. 1997; Findlater 1999; Findlater et al. 1998; Finlayson and Mithen 2007; Freeman and McEwan 1998; Wright et al. 1998; Grattan et al. 2007). In particular, the work of Barker et al. (2007) was crucial for establishing an important baseline of paleoenvironmental data in the region, while Grattan et al. (2007) recorded important data regarding the effects of the copper industry on polluting the environment. Meanwhile, Najjar led important work on Neolithic sites in the Faynan region, in particular the sites Tell Wadi Faynan and Ghuweir 1 (Najjar et al 1990; Simmons and Najjar 2006), and Adams developed the Wadi Fidan Project (Adams 1991).

4.2.2 ELRAP Investigations

The Edom Lowlands Regional Archaeology Project (ELRAP), directed by Thomas E. Levy and Mohammad Najjar, is a deep-time, anthropological archaeological study of the archaeological remains of the Faynan region (Figure 4.2). The project focuses in particular on technological development and its impact on social structure and change, in particular keying in on the role of copper exploitation, mining, and metallurgy (Levy et al. 2014). ELRAP began in 1997 as part of the Jabal Hamrat Fidan Project (Levy et al. 1999; Levy, Adams, and Najjar 2001, Levy et al. 2001), and ultimately came into its own in 2002.

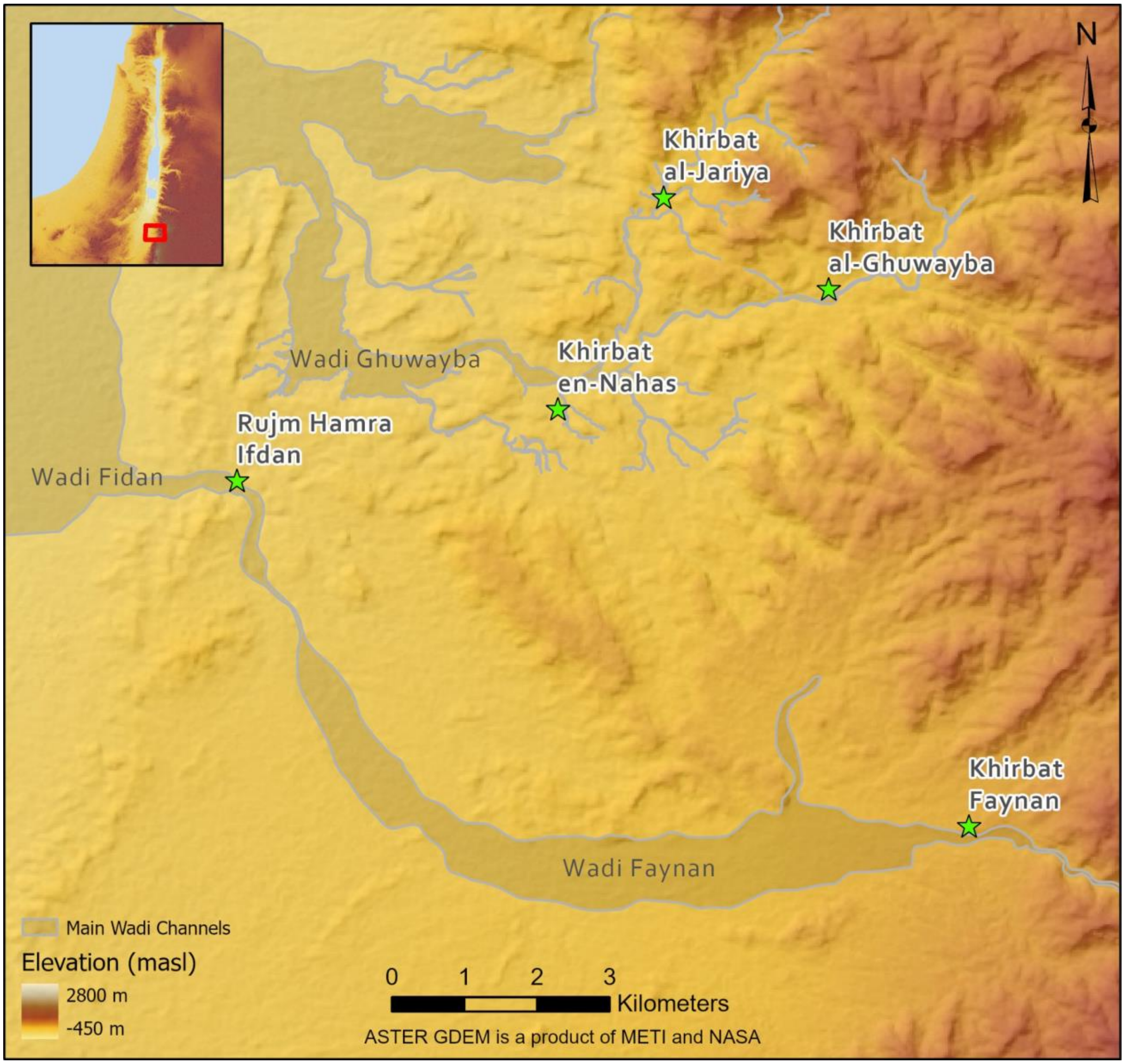

Figure 4.2: The major Iron Age sites and wadis in the Faynan region.

ELRAP, though adopting a deep-time perspective and investigating periods ranging from the Neolithic period to the Islamic period, has also had a major focus on the Iron Age. Excavations and surveys of Iron Age sites have included three seasons of excavation at the Wadi Fidan 40 cemetery, three seasons of excavation at the major copper production site Khirbat en-Nahas, two seasons of excavation at Khirbat al-Jariya (discussed extensively below), and single seasons at Ras al-Miyah East, Rujm Hamra Ifdan, Khirbat Hamra Ifdan, Khirbat al-Ghuwayba, and Jabal al-Jariya-1. (Ben-

Yosef 2010; Levy et al. 2004; Levy et al. 2008a; Levy et al. 2014; Ben-Yosef et al. 2010a; Ben-Yosef et al. 2009a; Levy et al. 2008; Smith et al. 2014a; Beherec et al. 2014). ELRAP also conducted several major surveys intended to investigate the Iron Age industrial landscape. These included surveys of the Wadi Fidan, Wadi al-Jariya, Wadi al-Ghuwayba, and multiple surveys of the terrain between lowland Faynan and the highland Edomite sites of the later Iron Age (Ben-Yosef et al. 2014; Ben-Yosef and Levy 2014a; Levy et al. 2001; Levy et al. 2003; Knabb et al. 2014; Smith 2009; Smith et al. 2014). The work conducted by ELRAP has been crucial in illuminating the history of copper production in Faynan, especially during its peak in the Iron Age.

4.3 Faynan

4.3.1 Khirbat en-Nahas

Khirbat en-Nahas (KEN) is the largest Iron Age copper production site in the southern Levant (Figure 4.3). The site has also become crucial for understanding the overall development of the copper industry in Faynan and its scale. The site, comprehensively remapped as discussed below, is over 10 ha in size and contains more than 100 structures that are the remainder of past industry and occupation of the site (Levy et al. 2014). KEN also features dozens of slag concentrations, ranging from mounds to scatters, that contain an estimated 50-60,000 tons of this ancient smelting byproduct (Hauptmann 2007). The most prominent remains at the site, aside from the slag that covers much of the site, is the large, 73 x 73 m fortress at the northern end of the site. The fortress' gatehouse was the focus of one of the most important excavation areas at the site, Area A. In addition to excavation in Area A, another area, Area F, was excavated in the interior of the fortress. Excavation in Area F uncovered evidence of metallurgical activity in a small structure and clarified the exterior wall of the fortress (Levy et al. 2014b). The next area, Area M, is located in the southeastern portion of the site and consisted of a stratigraphic probe into a deep slag mound. This area played an incredibly important role in understanding the true scale and chronology of Iron Age copper production in the southern Levant.

Along with the slag mound excavated and dated, Area M excavations also uncovered a relatively large complex of structures used for domestic purposes. Area S, located centrally at the site, consists of a structure surrounded by metallurgical debris. The area is significant for its use for industrial purposes, especially ground stone crushing (Levy et al. 2014b). Area T at KEN is somewhat unique at the site. Originally suspected to be a tower, the area was broadly excavated, uncovering a large, five building room surrounding a central courtyard. The building does feature a tower, along with administrative areas and possible industrial function as well (Levy et al. 2014b). In Area W, at the southern edge of the site, is also unique, in this case due to its location in a part of the site relatively free of slag. Ultimately, Area W was discovered to consist of several structures separated by alleys. One structure seems to have served as a storage facility, one was an elite residence, and one was a domestic household of a lower status individual.

Figure 4.3: An aerial view of Khirbat en-Nahas. Note the large 75m x 75 m 10th century BCE fortress at the northern edge of the site (the left side of this image). Photo credit: APAAME, APAAME_20151013_IAR-0067.

Area R, the last area at the site, bears additional discussion due to connections between the area and excavations at KAJ conducted in 2014 and discussed below. Area R was initially recognized as the most significant extant remains on the surface of the site, aside from the large fortress, and the remains in the area were thought by Nelson Glueck to have been a defensive tower (Glueck 1935). The area is located centrally at KEN and was the subject of two seasons of excavation, in 2006 and 2009. These excavations ultimately revealed a large (14.75 m x 13.16 m), monumental building with eight rooms and a stairwell (Figure 4.4). Interestingly, the building's style seems to parallel structures found at the Negev Fortress sites (Levy et al. 2014b). The building was interpreted as an elite residence and likely featured a second story (Levy et al. 2014b). The stratigraphy of the structure divides into three main phases: Layers R1, R2, and R3. Layer R1 in the area postdates Iron Age occupation at the site, though some Iron Age material finds including ceramics were found in this layer. As such, the excavators of the site interpret some of the finds from Layer R1 as collapse from an upper story of the building, contemporaneous with its use in Layer R2 (Levy et al. 2014b: 206). Layer R2 relates to the main occupation phase of the structure, and dates to the 10th-to-9th century BCE. Significant finds from Layer R2 at the exterior of the monumental structure include a figurine, a fenestrated stand, and a throne/dais (Levy et al. 2014b). Inside the structure, Room 1 is particularly significant. Finds include a fragment of a cup-spouted jar, decorated cups, and a Cypro-Phoenician juglet. These artifacts are interpreted by the excavators as corroborating the room's use during Layer R2 as an occupation layer. The other rooms excavated at the structure also revealed a number of fine goods, which together with Room 1's artifacts suggest the relative wealth of the building's inhabitants. Room 2, the central internal courtyard of the building, contained a scarab, as did Room 7. A small votive vessel made of chalk was recovered from Room 5 and beads were recovered from several rooms (Levy et al. 2014). These relatively fine finds, in addition to the architecture of the structure featuring a throne/dais, suggest elite use of the area.

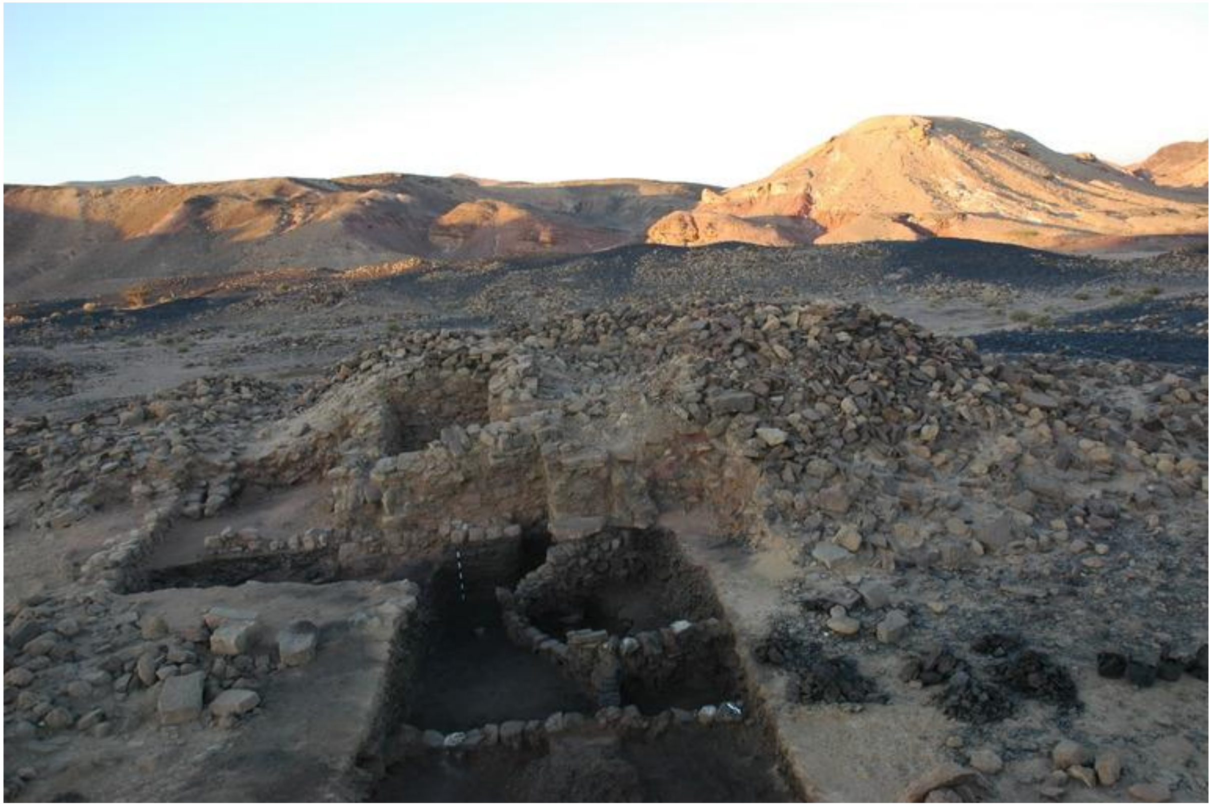

Figure 4.4: The monumental structure in Area R and courtyard during excavation. Photo credit: Thomas E. Levy, UC San Diego Levantine Archaeology Laboratory.

Layer R3 in Area R, pre-dating the elite residence in the area, provides interesting evidence of extensive slag crushing. Evidence of slag crushing is common in the earliest layers of KEN at most of the areas across the site (Levy et al. 2014). This layer was primarily revealed in the external courtyard of the structure to avoid damaging the structure itself. The courtyard in Layer R3 consisted of a great deal of slag as well as tuyères, well-preserved furnaces and furnace fragments, and other evidence of industrial activity. A furnace base discovered in this layer also provided useful evidence for the smelting technology employed at the time (Levy et al. 2014). Overall, the results from Area R suggest a defensible elite residence, likely strategically located with a view over the entire site at KEN. The remains from this area provide an interesting point of comparison for those from Area B at KAJ, discussed below.

4.3.2 Khirbat al-Jariya

Khirbat al-Jariya (KAJ), the subject of the present study, adds a level of complexity to our understanding of Early Iron Age copper production and society in Faynan. KAJ straddles the Wadi al-Jariya, a northern offshoot of the Wadi al-Ghuwayba, and is located ca. 3 km from Khirbat en-Nahas (Figure 4.1). The site is a relatively large copper production site, at 4.8 ha and featuring ca. 15-20,000 tons of copper slag (Hauptmann 2007: 131). The site is identifiable based on the slag mounds and architecture visible on the surface of the site (Figure 4.5). As discussed above, the site was published on by Kitchener (1884) and Gluck (1935: 23-6), who dated the site to the Iron Age based on ceramic typology. Hauptmann (2007: 131-2) subsequently radiocarbon dated the site to the Iron I and II, though leaving open the possibility of Late Bronze age occupation based on tuyère typology. Investigation into occupation at KAJ continued in 2002 with the Jabal Hamrat Fidan Project's survey and mapping of the site (Levy et al. 2003: fig. 16) and ultimately excavation of a small area (Area A) at the southwestern edge of the site conducted by the Edom Lowlands Regional Archaeology Project (Ben-Yosef et al. 2010). Area A consisted of a slag mound with an adjacent structure (Structure 276), which were both excavated. This excavation importantly provided a record of the trajectory of metallurgical production at the site for the first time (Ben-Yosef et al. 2010: 732–738). Ben-Yosef (et al. 2010) suggested that the site was initially occupied for the purpose of copper production, but that smelting activities at the site began opportunistically on the basis of the thin layer of crushed slag (Layer A6) above the bedrock. The remainder of the slag mound consisted of interspersed layers of slag and domestic refuse, and generally is interpreted by Ben-Yosef (et al. 2010: 738) as evidence for relatively small-scale production. Structure 276 was of unclear purpose, largely due to a lack of finds (Ben-Yosef et al. 2010: 739-40). Arguably the most significant outcome of the 2006 excavation at KAJ was the radiocarbon dating scheme, consisting of nine dates taken from Area A. These dates placed occupation at KAJ in the mid-11th to mid-late 10th centuries BCE (Ben-Yosef et al. 2010: 750). Ben-Yosef (et al. 2010: 744) argues that the site was initially the subject of opportunistic production, growing to larger scale before the site was ultimately abandoned in the mid-late 10th century BCE, potentially in association with the raid of Egyptian Pharaoh Sheshonq I to the southern Levant. This excavation established an important chronological framework within which we can understand the results of 2014 excavations at the site. The ceramics from the 2006 excavation were analyzed along with those from KEN, discussed below. 2014 excavation of the site, also discussed below, builds on and to some extent challenges the narratives established by previous investigation of the site.

Figure 4.5: An aerial view of Khirbat al-Jariya. Copper slag is visible across the central area of the site. Photo credit: APAAME, APAAME_20151013_REB-0108.

4.3.3 Khirbat al-Ghuwayba

Khirbat al-Ghuwayba (KAG) is another Early Iron Age site in the Faynan region with significance to understanding the Early Iron Age regional network of sites related to the copper industry (Figure 4.6). KAG is located ca. 3 km east of Khirbat en-Nahas and the site is located on both sides of the ‘Ain al-Ghuwayba, a perennial spring supporting feeding fruit orchards to this day. The site was first identified by Glueck (1935: 22-23) who described the remains of houses and metallurgical activity along with Early Iron Age ceramics. KAG was also surveyed by MacDonald (1992) and Hauptmann (2007), both of whom reported much the same results as Glueck. The site was ultimately excavated by ELRAP in 2009 (Ben-Yosef et al. 2009; 2014). This minor excavation focused on a Roman-Nabatean structure and some of the Iron Age metallurgical remains at the site. The results of the investigation generally corroborated an Early Iron Age date for some of the remains at the site, with one radiocarbon date lining up with the period (two others predate the Iron Age, likely due to the old wood effect; Ben-Yosef et al. 2014). Limited sherds recovered from the site also date to the Early Iron Age. Overall, KAG is relatively under-studied, though the site may have played a role in provisioning of copper production during the Early Iron Age (Liss et al. 2020).

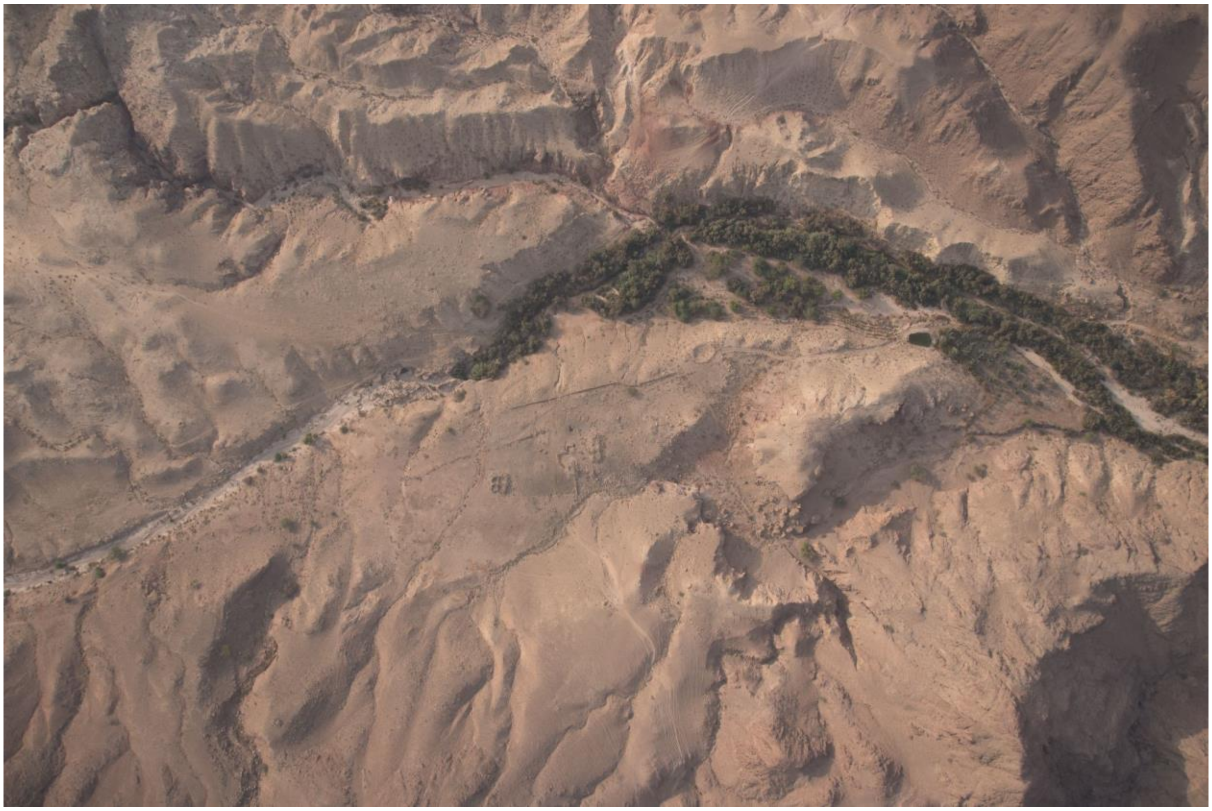

Figure 4.6: An aerial view of Khirbat al-Ghuwayba. The site occupies both sides of the central wadi in this image. The vegetation shown here is fed by the Ain al-Ghuwayba spring . Photo credit: APAAME, APAAME_20151013_REB-0087.

4.3.4 Rujm Hamra Ifdan

Rujm Hamra Ifdan (RHI) is another Iron Age site in Faynan, though quite significantly, occupation spans both the Early and Late Iron Ages. The site seems to have been a watchtower located in a strategic location ca. 5km southwest of KEN along the northern edge of the Wadi Fidan, a key entrance to the Wadi Arabah from the Faynan region (Figure 4.2; Smith et al. 2014c). Though the site was identified by Glueck (1934: 20), the site was confusingly identified as Khirbat Hamra Ifdan, the name now used to identify a different, primarily Early Bronze Age site discussed briefly below. Fortunately, Adams (1992) analysis of Glueck's description of the site allows him to correlate Glueck's Khirbat Hamra Ifdan with the site later renamed Rujm Hamra Ifdan, which also associates with Iron Age Sites 28 and 29 from the SGNAS survey (MacDonald 1992). The link to SGNAS Site 29 is particularly significant as this site was the findspot of an Early Iron Age cup-spouted jar, discussed in further detail below. RHI was excavated by ELRAP in two soundings (A and B), providing important data about the Iron Age occupation of the site. Sounding A, a 5x5 m probe near the top of the northern slope of the site, uncovered a good deal of Early Iron Age pottery, both handmade and wheel-made, along with evidence of cooking and some limited metallurgical activity (Smith et al. 2014c). This sounding was radiocarbon dated to the 10th-9th centuries BCE (Smith et al. 2014c: 735). Sounding B, located at the bottom of the same northern slope, resulted in the excavation of a much higher quantity of ceramics, nearly all wheel-made ceramics from the Late Iron Age. This sounding was dated to the 7th-6th centuries BCE, an Iron IIB date (Smith et al. 2014: 729-735). As such, the site provides important insight into the (relatively less significant) nature of Late Iron Age settlement in Faynan. In doing so, RHI undermines arguments that production at KEN should be considered an Assyrian-influenced Late Iron Age phenomenon (cf. Finkelstein 2005; Finkelstein and Piasetzky 2006, 2008). The dating of RHI Sounding B also contrasts with that of KEN, where C14 dates and ceramics are indicative of an occupation in the Early Iron Age (Levy et al. 2005, 2006, 2007). Beyond resolving chronological debates, the occupation of RHI also provides a useful point of comparison for the study of ceramics, discussed along with those from other Iron Age sites in Edom below.

4.3.5 The Ceramics of Khirbat en-Nahas and Iron Age Faynan

4.3.5.1 Typology

The ceramics from Khirbat en-Nahas were analyzed by Smith (Smith 2009; Smith and Levy 2008; 2014) alongside those from other excavations at nearby sites, including the small 2006 excavation at Khirbat al-Jariya, Rujm Hamra Ifdan (RHI), and the highland sites of Khirbat al-Malayqtah (KAM), Khirbat al-Kur (KIJ), Khirbat al-Iraq Shmaliya (KIS), and Tawilan. This was intended to generate an overall ceramic typology for the Biblical kingdom of Edom that updated previous Edomite typologies (Oakeshott 1978; Hart 1995; Pratico 1993; Zeitler 1992) that failed to adequately take into account the early Iron Age sites in Faynan (Smith and Levy 2014). The published typology serves as an excellent baseline against which the assemblage from the larger 2014 excavations at Khirbat al-Jariya can be compared. Moreover, the comparison between the lowland, early Iron Age sites (KEN and KAJ06) and the highland, late Iron Age sites (KAM, KIJ, KIS, and Tawilan) is also useful. In general, at KAM, KIJ, KIS, and RHI Sounding B, each of these sites dating to the late Iron Age, Bowls are overwhelmingly the most common form of vessel, with around 50% of the assemblage from each site (Smith and Levy 2014). Cooking Pots are also quite common at these late Iron Age sites, making up between 16 and 26 percent of the overall assemblage. These numbers drastically differ at the lowland, early Iron Age sites KEN and *KAJ06.* Smith and Levy (2014) argue that, though one might expect industrial sites such as these two to feature less domestic ware, and that is the case, the site type difference does not fully account for the differences seen between the highland and lowland sites. The differences in question are fairly significant, especially with regard to Cooking Pots, which make up only 2.5% of the assemblage at KEN and 3.9% of the assemblage from *KAJ06* (Smith and Levy 2014). Similarly, the percentage of bowls is significantly lower at these sites as well, making up only 36.9% and 18.6% of the KEN and *KAJ06* assemblages, respectively (Kraters make up 10.9% and 22.5%, respectively). Given that Bowls, Kraters, and Cooking Pots all are forms that often play important roles in food preparation and consumption, their lack of presence may be explained by the use of Handmade Arabah Ware (also known as Negebite Ware) for these purposes. The use of handmade ware (i.e., not wheel-made) for cooking at Early Iron Age sites in the Arabah and Negev has been attested to, especially in the form of so called “cooking kraters” and “Negebite/Edomite Cooking Pots (Bernick-Greenberg 2007b; Meshel 2002). Handmade vessels, by contrast to wheel-made bowls and kraters, make up a far higher share of the assemblages at the early lowland sites than at the later highland sites — 14.6% at KEN, 12.8% at *KAJ06,* and a whopping 58.7% at RHI Sounding A compared to not higher than 4% at any of the highland sites or RHI Sounding B (Smith and Levy 2014).

Beyond the general quantitative figures for ceramics from KEN and other Iron Age sites in Faynan, some key forms are worth discussing. First, the distribution of cooking pots at the site provides an interesting point of comparison to the presence of this form at KAJ. At KEN, cooking pots were generally not present in Areas A, R, or T, these areas being either elite residences or public areas (Smith and Levy 2014). Smith and Levy (2014: 431) suggest that this may suggest social stratification at KEN as well as a spatial distinction between food preparation areas and elite residences. Furthermore, cooking pots in general at the site were more likely to be found in 9th century BCE contexts than 10th century BCE contexts, suggesting a chronological development in their use as well.

The presence of fine-ware red-slipped and burnished bowls at KEN is also quite significant (Smith and Levy 2014). These bowls, which resemble those found at Early Iron Age sites in the western Negev (Smith and Levy 2014: 410), were petrographically examined by Smith (et al. 2014) and found to be made of loess soil, common in the Negev and southern Shephelah, as discussed above. This suggests that these bowls represent imports from sites in the Negev. The importance of red-slipped and burnished vessels from a chronological perspective is discussed in more detail below.

The presence of Qurayyah Painted Ware (also known as Midianite pottery) at KEN is another important indicator of trade relationships. Midianite pottery typically consists of vessels decorated with an off-white slip and painted with red and black designs (Bernick-Greenberg 2007a; Intilia 2016). These sherds originate in the Hijaz region of present-day Saudi Arabia near the site of Qurayyah and are also found at sites in the Negev Desert and Beersheba Valley, such as Tell el-Kheleifah, Tell el-Qudeirat, and Tel Masos (Smith and Levy 2014; Bernick-Greenberg 2007a). QPW is also found at sites in the Wadi Arabah, including notably at Timna as well as Barqa el-Hetiye (Fritz 1994; Bernick-Greenberg 2007a). Overall, the sherds date primarily to 13th and 12th centuries, with some examples dating to the 11th century BCE (Bernick-Greenberg 2007a). The sherds from KEN were subject to petrographic analysis, confirming their origin in the Hijaz (Smith et al. 2014a). Generally, QPW sherds can be considered imports, though they have also been argued to represent the presence of foreign metalworkers (Ben-Yosef 2010, 2016; Kleiman et al. 2017: 257-8; Rothenberg 1998).

4.3.5.2 Petrography and Slag Temper

Beyond typological analysis, ceramics from Faynan and KEN in particular have also been subject to petrographic analysis, with interesting results. Smith (et al. 2014b) conducted the most comprehensive petrographic study of ceramics from Edom, sampling 306 sherds and analyzing them with the petrographic microscope. This analysis resulted in the categorization of the sherds into six main petrographic groups and three smaller groups, divided by their geologic origin. These groups included the Lower Cretaceous Shales group, the Arkose group, the Disi Formation Sandstone group, the Paleozoic Micaceous Clay group, the Loess Soil Group, the Moza Dolomitic Clay group, and three other more particular groups (Smith et al. 2014b). The first three of these groups represent clays local to the Faynan region, indicating local manufacture of the ceramics with these wares (Smith et al. 2014b). The majority of the ceramics from KEN were manufactured with clay from the Lower Cretaceous Shales group or the Arkose group (Smith et al. 2014a) — the geological formations associated with these groups is discussed in greater detail both above and below. Perhaps more significant than the division of these ceramics into petrographic groups is the identification and analysis of slag temper in the ceramics from KEN. The practice of tempering ceramics with crushed slag has been identified in ceramics from Faynan, Timna, and the Negev (Al-Shorman 2009; Bachmann and Rothenberg 1980; Ben-Yosef, 2010; Glass 1988; Martin and Finkelstein 2013; Martin et al. 2013; Rothenberg, 1980; Slatkine 1978; Smith 2009; Tite et al. 1990). One key investigation was conducted by Al-Shorman (2009), who conducted petrographic study on ceramics recovered from KEN, including tuyeres, furnace linings and body sherds. Al-Shorman's (2009) results provided insight into the composition of local ceramics from Faynan, and argued that slag temper is an indicator of local origin for ceramics. Smith's (et al. 2014b) petrographic study also examined the phenomenon of slag temper, finding that 30 percent of the thin sections from KEN contained slag. This included both contamination of slag in finer wares and larger slag inclusions, likely intentional temper, in wares of the locally-made Lower Cretaceous Shale group (Smith et al. 2014a). Interestingly, of the seven thin sections sampled from sherds from KAJ, none contained slag, though this is likely to be a result of the small sample size rather than indicative of a broader trend (Smith et al. 2014a)

Despite the widespread presence of slag temper in ceramics from KEN (and other sites as discussed below), the purpose of intentionally tempering ceramic vessels with crushed slag is not well understood. Generally-speaking, tempering vessels (intentionally adding non-clay materials to a clay to improve its physical properties) can have a number of benefits, including to “correct stickiness, increase porosity, reduce shrinkage, decrease drying time, reduce deformation in drying, and improve firing characteristics” (Rice 1987: 74). The specific benefits provided by the temper depend on the material included in the ceramic (Rice 1987). As such the benefits provided by the inclusion of slag in ceramics is a potentially important line of study, though it remains unclear. Possibilities include improved vitrification of the clay (Al-Shorman 2009), increased heat resistance, important for tuyeres (Ben-Yosef 2010), increased rigidity of the ceramic (Tite et al. 1990), or improved toughness (Martin et al. 2013). Non-functional explanations are also possible, as the inclusion of slag could have had ritual significance or acted as a social symbol (Ben-Yosef 2010; Martin et al. 2013). Unintentional inclusion of slag through contamination of clay sources with crushed slag, readily available at both KEN and KAJ, is also possible in some cases but the majority of these ceramics were clearly intended to be tempered with the material (Martin and Finkelstein 2013: 23; Smith et al. 2014b: 156). In any case, the slag-tempered ceramics seen at KEN are also present at a number of other Iron Age sites in the Wadi Arabah and the Negev and seem to act as a marker of manufacture in the Wadi Arabah copper production regions.

The ceramic evidence from KEN provides a new comparative assemblage from the Faynan lowlands that can be useful for understanding a potential Early Iron Age Edom. Given the proximity and contemporaneity of KAJ and KEN, the ceramics from KAJ should be interpreted in the context of the larger assemblage from KEN (Smith and Levy 2014). Comparison with that assemblage allows for a full interpretation of how the ceramics from KAJ fit in with both the early Iron Age lowlands assemblages as well as the later Iron Age highlands assemblages. This comparison is crucial for understanding how KAJ fits into the larger picture of a potential Edomite polity developing in the early Iron Age, rather than in the late Iron Age in the highlands as is traditionally thought. However, recent archaeological investigation into the relationship between copper production sites in the Wadi Arabah and sites in the Negev desert also illustrate the need for comparison between these two regions and the extent of their economic and social connectivity. These comparisons can be very fruitful for understanding the ways in which elites involved in copper production in the Faynan region were able to expand the scale of their influence. To that end, a discussion of the extent to which evidence of elite activity is present at KAJ is necessary, as well as analysis of whether or not elite activity at the site can be connected to trade and the import of foreign ceramics. These lines of study are a main focus of the ceramic analysis performed and discussed below.

4.4 Timna

Sites in the Timna Valley have long been identified as important copper production sites (Petherick 1861; Frank 1934; Glueck 1935; Ben-Yosef 2016). However, their date had been the subject of ongoing investigation as they initially were dated to the Iron Age, subjected to the rule of King Solomon (Glueck 1940), before being reclassified as New Kingdom Egyptian-controlled sites of the Late Bronze Age (Rothenberg 1999). Recent excavations led by Erez Ben-Yosef, applying the same cyber-archaeology data recording system and high precision radiocarbon dating of stratified deposits methods developed by ELRAP in Faynan, have resulted in a re-dating of the main copper production sites into the Iron Age. Copper production at Timna (and Faynan), peaking in the 10th and early-9th centuries BCE, is now understood to have been locally-controlled by a centralized Edomite polity (Ben-Yosef 2016; et al. 2019). Copper mining and smelting in the Timna Valley took place at several main sites, several of which bear discussion as they have been the subject of important archaeological investigation.

4.4.1 Site 34

Site 34, also known as "Slaves' Hill," at Timna is perhaps the most striking of the sites in the valley, as the site is located atop a sandstone mesa rising 20 m above the valley floor (Ben-Yosef 2016). The site features slag mounds and architectural remains, which had been studied and mapped by Glueck (1935) and then Rothenberg (and Glass 1992). Ben-Yosef's (2016) comprehensive study excavated a wall and gatehouse and a slag mound, among other parts of the site, and generally investigated stone features and slag present on the surface at Site 34. The carved bedrock mortars and many ground stones present at the site were both likely used for industrial activity including crushing ores and slags (Ben-Yosef 2016). Radiocarbon dating of the remains at the site were crucial to reevaluating Site 34's chronology. The site, though previously dated to the LBA by Rothenberg and Glass (1992), actually was occupied in the early Iron Age (Ben-Yosef et al. 2012; Ben-Yosef 2016). More specifically, the site seems to have been occupied from the late 11th century to the late 10th century BCE (Ben-Yosef 2016). This dating is contemporary with the peak of copper production at sites in Faynan, including KEN and KAJ (Ben-Yosef 2016). Ben-Yosef (2016) attributes Site 34's development to a need for a defensible location to smelt copper, paralleling the construction of the large fortress at KEN (Ben-Yosef 2016). Interestingly, organic materials, including textiles, were incredibly well-preserved at Site 34, providing an interesting line of evidence for the lives of the inhabitants of the site (Ben-Yosef 2016; Workman 2016; Sukenik et al. 2017, 2021).

The ceramics from Site 34 represent an interesting and useful assemblage for comparative purposes for evidence from Faynan. The assemblage has been dated to the Iron I period, largely contemporaneous with early phases at Khirbat en-Nahas (Kleiman et al. 2017). The dating of Site 34's ceramics to the Iron I period rests on three main pillars: similarity to Iron I assemblages from other sites in the broader region, the presence of many handmade vessels (implying the assemblage should not be related to the LB III given a lack of handmade vessels from that period), and a lack of Iron IIA characteristic red slipped or hand-burnished vessels (Kleiman et al. 2017). Radiocarbon dates also help corroborate the dating of the site to the Iron I (Kleiman et al. 2017). Overall, the assemblage consisted of 45% wheel-made ware, 53% handmade ware, and 2% Qurayyah Painted Ware (Kleiman et al. 2017). Of the wheel-made sherds, bowls made up 32.68% of the assemblage, Kraters 46.69%, Jugs 8.56%, with other forms making up less than 6% each. Interestingly, only two sherds from Site 34 are potentially from wheel-made Cooking Pots, suggesting either that cooking was not done at the site or that handmade "Negebite Ware" was used for cooking purposes (Kleiman et al. 2017), as has been suggested in the literature (Amiran 1969; Meshel 2002; Bernick-Greenberg 2007b). It is also possible that little cooking was done at the site and that the site was primarily used for industrial purposes, with workers living in tents in the valley below (Kleiman et al. 2017). The low rate of traditional wheel-made cooking pots provides an interesting point of comparison for Early Iron Age sites in Faynan, where cooking pots are also relatively uncommon. The relatively high rate of handmade ware (53% of the assemblage) also stands out as an interesting point of comparison, as compared to sedentary sites in Judah and the Shephelah, but matches other sites at Timna and in the Negev desert (Bernick-Greenberg 2007x; Martin and Finkelstein 2013). Of the handmade ware, 61.74% were bowls, 36.01% were kraters, and other forms made up the remainder (Kleiman et al. 2017). The handmade ware is also significant as it consists of "Negebite Ware," a type characteristic of nomadic populations in the Early Iron Age discussed in greater detail below.

4.4.2 Site 30

Site 30 at Timna is one of the most significant sites in the Timna Valley, due to both its size (at 0.5 ha, a relatively large smelting site by the standards of the valley) and its significance for our understanding of the chronology of production in the region. The most prominent feature of the site is a 1m wide semicircular wall that encircles slag accumulations (Ben-Yosef et al. 2012). Site 30, like nearby sites, has a relatively long history of investigation having been studied by Petherick (1861), Frank (1934), Glueck (1935), and Rothenberg in detail (1962, 1973, 1980; Bachmann and Rothenberg 1980). Rothenberg's excavations identified three main strata at the site, with primary activity relating to the Late Bronze Age (Rothenberg 1980, 1990; Bachman and Rothenberg 1980). New excavations at the site were undertaken by Ben-Yosef (et al. 2012) and investigated metallurgical remains in two areas of the site. These excavations played a key role in re-evaluating Rothenberg's stratigraphy and chronology. Radiocarbon dates from renewed excavation at Site 30 dated occupation of the site from the 12th to 9th centuries BCE, without any indication of LBA settlement (Ben-Yosef et al. 2012). More specifically, the main phase of copper production at the site occurred from the late-11th century BCE to the second half of the 10th century BCE, ending contemporaneously with Shoshenq's campaign to the southern Levant. Overall, these results are quite significant as they corroborate the developing understanding of Wadi Arabah copper production reaching its peak in the 10th century BCE at both Faynan and Timna. The ceramics from this site are largely similar to those of Site 34 (Kleiman et al. 2017). Like other Iron Age sites at Timna, three main ceramic types are present: Negebite Ware, Qurayyah Painted Ware, and wheel-made ware, which includes Rothenberg's (1980) "normal types" and "Egyptian pottery." However, Egyptian pottery seems to not be present at the site (Kleiman et al. 2017).

4.5 The "Negev Fortresses" and "Negebite Ware"

4.5.1 The "Negev Fortresses"

The Negev Highlands experienced a wave of construction in the Iron Age that has been the subject of much discussion in the literature. This phenomenon included the settlement of upwards of 350 sites (Haiman 1994; Cohen and Cohen-Amin 2004). Approximately 60 structures are more well-built and vary according to their shape and size but generally consist of a casemate wall surrounding an open courtyard, known as the "Negev Fortresses" (Faust 2006b: 135). Three sites that can be considered part of the Negev Fortress phenomenon were first reported on by C.L. Wooley and T.E. Lawrence, who interpreted these sites as late-2nd millennium to early 1st millennium BCE outposts defending caravan routes (Woolley and Lawrence 1914-15). Fuller surveys by Glueck (1959, 1961), Aharoni (1967), and Rothenberg (1967) shed additional light on the phenomenon before Cohen's (1979, 1999; and Cohen-Amin 2004) comprehensive survey and excavations further clarified the scope of these sites. The structures are primarily oval (though some are rectangular), located on hilltops, and range from 217 to 3,500 sq. m with most of the fortresses between 350 and 800 sq. m (Faust 2006b). Arguments for the uses and political/ethnic association of these sites have been extremely varied. Initial arguments framed the fortresses as representative of a colonization effort of the Negev Desert by the United Monarchy of David and Solomon (Meshel 1974; Cohen 1980; 1986; Haiman 1994). This argument was updated by Faust (2006b), who suggested that the Negev sites represented populations resettled to the desert by the Israelite state in order to tax trade caravans. A second proposed explanation for the appearance of these fortresses developed through suggestions from Rothenberg (1967) and others (Aharoni 1979; Eitam 1988). These scholars suggested that the sites represented a process of sedentarization of pastoral nomads who had inhabited the region previously. This hypothesis was championed by Finkelstein (1984, 2005; Finkelstein and Perevolotsky 1990; Fantalkin and Finkelstein 2006), who argued that the structures had their roots in tent encampments surrounding animal enclosures and that the sedentarization process was driven by economic opportunity for nomads in the region to participate in the copper trade from Timna through Tel Masos.

Ultimately, a resolution to this debate required further archaeological investigation of sites in the Negev, Faynan, and Timna using cutting-edge scientific methods. In particular, excavations at the Negev sites Atar Haroa and Nahal Boqer shed light on their chronology and use (Shahack-Gross and Finkelstein 2008, 2017; Shahack-Gross et al. 2014; Boaretto et al. 2010). Atar Haroa is a single-period site and features a casemate wall surrounding an roughly ovular courtyard in the style characteristic of the Negev Fortress sites (Cohen 1970; Shahack-Gross and Finkelstein 2008). The site also features a four room house north of the oval enclosure (Cohen 1970). Excavated material remains from initial excavations in the 1960s included ceramics, grinding stones, and animal bones (Cohen 1970).More recent excavations at the site were conducted using microarchaeological methods and collected archaeobotanical remains at fine resolution (Shahack-Gross and Finkelstein 2008). These methods helped to clarify the subsistence strategies employed by the inhabitants of these sites. Prior studies, regardless of whether they had advocated for a model of colonization from the United Monarchy or a model of sedentarization of pastoral nomads, had assumed that inhabitants of Negev sites during the Iron Age settlement wave had practiced subsistence agriculture to complement pastoral activities (Shahack-Gross and Finkelstein 2008, 2017; Shahack-Gross et al. 2014). However, results from the more recent investigations indicated that inhabitants at the site herded livestock, but, surprisingly, did not engage in cereal agriculture (Shahack-Gross and Finkelstein 2008). The results from Nahal Boqer, a nearby site also of the Negev fortress type with a casemate enclosed courtyard and an associated pillared structure, corroborate findings from Atar Haroa, as each site lacks evidence of cereal cultivation during their periods of occupation. Ultimately, excavation results from Atar Haroa and Nahal Boqer seem to indicate that residents of the Negev Fortress sites practiced pastoral subsistence in a more or less sedentary lifestyle, while complementing their lifeways through involvement in the copper trade, which brought processed cereals as staple goods (Shahack-Gross and Finkelstein 2008, 2015, 2017; Shahack-Gross et al. 2014). These interpretations, however, were challenged by Bruins and van der Plicht (2017a, 2017b) who argue, based on their excavations at agricultural terraces at the Negev Iron Age site Horvat Haluqim, that inhabitants of the Negev in the Iron Age did practice cereal agriculture to a certain extent, along with pastoral subsistence. These scholars make this case based on terrace walls, microarchaeological evidence including soil pores, chemistry, and phytoliths, as well as macroarchaeological evidence such as silos and sickle blades (Bruins and van der Plicht 2017a). They also argue that evidence from Atar Haroa has been inappropriately interpreted to conclude a lack of agriculture in the Iron Age both at the site and across the Negev during the period (Bruins and van der Plicht 2017a, 2017b). Despite debate over the extent of agricultural practice in the Negev during the Iron Age, two aspects of the sedentarization wave that occurred during the period remain relatively undisputed: the practice of pastoral subsistence ways (whether alongside or in place of limited agriculture) and participation in the copper exchange originating in Faynan and Timna.

Dating the Iron Age Negev Highlands sites is perhaps the most important task in understanding their role in the exchange networks of the Early Iron Age. These sites, ca. 50 of which have been excavated, are traditionally dated to the early Iron IIA, primarily on the basis of ceramic evidence (Haiman 1994; Cohen and Cohen-Amin 2004; Mazar and Panitz-Cohen 2001; Herzog and Singer-Avitz 2004; Martin and Finkelstein 2013). A second dating consideration has been a list of sites reportedly destroyed by the Pharoah Shishak I in his campaign to the southern Levant (Mazar 1957). Significantly, many of these sites had been associated with the Negev sites as the list is assumed to include short-lived sites in the general region (Haiman 1994). Thus, the sites were assumed to have been destroyed by Shishak and gone out of use by shortly thereafter. However, these dating methods lacked the precision and reliability to generate a concrete understanding of how the sites' chronologies related to copper production in Faynan or even the exact relationship with Shishak's campaign.

Fortunately, recent radiocarbon dating projects at Negev Highlands sites helped to clarify the timeline of Negev settlement. Radiocarbon dates from Atar Haroa place the site firmly in the Iron IIA, primarily in the 9th century BCE, coinciding temporally with the second phase of production at Khirbat en-Nahas (Boaretto et al. 2010). The excavators of the site argue that this dating should mean that the Negev sedentarization wave and Negev Fortresses should be dated to the period immediately following the raid of Sheshonq I to the region (Boaretto et al. 2010; Shahack-Gross et al. 2014), rather than the traditional understanding that these sites were destroyed by the Egyptian raid (Cohen 1979; Haiman 1994). Again, excavation and dating of agricultural terraces at Horvat Haluqim seem to tell a somewhat different story. Radiocarbon dates from agricultural terraces at the site seem to indicate that activity at the site ranged from the LBA to the Iron I or II period, from the 12th to the 10th century (Bruins and Van der Plicht 2017a), though these dates were criticized by Shahack-Gross and

Finkelstein (2017). Regardless, even if a single site was home to limited agriculture over the period of transition from the LBA to the Iron Age, that site doesn't necessarily speak to the larger picture of Iron Age sedentarization in the Negev. In order to address the purpose and dating of the Negev Highlands sites, including the Negev Fortresses, it is necessary to view them through the lens of long-distance exchange patterns in the region. Based on recent evidence, Iron Age settlement in the Negev Highlands is now widely seen to have taken place due to the thriving copper trade originating in Faynan and Timna (Ben-dor Evian 2017; Ben-Yosef et al. 2016; Martin and Finkelstein 2013).

4.5.2 Ceramics from the Negev and "Negebite Ware"

The ceramics of the Negev sites provide another important line of evidence for characterizing settlement in the region during the Iron Age. Ceramics during the period can be considered in two groups: wheel-made and handmade ceramics. The wheel-made assemblage from the ca. 50 Negev sites excavated thus far represents the majority (64%) of the overall number of ceramics found (Cohen and Cohen-Amin 2004; Martin and Finkelstein 2013). Of these wheel-made vessels, 60% of them are closed forms, including many storage jars and pithoi, representing 25% and 15%, respectively, of the wheel-made assemblage (Martin and Finkelstein 2013). Aside from closed vessels, bowl forms and cooking pots are less common, at 9% and 13% of the wheel-made total, respectively (Martin and Finkelstein 2013). Overall the wheel-made assemblage seems to parallel Iron IIA assemblages from sites in southern Israel, providing some insight into the dating of the Negev sites (Haiman 1994; Cohen and Cohen-Amin 2004; Mazar and Panitz-Cohen 2001; Herzog and Singer-Avitz 2004; Martin and Finkelstein 2013).

Handmade ceramics from the region, on the other hand, are notorious as "Negebite Ware," a coarse, handmade ware often featuring straw or organic material tempers (Albright 1940; Bernick-Greenberg 2007b; Cohen and Cohen-Amin 2004; Haiman and Goren 1992; Meshel 2002; Tebes 2006). The coarseness of the fabric and temper is particularly diagnostic of this ware. These ceramics, making up the remaining 36% of the Negev Highlands assemblage, are almost entirely (94% of the handmade vessels) open forms, the majority of which are vessels with flat bases and plain rims (Martin and Finkelstein 2013). These vessels were initially categorized by Woolley and Lawrence (1914-15). Since then, many interpretations as to the use and significance of these vessels have been put forward. Glueck (1959: 93) described the "coarse and crude and almost always handmade" pottery and suggested it related to sedentarized nomads during the Iron II period. Aharoni (1958) was the first to suggest an association of these vessels with food preparation, adding a proposal that Negebite Ware vessels were sold by nomads occupying the sites in the region. Haiman and Goren (1992) later concurred with the suggestion of food preparation and also suggested a nomadic affiliation. Cohen and Cohen-Amin (2004: 140-1), on the basis of comprehensive survey of the Negev, including of the "Negev Fortress" sites, suggested that Negebite Ware vessels were produced at one workshop and were sold around the Negev. More recent analyses have generally concurred that these ceramics are the result of household production by pastoral nomads, who supplemented these locally-made vessels with some wheel-made imports from sedentary sites (Tebes 2006; Martin and Finkelstein 2013). This line of thinking aligns with the hypothesis that the Iron Age wave of settlement in the Negev came about from sedentarization of pastoral nomads rather than enforced resettlement or colonization of the area (Finkelstein et al. 2018). As such, Negebite Ware may represent the presence of nomadic people engaged in copper manufacture and trade (Martin et al. 2013; Tebes 2006). The density of this ware in the Negev Highlands seems to indicate the sedentarization of nomadic populations at sites in the Negev Highlands as they were able to play a role in the lucrative copper trade through the Negev.

Compositional analysis of the Negebite Ware sherds from Negev Highlands sites also proved critical in understanding their use and history, as well as drawing connections to nearby regions. Until recently, only limited studies had been conducted on these wares and their geochemical signatures, with only 11 Negebite Ware vessels from the Iron II analyzed through petrography or INAA overall (e.g. Haimann and Goren 1992; Slatkine 1974, 1978; Glass 1988; Gunneweg et al. 1991; Iserlis and Tareani 2011; Smith 2009). This lacuna was addressed by Martin, who conducted petrographic analysis on ca. 200 vessels excavated in the Negev Highlands regions, including both wheel-made and handmade sherds (Martin and Finkelstein 2013; Martin et al. 2013). Ultimately, this analysis classified four main petrographic groups: slag-tempered clays, igneous rock-tempered clays, clays with de-dolometic iron oxides, and loess clays (Martin and Finkelstein 2013). The first three of these ware groups originate in the Wadi Arabah, while the fourth is representative of ceramics originating in the Northern Negev, southern Coastal Plain, or southern Shephelah (Martin and Finkelstein 2013). Perhaps the most significant of Martin's results came as a result of his analysis of the slag-tempered clay group. Martin (et al. 2013) argued that vessels in this petrographic group were produced at copper-smelting sites in the Wadi Arabah, likely Faynan due to the greater scale of industry vis-à-vis Timna and the greater proximity of the region. Slag-tempered vessels were also chemically analyzed by Yahalom-Mack and colleagues (2015), who measured the lead isotope ratios of slag inclusions in Negev Highland ceramics. This analysis also suggested that these vessels likely originated in Faynan due to the chemical signature of the slag (Yahalom-Mack et al. 2015). Notably, this practice of slag-tempering had been seen in ceramics from Faynan and Timna, as discussed above (Al-Shorman 2009; Glass 1988; Smith 2009; Tite et al. 1990). The practical advantages of tempering ceramics with slag are not quite clear, though it may have increased the toughness and strength of the ceramic (Martin et al 2013). It is also possible that the tempering may have served a ritual or cultural purpose (Ben-Yosef 2010; Martin et al. 2013). In general, the presence of slag-tempered ceramics at sites across the Wadi Arabah and Negev seems to indicate a cultural similarity between these sites.

4.6 Highland Edom

The traditional homeland of the Biblical Edomites is to be found in southern Jordan's highland plateau, east of the Wadi Arabah. Much of what we know about Edom comes from three main sites located along the plateau: Tawilan (Bennett and Bienkowski 1995), Buseirah (Bienkowski 2002), and Umm el-Biyara (Bienkowski 2011). Other sites are known from highland Edom as well, including

Ghareh (Hart 1988, 1990), es-Sela', Ba'ja, Umm el-Ala, (Lindner 1992), Khirbat al-Malayqtah, Khirbat al-Iraq, Khirbat al-Kur (Smith et al. 2014), but are beyond the scope of the present study. Tawilan, Buseirah, and Umm el-Biyara were each excavated by Crystal-M. Bennett, and trailblazing archaeologist who only managed to publish preliminary reports (Bennett 1966; 1967-68; 1971; 1973; 1974; 1975; 1977; Bennett and Bienkowski 1995). These sites were three of the main centers of a hypothesized Edomite "tribal kingdom" during the Iron IIB period (LaBianca and Younker 1995; Bienkowski and van der Steen 2001). The Late Iron Age date for the founding of these and other Edomite sites has been challenged by Finkelstein (1992a), arguing for an Iron I origin, however this is not likely (Bienkowski 1992). Under the Late Iron Age tribal kingdom model, Edomites would have practiced mixed subsistence of pastoralism and agriculture, nomadism and sedentism, along with opportunistic copper-production under a kin-based tribal model (Bienkowski and van der Steen 2001). An alternative explanation of the political structure of Edom comes from Porter (2004), who emphasizes the role of Edomite elites in developing the "Qos cult," in order to legitimize their authority and encourage sedentarization to provide agricultural tribute to neighboring empires. Both of these models fail to consider the role of Early Iron Age settlement in the lowlands of Faynan in the initial development of Edomite social complexity. Smith (et al. 2014), taking a more holistic perspective, also prefers the term "kingdom" for the Late Iron Age polity, based on previous research and original probes at a number of highland sites and sites in the transitional zone between lowlands and highlands. Though these sites postdate the Early Iron Age focus of this discussion, a brief review of their significance is warranted given the close relationship between lowland and highland Edom. The Edomite highlands are easily accessible from Faynan, as it is possible to travel along the wadis of the region and reach the highlands within one day's walk (Levy 2007). Understanding the relationship between these two ecological zones is an important research goal (cf. Smith et al. 2014), though somewhat beyond the scope of this discussion.

4.6.1 Umm el-Biyara

Umm el-Biyara is located on a mountain plateau overlooking Petra (Bennett 1966). The site was visited by Glueck (1934: 77; 1935:82) who identified it with the biblical site Sela'. Bennett's excavation of the site in the 1960s intended to test this identification and collect stratified Edomite pottery from the site (Bennett 1966). Rather than confirming that the site represented Sela', these excavations uncovered domestic houses featuring evidence of looms and spindle-whorls (Bienkowski 1990; 2011). These structures represented a single period of occupation, despite Bennett's categorization of the site into three phrases (Bennett 1966; Bienkowski 1990; Bienkowski 2011).The most significant finding of the excavations was a royal seal, inscribed "Qos-Gabr, King of Edom" (Bennett 1966). This finding is significant for two mean reasons: first, the name Qos-Gabr is theophoric, referencing the Edomite God Qos, and second, Qos-Gabr is also known from Esarhaddon's Prism B (ca. 673-2 BCE; Pritchard 1969: 291) and a description of the first campaign of Ashurbanipal (667 BCE; Pritchard 1969*:* 294; Bienkowski 1990). Thus, the seal created a chronological anchor for dating settlement at the site to the early-to-mid-7th century BCE.

4.6.2 Tawilan

Not far from Umm el-Biyara, Tawilan is another Late Iron Age highland site providing important insight into the Edomite polity of this time period. This site was also surveyed by Glueck (1934: 13-14; 1935: 82-83) who argued that the site spanned the length of the Iron Age. Bennett excavated the site over the course of several field seasons in the 1960s-1980s, intending to test Glueck's hypotheses (Bennett (1969; 1970; 1971; 1984). Unfortunately, the results of Bennett's excavations are subject to a number of issues that limit their utility for understanding stratigraphy at the site (Bienkowski 1995). Three main areas at the site were excavated (Areas I, II, and III), resulting in eight "Integrated Stages," i.e. strata (Bienkowski 1995). However, these phases were not sufficient to produce a stratified sequence of ceramics from the site (Bienkowski 1995). Bienkowski (1995) proposes that the first five stages of the stratigraphy at the site, which have consistent material culture, relate to Late Iron Age/Early Persian occupation of the site, likely from the 7th century BCE to as late as the 4th century BCE. These strata feature rectangular stone structures, occasionally featuring plastered walls, as well as a wealth of finds indicating agricultural and domestic use of the site, with ca. 45% of finds relating to food preparation, consumption, and storage (Bienkowski 1995: 104). Loom weights and spindle whorls also represent textile production at the site, while sheep and goat bones suggest that pastoralism was practiced alongside agriculture (Bienkowski 1995). Beyond Bennett's initial excavations, Tawilan was also subject to recent excavations under ELRAP's Lowland to Highlands of Edom (L2HE) Project. Two 5x5 m probes uncovered walls and storage jars, and generally confirmed the dating and use of the site as a Late Iron Age domestic village (Smith et al. 2014a).

4.6.3 Buseirah

The most famous of the Edomite highland sites is Buseirah, associated with Biblical Bozrah. The site was visited by many travelers in the 19th and 20th centuries and was surveyed by Glueck (1934: 78-9), who initially identified the site as Nabatean (Bienkowski 2002). Buseirah was excavated for the first time by Bennett (1973; 1974; 1975; 1977; 1983), who sampled four main areas at the site: Areas A, B, C, and D. Overall, the site is ca. 8 ha and is located on a promontory on the north end of a present-day village (Bienkowski 1990; 2002). Area A represents the highest point of the site, and excavation in this area revealed structures built of large stones, indicating their relative importance. These structures may represent a temple, palace, or residency (Bennett 1977; Bienkowski 1995; 2002). Area C also represents a local high point and also contains a large building on a stone platform, likely a palace or residence (Bienkowski 2002). Areas B and D are located West and East of Area A, respectively. Overall, excavations uncovered a relatively large administrative complex of two buildings fortified by a town wall (Bienkowski 1990; 2002). Much like Tawilan, the quality of the recording of excavation at the site has limited the ability to interpret the ceramics from the site in a stratified sequence (Bienkowski 2002). However, the site was likely occupied between the late 8th century BCE and the 4th-3rd century BCE (Bienkowski 2002). In this period, residents of the site likely practiced agropastoralism and Buseirah was the most significant site in the hypothesized Edomite "tribal kingdom," in which even a relatively large site such as Buseirah only wielded limited influence (Bienkowski 2002; LaBianca and Younker 1995). However, the site has been argued to have played a key role in the extraction of agricultural tribute from the region (Porter 2004). Recent fieldwork at the site has shed additional light on its use and occupation during the Late Iron Age. In particular, geophysical survey has identified additional domestic architecture in Area B and a large public complex in Area A (Corbett et al. 2016). In addition, recent examination of Edomite foodways based on evidence from Area DD, an expansion of Area D at Buseirah, has shed additional light on the inhabitants of the site and their ties to local Levantine traditions (Brown 2018a, 2018b). Most significantly for comparison to Khirbat al-Jariya, Buseirah is located very close to Faynan, a distance traversable in one day by foot (Levy 2007; Ben-Yosef et al. 2014). The Wadi Dana provides access between the two areas, and this route was likely used in the Iron II period to travel between the lowlands and highlands (Bienkowski 2002; MacDonald et al. 1992).

4.6.4 The Transitional Zone

The area between the Edomite highlands and the Faynan region is an important transitional zone. This region was surveyed intensively by the Faynan Busayra Road Survey (FBRS) conducted by ELRAP (Ben-Yosef et al. 2014). This survey recorded 20 Iron Age II sites between Faynan and Buseirah, the most significant of which are Khirbat al-Ghuwayba (discussed above) and two hilltop fortresses, known as Ras al-Miyah West and Ras al-Miyah East (Ben-Yosef et al. 2009, 2014). These fortresses also overlook a number of Iron Age mines, and it is likely that activity in the Ras al-Miyah area focused on mining during the Late Iron Age (Ben-Yosef et al. 2014). Ras al-Miyah East features a large watchtower, though the fortress' construction was not completed. The site is located nearby a sherd scatter, among which was found a figurine, possibly indicating that the sitte (known as FBRS

27) may have been a shrine to the Edomite god Qos (Ben-Yosef et al. 2014). Ras al-Miyah West, on the other hand, is another large fortress with a tower and a courtyard. Ceramics from this entire complex suggest a Late Iron II date (Ben-Yosef et al. 2014). The region between the lowlands and highlands features other sites as well, including an Iron Age caravanserai (FBRS site 12) along the Naqb ad-Dahal road connecting Khirbat al-Jariya to the highlands (Ben-Yosef et al. 2014). These sites provide interesting and tangible evidence of the connections between the lowlands of the Wadi Arabah and the highlands of Jordan.

4.6.5 The Late Iron Age Ceramics of Highland Edom

The Late Iron Age ceramic assemblage of highland Edomite sites share some general unifying characteristics, despite overall limitations in our understanding of the typology of this region. A primary characteristic among the Edomite assemblage is the presence of painted pottery, known simply as “Edomite Pottery,” “Buseirah painted ware,” or “Southern Transjordan-Negev Pottery (STNP)” (Bienkowski 1992b; Hart 1995a; Tebes 2011). This type has been found at Iron Age II sites at all sites in Edom, including Umm al-Biyara, Tawilan, and its namesake Buseirah, but also at many sites in the Beersheba Valley, Negev, and Wadi Arabah, including Tell el-Kheleifah (Pratico 1993; Thareani 2010). The identification of Edomite Pottery dates back to Glueck, who found and classified this type in his survey of Transjordan (Glueck 1935: 123-137). These ceramics were analyzed by Oakeshott (1978), whose typology, despite critiques, has played a central role in the publishing of Edomite assemblages to this day. Publications by Mazar (1985), Hart (1989; 1992; 1995a), Zeitler (1992), Pratico (1993), Bienkowski (and Oakeshott 2011; et al. 2002), and Tebes (2011) have shed additional light on the ceramics but without fundamentally changing our understanding of the type. Some of the main characteristic types of Edomite Pottery are black and colored painted bands on bowls, “triple-ridged” storage jars, “Edomite cooking pots,” which feature a stepped rim, bowls with a denticulated fringe, and Assyrian-influenced carinated bowls (Hart 1995a; Tebes 2011). At Buseirah, platters are common, and approximately half of the bowls are painted with red, brown, black,or white slips, in some cases with geometrical designs (Oakeshott 1983). A unique, straight-sided bowl referred to as a “cup” and featuring painted bands of decoration and often tripod feet is also present (Bienkowski et al. 2002). The assemblage from Tawilan is similar, though of lower quality, featuring banded bowls, triple-ridged storage jars, and Edomite cooking pots (Oakeshott 1983; Hart 1989, 1995a). The Umm el-Biyara assemblage is “rather different,” as it lacks painted pottery, though still features other Edomite forms including triple-ridged storage jars and Edomite cooking pots (Hart 1989). This lack of painted pottery has been argued by Oakeshott (1978), Mazar (1985), and Hart (1989) to have chronological significance; however, this seems not to be the case (Bienkowski 1995; Singer-Avitz 2004). In total, Edomite pottery should be seen as characteristic of Late Iron Age sites in the highlands of southern Jordan. However, the presence of these ceramic forms do not straightforwardly map on to ethnicity, and a nuanced perspective toward associating “Edomite Pottery" with people and trade connections should be taken (Brown 2018a, 2018b; Thareani 2010; Tebes 2011; Whiting 2007).

The main relevancy of the ceramics of Late Iron Age highland Edom to the ceramics of Khirbat al-Jariya lies in the degree to which these assemblages represent a continuation of forms from Early Iron Age sites in Faynan. Smith and Levy (2008) argued in a preliminary analysis of the ceramics from Khirbat en-Nahas that this assemblage showed most similarity to highland sites, thus representing the first part of a continuous “local regional ceramic tradition specific to Edom.” In their view, this continuity was most clearly reflected in types BL3, BL21, BL30, KR19, PT5, JG3, and JG4 from KEN (Smith and Levy 2008). However, this interpretation was challenged by Finkelstein and Singer-Avitz (2009), who challenged a number of Smith and Levy’s interpretations. Most significantly, these scholars (Finkelstein and Singer-Avitz 2009) argue that the preliminary ceramic evidence from KEN represented primarily Iron IIB and IIC types, rather than IIA types as suggested by Smith and Levy (2008). Furthermore, Finkelstein and Singer-Avitz (2009) argued that it was necessary to compare the assemblage from KEN primarily to ceramics from present-day Israel rather than in Jordan, given a lack of stratified assemblages, as discussed above. Bienkowski (2011) offered another critique, suggesting that many of the similarities between the ceramics of KEN and those of Umm el-Biyara may only represent widespread types rather than specific parallels with chronological significance. One specific challenge presented by Bienkowski is on the subject of KEN BL22, which Smith and Levy (2008) interpreted as an earlier form of Assyrian-influenced bowls from the 8th and 7th centuries BCE. Bienkoswki (2011) instead preferred an explanation that the KEN bowls are not an earlier form but actually are identical to the later types, suggesting that ceramics from KEN postdate the 9th century BCE abandonment of the site postulated by its excavators. This thread was later picked up on by Tebes (2021), who made a similar argument as to the extension of settlement at KEN based on supposedly Late Iron Age ceramic forms. However, the complete assemblages from KEN and other sites in Faynan presented by Smith and Levy (2014) suggest that forms from KEN do represent earlier stages of a regional ceramic tradition extending through the length of the Iron Age in highland and lowland Edom.

4.7 Other Iron Age Sites

4.7.1 Tel Masos

Tel Masos is one of the most critical sites for understanding the development of trade connections in the Early Iron Age. As discussed above, Tel Masos has been argued as the center of a chiefdom that controlled copper production in Faynan (Finkelstein 1988, 2005; Fantalkin and Finkelstein 2006). In Finkelstein’s view this chiefdom included settlements such as Arad XII, Tel Esdar II, Beersheba VII, and sites in the Negev Highlands (Fantalkin and Finkelstein 2006). These sites, in turn, are also important to our picture of Early Iron Age political and economic development. However, Tel Masos itself bears further discussion. The site is located in the Beersheba Valley ca. 12km east of Beersheba. Four main areas were excavated at the site: Areas A, B, H, C, and F (Kempinski and Fritz 1983). Excavation of these areas revealed three strata. Stratum III is a Late

Bronze Age phase relating to the 13th-12th centuries BCE and represents the initial settlement at Tel Masos after an occupation gap (Kempinski and Fritz 1983). Stratum II was occupied during the Early Iron Age (12th to 11th centuries BCE) as a continuation from Stratum III and represents the peak of settlement at the site. This stratum is notable for its public architecture, four-room houses, and relative wealth of finds (Fritz and Kempinski 1983; Finkelstein 1995). Stratum II also features evidence of copper processing, specifically unrefined copper ore in addition to three crucibles, which may have been used for smelting (Kempinski and Fritz 1977: 158; Kempinski et al. 1983: 21) as well as copper/bronze items (Crüsemann 1983; Lupu 1983). Fritz (2002), one of the excavators, argues that these metallurgical remains are evidence of the import and processing of ores from Faynan. Along similar lines, Finkelstein (2005) contests that the metallurgical evidence, along with the presence of Negebite Ware at the site, illustrate that copper production at Khirbat en-Nahas was controlled by the Tel Masos chiefdom. However, as discussed above, the evidence from Tel Masos does not convincingly demonstrate that substantial copper manufacture was done at the site (Yahalom-Mack 2010: 272-3). Moreover, it is unlikely that ores from Faynan were imported to Tel Masos given the economic inefficiency in doing so (Artzy 2003). Instead, the metalworking installations at Tel Masos may have been used for remelting or recycling of copper (Artzy 2003). However, it is likely that copper from Faynan was exchanged through Tel Masos due to its central location on regional trade networks (Ben-Dor Evian 2017; Ben-Yosef 2010; Singer-Avitz 2008). However, interpreting the archaeological evidence from Tel Masos accurately is challenging due to the poor standards of excavation and publication at the site (Dever 1990).

The ceramics of Tel Masos Stratum II provide interesting insight into the chronology of the Early Iron Age and a useful basis for comparative study. In particular, evaluating the similarity of the Tel Masos assemblage to that of Khirbat al-Jariya is critical for understanding whether or not a chiefdom based at Tel Masos controlled copper production in Faynan. The assemblage of Tel Masos Stratum II is the richest at the site. Stratum II features a good deal of continuation of types from the previous LBA Stratum III (which is not discussed here due to its lack of contemporaneity to settlement in Faynan) (Fritz and Kempinski 1983). However, one important contrast is the appearance of red-slipped and hand burnished bowls (Fritz and Kempinski 1983), which are a characteristic type of the Iron IIA period (Cohen and Cohen-Amin 2004; Mazar 1997; Mazar 1998). The excavators of Tel Masos generally date Stratum II to the late 11th century BCE on the basis of a few ceramic types that serve as "chronological pegs" for their analysis: two forms of cooking pot, one of which represents continuation from the Stratum III, late 12th century BCE type, and a later form bears similarity to 10th century BCE types (Fritz and Kempinski 1983). Also significant for their analysis is a specific bowl type referred to as an "Egyptian flower-pot," which is present at Tel Masos but apparently generally goes out of use by the end of the 11th century BCE (Fritz and Kempinski 1983). In terms of drawing parallels to strata at other sites, the excavators compare the assemblage from Tel Masos Stratum II to Megiddo VIA and Qasile X, which corroborate the 11th century BCE — i.e. Iron Age I — date (Fritz and Kempinski 1983). However, this interpretation has been challenged by Herzog and Singer-Avitz (2004), who argue that Tel Masos Stratum II should be considered an Early Iron Age IIA phase. These scholars suggest that some Stratum III sherds at the site were inappropriately classified as Stratum II finds, corrupting the interpretation of the date of Stratum II. By reassigning these sherds, including the Egyptian flower-pot discussed above, to the earlier Stratum III, Herzog and Singer-Avitz (2004) are able to re-date the Stratum II assemblage to the Early Iron IIA, paralleling Arad XII, Beersheba VII, and Lachish V. Vessel types of particular significance to this re-dating include the red-slipped hand-burnished bowls, "handled cooking pots, medium-sized storage jars, neckless pithoi with thickened rim, and a black juglet." (Herzog and Singer-Avitz 2004: 223). However, it may also be possible that the Tel Masos Stratum II assemblage represents a transitional phase between the Iron I and Early Iron IIA periods (Mazar 2015).

4.7.2 Beersheba

Tell Beersheba is another significant Iron Age site located in the Beersheba Valley, ca. 4 km east of the present day town of Beer Sheva (Aharoni 1973; Herzog 1984). The site is important for the early development of the Iron Age kingdom of Judah (Herzog and Singer-Avitz 2004). The Early Iron Age remains consist of architecture in the southeast portion of the site (Herzog 1984). Excavators initially interpreted Strata IX-VI at the site as Iron Age I layers (Herzog 1984). However, Strata VII can be associated with the Early Iron Age IIA, while Strata VI-IV are Late Iron Age IIA layers on the basis of ceramic evidence (Herzog and Singer-Avitz 2004). The Iron I levels at the site feature residences and possibly granaries cut into the side of the slope of the site (Herzog 1984). These features were filled and replaced by stone structures at the end of the Iron I period (Herzog 1984). At the outset of the Iron IIA period, in Stratum VII, many connected four room houses were constructed, their outer walls forming a protective barrier around the settlement (Herzog 1984; Herzog and Singer-Avitz 2004). An opening in this barrier on its southwestern side was flanked by two structures, potentially watchtowers. Though excavation of the Early Iron Age strata at the site was limited to this sequence of buildings, excavators suggested on this basis that the overall site would have been an enclosed settlement with similarity to the Negev Fortresses (Herzog 1983; Herzog and Singer-Avitz 2004). This parallel implies that Beersheba Stratum VII may have been involved in regional exchange networks of the Early Iron IIA. Stratum VI saw the dismantling of the structures of Stratum VII, likely in preparation for the construction of of a Late Iron Age IIA fortified city featuring a city wall and a four-chambered gate (Herzog and Singer-Avitz 2004). The continuation of settlement at the site into the Late Iron Age IIA differs from Tel Masos, where the site was abandoned following the Early Iron IIA (Herzog and Singer-Avitz 2004).

The ceramics of Tel Beersheba help to frame the strata of the site into historical periods. Herzog and Singer-Avitz (2004) place Strata IX through VIII into the Iron Age I, VII into the Early Iron Age IIA, and VI through IV into the Late Iron Age IIA. Tel Beersheba is one of only a few sites in the region with a substantial Early Iron Age from each of these periods with a ceramic assemblage recovered from a well-stratified excavation (Herzog and Singer-Avitz 2004). Thus, the ceramics of Tel Beersheba are critical in differentiating the material culture of the Early Iron Age IIA from the Late Iron Age IIA. Given the overall similarity of ceramic forms from the Iron Age IIA, Herzog and Singer-Avitz (2004; Singer-Avitz 2016) depend on the presence of key "indicative vessels," the presence or absence of which allows for the differentiation of the material culture of EIAII Stratum VII from the LIAII Strata VI-IV. Some of the key forms include Cooking Pots, of which Type CP-I appears only in Strata V and IV and CP-II appears from Strata IX-VII and not later (Singer-Avitz 2016). The stratigraphic difference is also reflected in storage jars. Cup-spouted storage jars (Type SJ-X) at the site appear in Late Iron IIA Stratum V and IV and not earlier (Singer-Avitz 2016). The early strata (IX-VIII) also help indicate that red-slipped and hand-burnished vessels are present in strata as early as the Iron Age IA, despite their nature as characteristic Iron IIA forms (Herzog and Singer-Avitz 2004; Singer-Avitz 2016). However, this type of decoration does peak at Tel Beersheba in the Early Iron IIA Stratum VII (Singer-Avitz 2016).

4.7.3 Tell el-Quedeirat

Tell el-Qudeirat is another site that played a central role in the Early Iron Age exchange networks of the Southern Levant. The site is located in the eastern Sinai desert, in an oasis in the Wadi el-Qudeirat in present-day Egypt (Cohen and Bernick-Greenberg 2007a). Tell el-Qudeirat has been identified as the Biblical Kadesh Barnea, a key site mentioned in many Biblical passages (Cohen and Bernick-Greenberg 2007a). The site was subject to early investigation by C.L. Woolley and T.E. Lawrence (1914-1915) and Nelson Glueck (1935), among others, before being excavated by Dothan (1965) and more extensively by Cohen (Cohen and Bernick Greenberg 2007a). Cohen's excavations uncovered three Iron Age fortresses, built on top of one another with some later remains as well. The Iron Age sequence of occupation was interpreted to have taken place over three strata. The Iron IIA Stratum 4 represents the earliest occupation at the site. Substratum 4c consists of pre-fortress settlement, which was “barely excavated” and of unclear date (Cohen and Bernick-Greenberg 2007a). Singer-Avitz (2008) argues, based on the presence of Qurayyah Painted Ware at Tell el-Qudeirat, that Stratum 4c should be dated to the 12th century BCE (Iron I), during which time it served as a trade outpost along the Darb el-Ghazza trade route to Egypt. However, Qurayyah Painted Ware has been shown to have been used into the Iron IIA period, undermining Singer-Avitz’s argument (Ben-Yosef 2016; Ben-Dor Evian 2017). Substrata 4b and 4a at Tell el-Qudeirat represent a 10th century BCE ca. 27 m oval casemate fortress at the site and an unfortified settlement west of the fortress (Cohen and Bernick-Greenberg 2007a). This fortress of Stratum 4 is argued by Cohen (and Bernick-Greenberg 2007a) to parallel to the Negev Highlands fortresses and thus be part of the same phenomenon leading to sedentarization in the Negev, discussed above (Cohen and Bernick-Greenberg 2007a). This is disputed by Finkelstein (2010), who interprets the Stratum 4 settlement at Tell el-Qudeirat as an ordinary settlement, differentiated from the Negev Highlands sites by the presence of evidence suggesting agricultural activity at the former site and a lack of such evidence at the latter sites. However, considering either interpretation of the dating and style of the site, the presence of Early Iron Age settlement featuring extensive evidence for trade connections at the site means it is likely that the Stratum 4 settlement played a role in copper exchange networks originating in the Wadi Arabah (Ben-Dor Evian 2017). Ultimately, Cohen and Bernick Greenberg (2007a) argue that the oval fortress was replaced by a rectangular fortress in the Iron IIB Stratum 3, which itself was replaced with a rectangular fortress featuring a casemate wall in the Iron IIC Stratum II.

The ceramics of Tell el-Quedeirat are notable especially for the high rate and variety of Negebite Ware (Bernick-Greenberg 2007b). Tell el-Qudeirat features more Negebite Ware than any other site and makes up 45% of the ceramics from Iron IIA Stratum 4 and 80% of the ceramics from Iron IIB Stratum 3a-b (Bernick-Greenberg 2007b,) rates comparable to sites in the Negev and Timna (though the overall quantity at Tell el-Qudeirat is higher). The sheer number of Negebite Ware vessels from the site allowe Bernick-Greenberg (2007b) to attempt to develop a typology of these vessels, ultimately classifying the vessels into bowls (ca. 58% of the total Negebite Ware vessels), cooking kraters (ca. 22%, and discussed above), thin-walled cooking pots (ca. 6%), juglets and jugs (ca. 6.5%), and varia (ca. 6.7%). The petrographic study of these vessels indicates that most of the vessels were produced somewhat carelessly using a coarse-tempered loess-based fabric (Bernick-Greenberg 2007b). The thin-walled cooking pots, on the other hand, seem to have been produced with a different fabric, perhaps by using a mold (Bernick-Greenberg 2007b). These cooking pots provide an interesting point of comparison for cooking techniques at Khirbat al-Jariya.

The wheel-made ceramics of Stratum 4 at Tell el-Qudeirat make up ca. 55% of the total assemblage. Generally speaking, the wheel-made assemblage consists of Early Iron IIA ceramics paralleling Tel Masos Stratum II and Arad XII as well as Late Iron IIA ceramics, such as the Black-on-Red juglet that is characteristic of the later period (Bernick-Greenberg 2007a; Finkelstein 2010; Herzog and Singer-Avitz 2004). However, Singer-Avitz (2008) argues that several sherds from Substratum 4b can be dated to the Iron I. The presence of Qurayyah Painted Ware at the site, as discussed above, has also been controversial with regard to dating. Two mostly-whole vessels and 18 sherds of this ware were found at the site, the majority of which related to Stratum 4 and likely relates to the Early Iron IIA (Bernick-Greenberg 2007a; Ben-Yosef 2016; Ben-Dor Evian 2017). A fuller discussion of the significance of Qurayyah Painted Ware is above. However, in general, the presence of various types of imported wares suggest that Tell el-Qudeirat had established trade connections with sites in different regions (Bernick-Greenberg 2007a). This likely includes the copper production sites of the Wadi Arabah (Ben-Dor Evian 2017).

4.7.4 Arad

The desert site of Arad is also important for understanding the chronology of the Iron Age in the south of Israel. The site is located in Judah in the Beersheba ValleyThe site was excavated over several seasons by Aharoni and Amiran and consists of an Early Bronze Age city below an Iron Age fortress mound (Herzog 2002). The mound consists of 12 strata, which were reinterpreted by Herzog

(2002). The first Iron Age phase of the site, dated by Herzog (2002) to the 10th century BCE, is Stratum XII. This stratum represents a small village containing pillared houses on top of the highest hill of the site. It is likely that Early Bronze age structures were also re-used during this phase (Herzog 2002). Following this early phase, three Iron Age (9th century BCE) fortresses were constructed in succession: one in Stratum XI, one in Strata X to VII, and one in Stratum VI. The Late Iron IIA Stratum XI fortress features casemate walls and towers and measures approximately 55 x 50 m (Herzog 2002). This fortress was replaced by an Iron IIB solid-walled fortress that persisted — with intermittent destructions — from Stratum X to Stratum VII with some architectural modifications in each Stratum.

The relationship between these Iron Age strata and the campaign of Egyptian Pharoah Sheshonq I to the Levant in the mid-to-late 10th century BCE is one of the most significant linchpins of the Iron Age chronology debate. Sheshonq I's raid provides a key link between archaeological evidence and historical evidence, both Biblical and extra-Biblical. The raid is mentioned in the Biblical verses 1 Kings 14:25-28 and 2 Chronicles 1-12, in which Sheshonq (spelled Shishak) is described as carrying off the treasures of the Jerusalem temple. More significantly for correlating the raid to the archaeological record is an inscription on a wall in the temple of Amun at Karnak, which describes many of the sites Shoshenq destroyed on his campaign (Simons 1937; Kitchen 1986). Many of the sites described in this list have been correlated with archaeological sites featuring destruction layers in the early part of the Iron Age, as these sites presumably would have been sacked by the pharaoh on his raid (Finkelstein 2002). One key site in this list has been interpreted as Arad-Rabbath, i.e. Great(er) Arad, which can be linked with the site at Tel Arad known today (Kitchen 1986: 440). Finding Arad in Shoshenq I's list helps to situate the list geographically but more clarification is needed to refine the list chronologically. Initial interpretations suggested that the Great Arad of Shoshenq I's raid was to be associated with the first fortress at Arad, the Late Iron IIA casemate fortress of Stratum XI (Y. Aharoni 1981). However, Arad XI, being a Late Iron IIA stratum, postdates the 10th century BCE timeframe of Sheshonq I's campaign. As such, Arad XII must be the settlement mentioned by Sheshonq (Finkelstein 2002; Mazar and Netzer 1986). Since the ceramics of Arad represent the culture of the Early Iron IIA period, this link provides a chronological and typological anchor for both the dating of Arad XII and the campaign of Sheshonq I in the 10th century BCE.

The ceramics of Arad were preliminarily published (Y. Aharoni and Amiran 1964; Y. Aharoni 1967; 1968; M. Aharoni 1981; Herzog et al. 1984) before being reinterpreted (Singer-Avitz 2002). Some discussion of the Iron Age IIA assemblages (those from Strata XII and XI) can be useful for the purposes of comparison with ceramics from Faynan. Generally, the ceramics of Arad XII parallel Beersheba VII, Tel Masos II, and Lachish , while Arad XI parallels Lachish IV and Tel Beersheba V-IV, though generally the assemblages are similar (Singer-Avitz 2002). Red-slipped and burnished bowls are present in these strata, though are more common in Stratum XI (Singer-Avitz 2002). An important difference in cooking pot style also serves to differentiate the two strata. In Stratum XII, a cooking pot with an inverted straight rim is present, while a cooking pot with a grooved rim becomes popular in Stratum XI. Similarly, no Amphoriskoi are found in Stratum XII but are present in Stratum XI (Singer-Avitz 2002). Another important type for comparative purposes is the presence of cup-spouted jars. Storage jars in general are rare in Stratum XII, and cup-spouted jars with spouts laying flush against the shoulder of the vessel appear for the first time in Late Iron IIA Stratum XI. Later, Iron IIB strata at the site also feature a relatively standardized type of cup-spouted jar with a cup spout connecting at the rim of the vessel and with three loop handles (Singer-Avitz 2002). This difference has chronological significance (Herzog and Singer-Avitz 2004), discussed in greater detail below. In general, the ceramics of the Early Iron Age of Arad are some of the most critical for differentiating the early and late phases of the Iron IIA period (Herzog and Singer-Avitz 2004).

4.7.5 ‘En Hazeva

‘En Hazeva—alternatively known as Mezad Hazeva or with alternate spellings Hazeva or Hatzeva—is an important site in the Wadi Arabah only ca. 20 km northwest of Faynan. The site was likely an important trade outpost during the Iron Age (Singer-Avitz 1999: 57). ‘En Hazeva was reported on by a number of early scholars, including (Musil 1907: 207–209), Frank (1934: 254–255), and Glueck (1935: 17–20, 115), before being excavated by Cohen and Yisrael (1995; Cohen 1991, 1994) who have not published a final report on the site. The site features six occupation levels, ranging from the Early Iron Age 10th century BCE to the Late Byzantine and Early Islamic Periods of the 6th and 7th centuries BCE (Cohen and Yisrael 1995: 223). The first three strata at the site, Strata 4, 5, and 6, consist of Iron Age fortresses. The Stratum 4 (7th-6th centuries BCE) fortress is exposed on its eastern side and features two ca. 11x11 m towers (Cohen 1994; Cohen and Yisrael 1995: 224). This stratum also features a very significant Edomite shrine with seven stone altars and many ceramic objects including stands, incense burners, and chalices (Cohen and Yisrael 1995: 224). Finkelstein (1992b) has suggested that this type of shrine, also present at Horvat Qitmit, may represent a shrine along trade routes from Arabia. Stratum 5 at ‘En Hazeva, representing the 9th-8th centuries BCE, consists of a 100 x 100 m casemate fortress with an inner fortress, well-exposed through excavation. The excavators argue that the gatehouse of the fortress of this stratum bears similarity to that of Tell el-Kheleifah and Tel Jezreel (Cohen and Yisrael 1995: 229). Ussishkin (2010) has argued that the remains of walls at the site represent foundations rather than walls, suggesting the existence of mudbrick walls above the foundation, and compares the gatehouse of the site to those at Megiddo IVA and Lachish IV-III. Furthermore, the ca. 1 ha size of the fortress leads excavators to suggest that the Stratum 5 site, which also features well-preserved granaries, is a fortified city rather than exclusively a fortress (Cohen and Yisrael 1995: 229). Finally, Stratum 6 at the site apparently dates to the 10th century BCE and consists of a rectangular structure of ca. 13x11.5 m bearing similarity to the “Negev Fortresses” (Cohen and Yisrael 1995: 229). Excavation of this stratum also recovered a complete Negebite Ware vessel, providing another link to the Negev sites at which these ceramics are common (Cohen and Yisrael 1995: 229). Overall, “very little is known about the unique and important site of ‘En Haseva” due to the lack of a final publication on the site (Ussishkin 2010: 252). However, it is likely that the 10th century BCE Stratum 6 played an important role in the copper exchange networks active in the region at the time, similar to the contemporaneous Negev Fortresses.

4.7.6 Lachish (Tell ed-Duweir)

Lachish is a key site in the Iron Age Kingdom of Judah. The site is mentioned in the Bible, leading to extended debates over which site is to be identified as biblical Lachish (Albright 1929; Beyer 1931; Kellermann 1978; Ahlström 1980, 1983, 1985; Davies 1982, 1985). However, the site today is identified with Tell ed-Duweir located in the Shephelah region (Ussishkin 2004). The site is perhaps most famous for its destruction at the hands of the Neo-Assyrian campaign led by Sennacherib in the Late Iron Age. However, the Early Iron Age is the more relevant period for comparison with sites in Faynan. Lachish experienced an occupation gap in the Iron I period, but the site was reoccupied in the Early Iron IIA period, represented by Stratum V (Ussishkin 2004). Despite several excavation campaigns at the site, few remains can be concretely associated with Stratum V at the site. Later strata feature Palace Forts, but Stratum V apparently does not (Ussishkin 2004). As such, Lachish during the early Iron Age was likely a small site of ca. 3-4 ha, occupying only the northeast part of the mound, though fortified by a city wall (Garfinkel et al. 2019). However, Finkelstein (2020) has challenged the interpretation of Lachish V being fortified by a city wall, instead preferring an explanation for this newly-discovered wall as a Stratum IV revetment. Garfinkel (et al. 2019) also provide radiocarbon dating that would suggest that this Early Iron IIA stratum was constructed in the 10th century BCE, though ceramic analysis — to be taken with a grain of salt — suggests a date in the 9th century BCE (Ussishkin 2004; Zimhoni 2004).

Stratum IV at Lachish, considered a Late Iron IIA layer, represents an enormous development in the size and complexity of the site. At the outset of Stratum IV, the site was fortified with city walls, a monumental gate, and a “Palace-Fort.” These fortifications are the most substantial Iron Age fortifications of the entire region, and indeed the Palace-Fort is the largest Iron Age structure yet found in Israel (Ussishkin 2004: 79, 81). This construction represents a transition of the site into a Judean fortress intended to protect Judah from incursion from the southwest. The significance of the fortress and its architecture has been used to argue for a substantial level of organization and centralization required, suggesting that the fortress represents a *terminus ante quem* for Judean statehood (Jamieson-Drake 1991; Ussishkin 2004). As such, the dating of this Strata is quite significant. On the basis of ceramics, Zimhoni (2004) suggests a date in the mid-9th century BCE for the founding of the fortress, meshing with recent radiocarbon results (Garfinkel et al. 2019).

The ceramics of Lachish, given the controversy over the chronology and significance of layers during the archaeological periods Early Iron IIA and Late Iron IIA, are quite significant to the overall picture of the site. However, using the ceramics as a chronological indicator is challenging, and “it is impossible to propose absolute dates for Levels V and IV at Tel Lachish and the vessels found at them and at other sites in the region” (Zimhoni 2004). Still, the Early Iron IIA/Late Iron IIA divide can be elucidated on by study of the corresponding Strata V and IV at Lachish, despite the similarity between their respective ceramic assemblages. In fact Lachish is one of only three sites in Judah with strata that can be clearly associated with the Early Iron IIA and the Late Iron IIA (Herzog and Singer-Avitz 2004). Perhaps most notable among the ceramics of these Iron IIA layers is the widespread presence of red slip and burnish among the bowls recovered. In Stratum V, 80% of bowls featured surface treatment, while in Stratum IV, 72% were treated. The bowls of these strata are generally “hand burnished,” indicating that they were irregularly burnished rather than smoothly and continuously burnished on a wheel (Zimhoni 2004: 1675). By Stratum III at the site, an Iron IIB stratum, only 25-30% of bowls were slipped (Zimhoni 2004). As such, overall, the evidence from Lachish indicates that red-slipped and burnished bowls are very characteristic of the Iron IIA, though this decoration does continue later into the Iron Age. Zimhoni (2004) in her analysis applies a similar method to that of Singer-Avitz in looking for key identifying types that can differentiate between the two strata with similar material culture. Of these, bowl types and decoration styles are particularly significant, as are changes in cooking pots and storage jars (Zimhoni 2004). Beyond these significant types, Lachish

Stratum IVB also features two fragments of cup spouts (Fig. 25.32:12; 25.33:14) and a more complete cup-spouted jar (Fig. 25.44:10), a significant type discussed in further detail below.

4.8 Other Evidence of the Copper Exchange

The sites discussed above provide important indirect evidence of the Early Iron Age copper exchange and its relationship to social complexity. This indirect evidence complements a limited but growing corpus of direct evidence for the destination of copper produced in the Wadi Arabah at sites like Khirbat al-Jariya, Khirbat en-Nahas, and Timna. The range of sites at which copper sourced to the Wadi Arabah has been found reflects a flourishing interregional trade network during the Early Iron Age (Figure 4.7). Based on sourced copper, two trade routes are apparent: exchange to Egypt and a widely used coastal/maritime trade route that dispersed copper to many sites across the Southern Levant and beyond.

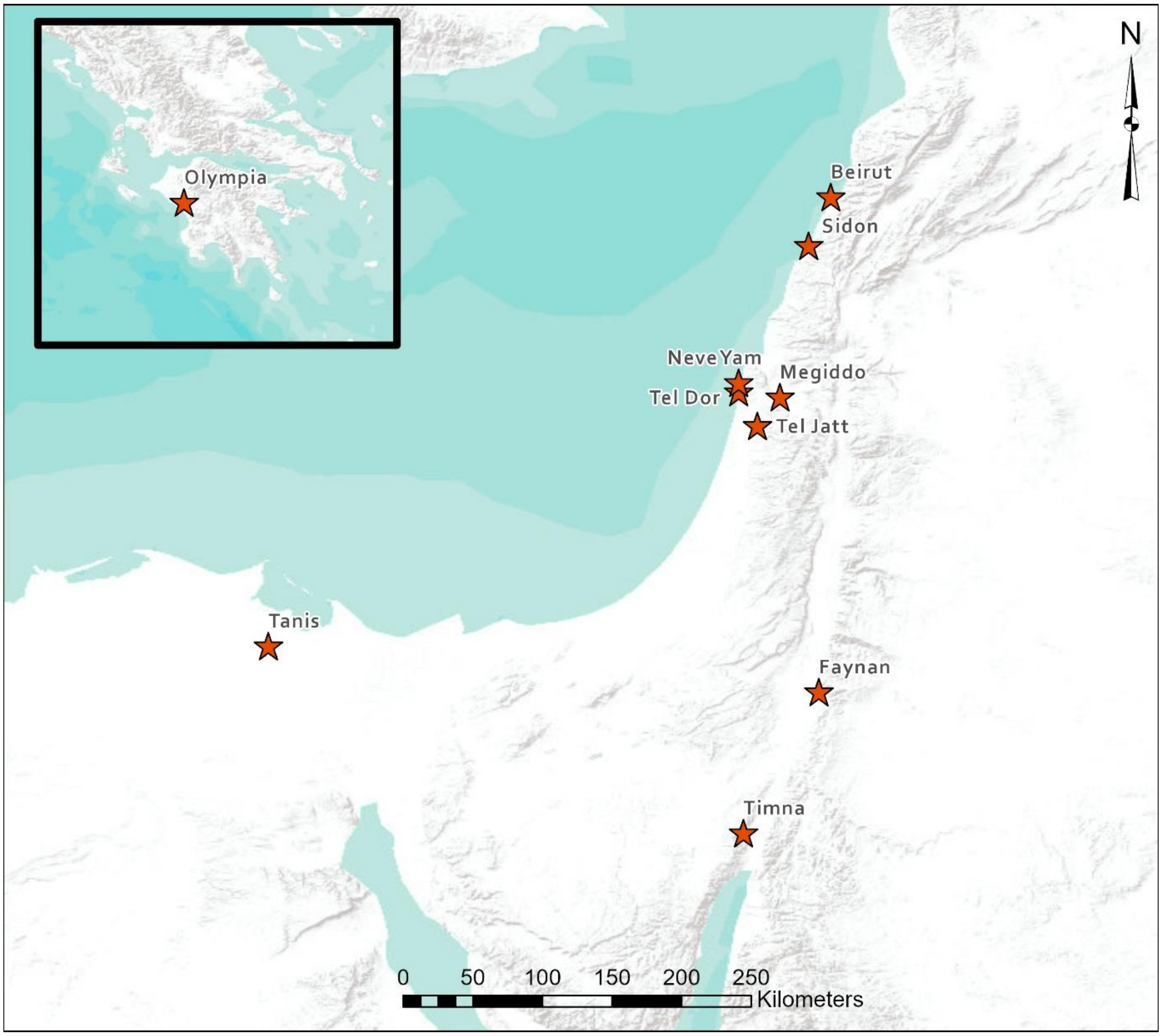

Figure 4.7: The sites at which Iron Age copper artifacts have been found and sourced to the Wadi Arabah via lead isotope analysis.

The exchange of copper produced in the Wadi Arabah has long been suspected but only recently evidenced through lead isotope analysis. As discussed above, Tell el-Qudeirat (Kadesh Barnea) and the Negev fortresses have been linked to the copper trade as a waystations on the way to Egypt from Faynan on the basis of circumstantial evidence (Ben-Dor Evian 2017). However, new evidence has verified the existence of trade routes between the Wadi Arabah copper districts and Egypt. Lead isotope analysis of *ushabtis* (Egyptian servant statues), apparently from the tomb of Egyptian pharoah Psusennes I in Tanis has revealed that several—and possibly all—of these late 11th century BCE artifacts were produced with copper from the Wadi Arabah (Ben-Dor Evian 2021; Vaelske et al. 2019b). Interestingly, these artifacts seem to predate settlement at Tell el-Qudeirat, though they are contemporaneous with copper production at Timna and in Faynan (Ben-Dor Evian 2021; Ben-Yosef et al. 2012, 2019; Levy et al. 2014b; Liss et al. 2020). One possible resolution to this apparent contradiction is that Arabah copper may have been traded via maritime routes to Egypt (Vaelske et al. 2019b). In general, these lines of isotopic evidence suggest that copper production prior to the 10th century BCE met demand of the Egyptian Third Intermediate Period. The importance of Arabah copper to Egyptian society likely remained paramount, as increasing evidence suggests that Egyptian Pharoah Sheshonq I conducted his raid into the Levant in part to retain control over copper production in the region, resulting in a restructuring of the industry (Ben-Yosef 2010: 881-923; Ben-Yosef et al. 2012; Levy et al. 2008, 2012; Sapir-Hen and Ben-Yosef 2013). However, no isotopic evidence yet corroborates a continued trade with Egypt into the late 10th and 9th centuries BCE.

The second trade pattern evident from lead isotope analysis of Iron Age copper artifacts is a maritime trade along the Mediterranean coast of the Levant. Several lines of evidence combine to clearly indicate a maritime exchange network. First, Yahalom-Mack (et al. 2014) associated eight ingots recovered from a shipwreck off the northern coast of present-day Israel near Kibbutz Neve Yam (Galili 1984; Galili et al. 2011; Galili and Sharvit 1999) with the copper ores of the Wadi Arabah, likely those in Faynan. The shipwreck was dated to the 2nd or 1st millennium BCE based on anchor typology (Galili and Sharvit 1999). The identification of copper from Faynan narrows the date of this shipwreck to the 12th to 9th centuries BCE, the periods during which copper production in Faynan occurred. These ingots illustrate that Faynan copper was exchanged via maritime routes along the Mediterranean coast. Other sourced copper artifacts illuminate the extent of Phoenicians involvement in this trade network. Copper artifacts from Tel Dor, found to be consistent with Arabah ores based on lead isotope analysis (Yahalom-Mack and Segal 2018b), suggest that this coastal site was a key node in the exchange network. Similarly, the sourcing of copper artifacts from Sidon and Beirut provides evidence of the involvement of these Phoenician sites in maritime copper exchange and the geographical extent of the trade network (Vaelske and Bode 2018-2019; Vaelske et al. 2019a). Though it is conceivable that copper sourced to the Wadi Arabah from the late 11th-early 10th century BCE Tel Jatt hoard (Artzy 2012; Stos-Gale 2006) and late Iron I Stratum VIA Hoard 12/Q/76 at Megiddo (Eliyahu-Behar and Yahlom-Mack in press; Hall 2021; Yahalom-Mack et al. 2017) could have reached these sites via overland trade routes, it is likely that these artifacts also relate to the Phoenician maritime trade (Artzy 2006: 23, 75). These Early Iron Age copper artifacts also provide an interesting point of comparison for 11th century activity in Faynan. Finally, maritime exchange of Faynan copper is also demonstrated by Kiderlen's (et al. 2016), analysis of 11 tripod cauldrons cast in Olympia, Greece between 950 and 750 BCE. The results of this study indicates that these 11 cauldrons contain copper from the ores of Faynan (Kiderlen et al. 2016). Thus, copper must have been traded through maritime routes, likely along the coast of the Northern Levant and Anatolia, to reach Olympia (Kiderlen et al. 2016). These studies provide an important comparative basis for study of ceramics from Faynan, given the likelihood of existing trade routes between Faynan and the Mediterranean Coast. In total, these sourced artifacts indicate that copper produced at Faynan and Timna was traded over long distances to the Mediterranean coast and major sites in the Southern Levant. The route that copper exchanged in these networks took to the Mediterranean coast is addressed by the analysis presented below.

4.9 Conclusions

The discussion of the sites and regions above provides important context for understanding the role inhabitants of Khirbat al-Jariya (KAJ) played in interregional exchange networks during the Early Iron Age. Taking a broad perspective on the evidence presented here allows for the observation of a few main trends. First, the evidence is clear that copper production in Faynan, centered at Khirbat en-Nahas (KEN), spanned the 12th to 9th centuries BCE, peaking in the 10th to 9th centuries BCE, largely the Iron IIA Period (Levy et al. 2014b). This dating, though contested (Finkelstein 2005; Finkelstein and Singer-Avitz 2008, 2009; Finkelstein and Piasetzky 2008; Kefafi 2014; Tebes 2021; Van der Steen and Bienkowski 2006), is well-evidenced through the publication of 108 high-precision radiocarbon dates (Levy et al. 2014b) as well as ceramic evidence (Smith and Levy 2014). Thus, KEN likely played a central role in an Early Iron Age regional network of sites that prominently included, among other sites, Rujm Hamra Ifdan (RHI), Khirbat al-Jariya, and Khirbat al-Ghuwayba (Ben-Yosef and Levy 2014a; Liss et al. 2020).

In addition, the ceramics of KEN and RHI-A can be compared to the assemblages of Late Iron Age Edomite sites, including Busayra (Bennett 1974, 1975, 1977, 1983), Tawilan (Bennett 1984; Bennett and Bienkowski 1995), and Umm al-Biyara (Bennett 1966). The ceramics of Edomite highland sites have been well-studied by scholars such as Oakeshott (1978, 1983), Mazar (1985, Hart (1989; 1992; 1995a), Zeitler (1992), Pratico (1993), Bienkowski (and Oakeshott 2011; et al. 2002), and Tebes (2011), even if the overall assemblage is not as well-known as those of sites on the western side of the Jordan River. As Smith and Levy (2014) argue, the KEN assemblage contains parallels and precursors to the types of ceramics found at these later sites in the traditional highlands of Edom. This proposal, though not the main focus of the analysis presented below, is addressed through the analysis of the assemblage from KAJ described below.

The ceramic evidence from KEN and RHI Sounding A, in comparison to sites in the highlands of Jordan and RHI Sounding B, also establishes an important baseline for comparative analysis of Early Iron Age assemblages from Faynan both in terms of quantitative and qualitative study. The KEN assemblage suggests that certain areas at the site, including Areas R and T, were occupied by elites who had access to fine, imported ceramics, including red-slipped and burnished bowls likely imported from the Negev (Smith and Levy 2014; Smith et al. 2014b). Thus the ceramics of KEN provide a basis for comparison with Iron IIA sites in the Negev—both the so-called “Negev Fortresses” and other contemporaneous sites such as Tell el-Qudeirat, Tel Beersheba, Tel Arad, and others. Relatively high rates of handmade ceramics in both Faynan and the Negev Fortresses suggest a link between these two regions, as does the presence of imports from the Negev at KEN (Cohen and Cohen-Amin 2004; Martin and Finkelstein 2013; Martin et al. 2013; Smith and Levy 2014; Smith et al. 2014b). However, these links are not enough to substantiate Finkelstein's (1984, 1995; 2003, 2005; Fantalkin and Finkelstein 2006; Finkelstein and Piasetzky 2008) contestation that the Negev Highlands sites were part of a "desert chiefdom" centered at Tel Masos that also controlled copper production in Faynan. However, the metallurgical evidence from Tel Masos on which this argument is partially-based is not entirely convincing (Artzy 2003; Kempinski and Fritz 1983; Yahalom-Mack 2010: 272-3). Evidence seems to suggest that Tel Masos operated as a trade outpost rather than the center of a large copper-producing polity (Ben-Dor Evian 2017; Ben-Yosef 2010; Singer-Avitz 2008). However, the question of whether copper production in Faynan was locally or externally controlled is subjected to testing on the basis of ceramic evidence from Khirbat al-Jariya, discussed below. Also tested here is the hypothesis that copper produced in Faynan was primarily traded through the Negev, a proposal that has been addressed based on ceramic evidence from the Negev sites (Martin and Finkelstein 2013) and evidenced though not formally tested by the study of the KEN assemblage (Smith and Levy 2014; Smith et al. 2014b). Overall, the Iron Age sites and ceramic traditions discussed in this chapter help to provide a social framework in which we can understand occupation and copper production at Khirbat al-Jariya. Addressing the relationships between KAJ and these sites and regions is critical for understanding exchange networks and elites involvement therein during the Early Iron Age.

Chapter 5: Hypotheses and Correlates

Knowledge of the past cannot not be known objectively but rather must be inferred (Trigger 2008: 508). The inferences made by different archaeologists will necessarily be biased as different observers record and perceive even archaeological “facts” in different ways (Clarke 1968: 19). However, rather than rendering archaeological analysis meaningless, the subjectivity of even “facts” only reinforces the importance of systematic examination of interpretations (Trigger 2008: 518) Thus, the study of archaeological data can benefit from rigorous analysis and testing (Clarke 1968). Such testing can be done through the use of “conditional statements of relationship between two or more variables that have empirical references,” i.e. hypotheses (Clark and Abbot 2018). Archaeological hypotheses are evaluated through “test implications,” which are the archaeological correlates of the proposal (Clark and Abbot 2018). This section presents the hypotheses that are tested through the analysis presented below. Primarily, the hypotheses focus on four main aspects: the presence of elites in Area B of Khirbat al-Jariya, local control of society and the copper industry in Faynan, the exchange routes of copper, and the role of the copper exchange in developing social complexity.

Table 5.1: Hypotheses tested in this study and expected results.

Hypothesis	*Alternate Hypothesis*	*Method(s) of Testing*	*Expected Results Assuming Hypothesis*	*Expected Results Assuming Alternate Hypothesis*
Area B Building 2 Contains an Elite Context	Building is a non-elite residential or industrial context	Study of serving/food preparation vessels; comparative study of ceramics from Building 2 with elite contexts at KEN and non-elite contexts at KAJ	More serving vessels than food preparation vessels. Ceramics from Building 2 are finer than those found in Areas A and C at KAJ. Building 2 ceramics will bear similarity to elite contexts at KEN	Substantial presence of food preparation vessels. Ceramics from Building 2 are not noticeably finer than those from other Areas at KAJ. Parallels in the Area B assemblage are to non-elite contexts
Local Organization of Society and Copper Production	Tel Masos-based organization	Petrographic Analysis Typological Analysis	Local clays used to produce ceramics. Homogeneous assemblage. Assemblage similar to KEN, "local Edomite" assemblage	Homogeneous assemblage. Tel Masos imported ceramics, many parallels to Tel Masos, especially in elite contexts.
Trade of copper primarily through Negev	Trade of copper primarily through other regions, such as north to Moab or south to present-day Saudi Arabia	Ceramic Analysis , Petrographic and Typological	Similarity of ceramics between Faynan and sites in the Negev and coastal plain, possible sourcing of Faynan ceramics to Negev	Dissimilar ceramics between Faynan and Negev, few ceramics sourced to Negev. Greater similarity in assemblage to another region, ceramics sourced to other regions.
Trade Catalyzed Social Complexity	Trade did not catalyze social complexity	Comparative study of Faynan ceramics from elite and non-elite contexts to other regional assemblages	Evidence of "elite" foods, fine serving vessels used to reinforce social status of elites in elite contexts	Locally-produced ceramics, no evidence of "elite" foods at the site.

Hypothesis 1: The central rooms in Building 2 in Area B at Khirbat al-Jariya represent an elite context

Test Implication 1: “Elite foods,” especially those that are rare, imported, or require high effort to produce or obtain, will be present in Building 2 but not elsewhere at the site (cf. Turkon 2004: 227)

Test Implication 2: There will be a lack of evidence for food preparation in the central rooms of Building 2, reflecting the spatial differentiation of cooking (Gumerman 1997; Turkon 2004)

Test Implication 3: There will be a higher proportion of serving vessels in the central rooms of Building 2 than in other parts of the site (cf. Brumfiel 1987; Garraty 2000; Hirth 1993; Turkon 2004). These vessels will be more likely to be decorated fine-wares (cf. Smith 1983; Rice 1987: 236-240; Singer-Avitz 2016: 508).

Test Implication 4: Imported ceramics will be disproportionately common in the central rooms of Building 2 (cf. Smith 1987).

Test Implication 5: The ceramics of the central rooms of Building 2, the hypothesized elite context, will bear similarity to the assemblages of Areas R or T, elite contexts at the nearby site of Khirbat en-Nahas.

The first hypothesis tested is the proposal that Building 2 in Area B represents an elite context. Excavation at Area B in 2014 intended to test whether or not the structure was an elite or administrative complex comparable to Areas R or T at Khirbat en-Nahas (Liss et al. 2020: 417; Levy et al. 2014). However, initial results of the excavation, not factoring in ceramic evidence, characterized the structure as industrial rather than residential or administrative (Liss et al. 2020: 423). Thus, the present study tests whether or not the central rooms (primarily Rooms 1 and 3, and to a lesser extent the partially unexcavated eastern side of the structure) in Building 2 should be considered an elite context occupied and used by high-status individuals at the site. The presence of elites in Building 2 would likely be reflected in the material culture of the site in a number of ways, providing avenues for the testing of this hypothesis. First, as discussed above, foodways can provide important insight into social status (Appadurai 1981; Turkon 2004). This is true at copper production sites in the Wadi

Arabah where evidence of smelters' diets has been used to interpret their social status (Ben-Yosef et al. 2017; Muniz and Levy 2014; Sapir-Hen and Ben-Yosef 2014; Sapir-Hen et al. 2018). Generally, speaking, elites have access to high-quality foods that are rare, imported, or require high effort to produce or obtain; these foods can come to symbolize status (Turkon 2004; Hastorf 2003). Thus, if the central rooms at KAJ were used by high-status individuals, we would expect to find evidence that such foods were exclusively available to occupants of the structure and not present elsewhere at the site. The importance of foodways in testing social status includes evidence of food preparation and consumption, both of which are highly-significant. Given the difficulty of food preparation, elites often prefer to outsource food preparation, meaning that food preparation contexts can be spatially differentiated (Gumerman 1997; Haviland and Moholy-Nagy 1992; Hendon 1996; Turkon 2004). This has two implications, both of which can be tested through ceramic evidence at KAJ. First, if elites are present in the central rooms of Area B, we would expect this context to feature a relative lack of evidence for food preparation. A corollary to this expectation is that food preparation areas might be found in other, non-elite contexts. Second, the presence of high-status individuals in Area B would also imply that this context would have a relatively high rate of serving vessels, which themselves are disproportionately likely to be decorated (cf. Brumfiel 1987; Garraty 2000; Hirth 1993; Rice 1987:236-240; Singer-Avitz 2016: 508; Smith 1983; Turkon 2004). These two test implications of the presence of elites in Area B are considered in this study. Moreover, were elites present at KAJ in Area B, these contexts would be expected to have higher rates of fine imported ceramics than other parts of the site (cf. Upham 1982). Similarly, if Building 2 is indeed an elite context, its ceramic evidence would be expected to parallel the assemblages of elite contexts at the contemporaneous nearby site of Khirbat en-Nahas, especially Areas R and T.

Hypothesis 2: Society and copper production at Khirbat al-Jariya was organized locally

Test Implication 1: Form analysis of ceramics from Khirbat al-Jariya will reveal more parallels to the assemblage of Khirbat en-Nahas (Smith and Levy 2014), demonstrating shared ceramic traditions reflective of a community of practice (cf. Roux 2016; Lave and Wenger 1991; Wenger 1998).

Test Implication 2: Petrographic analysis of ceramics from Khirbat al-Jariya will demonstrate the homogeneity of the assemblage both internally and by comparison to ceramics from Khirbat en-Nahas in terms of clay choice and technological traditions. This would illustrate that technical traditions of the chaîne opératoire were shared within one social group (cf. Roux 2016).

The second hypothesis tested is that the copper industry of Faynan was locally controlled and was not subject to the authority of a Tel Masos-centered polity as suggested by Finkelstein (2005; Fantalkin and Finkelstein 2006; Finkelstein and Piasetzky 2008: 89). This hypothesis can be tested through study of the chaîne opératoire of ceramic production in Early Iron Age Faynan. As discussed above, each decision made in the process of ceramic production is also socially and possibly ideologically meaningful (Albero 2014: 57; Sillar and Tite 2000). The examination of the combined processes of production can shed light on social groups as technological traditions are passed down within social groups; these are "communities of practice" (Lave and Wenger 1991; Roux 2016, 2019; Wenger 1998). Thus, if Iron Age society and copper production in Faynan was the result of local processes of sociopolitical development rather than external control or organization, we would expect a great similarity in ceramic technology at the local level. More specifically, we would expect that if production in Faynan was locally controlled, that the ceramic forms found at KAJ would primarily reflect similarity to assemblages at other Early Iron Age sites in Faynan, most notably KEN. These parallels would suggest shared techniques and a similarity in chaîne opératoire—and therefore social organization—between the two sites. Petrographic analysis can also shed light on the consistency of the KAJ assemblage in comparison to itself and the ceramics of KEN. A society organized locally would likely be reflected in a homogeneous assemblage (cf. Roux 2016), which often feature local clays and a consistency in technology. Thus, were society organized locally, the majority of ceramics should be composed of local clays, similar to the assemblage at KEN (cf. Smith et al. 2014b), and feature similar technical traditions such as tempering and clay processing. On the other hand, were society and production at KAJ organized by an external entity, such as a Tel Masos chiefdom, one would expect the ceramic evidence vis-à-vis the chaîne opératoire to present itself differently. Tel Masos is not located in the same geological environment as Faynan (Crouvi et al. 2017; Sneh 1998). Thus, if one were to assume that inhabitants of Tel Masos were part of the same social group as the occupants of KAJ, one would expect to see ceramics recovered from the latter site produced with non-local raw materials though produced in a similar tradition (cf. Roux 2016; Roux 2019). This would be reflected in parallels in forms between KAJ and Tel Masos. Alternatively, were KAJ controlled by a foreign population at Tel Masos, one would expect to see a heterogeneous assemblage at KAJ, with different technical traditions reflected in ware forms and fabrics (cf. Roux 2016; Roux 2019). Thus, analysis of the chaîne opératoire as applied to the ceramics of KAJ can facilitate the testing of the hypothesis of local control.

Hypothesis 3: Copper was exchanged primarily through the Negev Desert

Test Implication 1: Imported ceramics will primarily come from the Negev.

Test Implication 2: Ceramics at KAJ will have a higher rate of typological and petrographic parallels with assemblages from the Negev than sites from other regions, particularly Moab and the Hejaz.

The third hypothesis addressed tests the idea that copper would have been traded from Faynan through the Negev desert, via the Negev Fortress sites, on its way to the Mediterranean (Martin and Finkelstein 2013; Martin et al 2013; Shahack-Gross and Finkelstein 2008: 980) or Egypt (Ben Dor

Evian 2017; Ben-Yosef and Sergi 2018). These suggestions accord with evidence from lead isotope analysis of Early Iron Age copper artifacts sourced to the Wadi Arabah (Artzy 2006, 2012; Ben-Dor Evian et al. 2021; Eliyahu-Behar and Yahalom-Mack in press; Hall 2021; Kiderlen et al. 2016; Stos-Gale 2006; Yahlom-Mack and Segal 2018a, 2018b; Yahalom-Mack et al. 2014, 2017). Another suggestion for the movement of copper has been made by Finkelstein and Lipschits (2011: 146), who proposed that copper would have also been exchanged north along the King's Highway through the polity of Moab, bringing it prosperity, on its way to "Damascus and beyond." Thus, the hypothesis that copper was predominantly traded westward through the Negev is tested against the alternative that substantial amounts of copper were exchanged along different trade routes, whether that be north through Moab or even south through the Hejaz. Regardless of the destination, a trade of potentially thousands of tons of copper would presumably have brought other trade goods in return. Thus, by studying the material evidence at KAJ, it should be possible to understand the exchange networks in which occupants of the site participated. Were copper traded primarily through the Negev, we would expect the ceramics of KAJ to reflect this trade in two ways. First, imports found at KAJ would likely largely come from the Negev, as participation in an active trade network would likely have brought ceramic imports. This premise is supported by the presence of many ceramics petrographically sourced to the Wadi Arabah, and likely Faynan, recovered from Negev Highlands sites (Martin and Finkelstein 2013; Martin et al. 2013). It is possible that the import of foodstuffs, whether "elite" foods or staple goods imported to supplement diet or mitigate subsistence risk, to Faynan in exchange for copper would also leave traces in the ceramic vessels possibly used to carry or store these goods. Demonstrating the importation of ceramics from the Negev through petrographic study would thus further corroborate the importance of a trade between these two regions. The second test implication of the hypothesized exchange of copper primarily westward through the Negev would be the existence of typological and petrographic parallels between KAJ ceramics and those of Negev sites. The founding of the Negev Highlands sites has been proposed to have come about through the sedentarization of pastoral nomads who were likely affiliated with copper producers in Faynan and Timna due to the economic opportunities provided by a flourishing copper trade (Finkelstein 1984; 1995; Fantalkin and Finkelstein 2006; Martin and Finkelstein 2013; cf. Finkelstein and Perevolotsky 1990). If indeed occupants of these sites were part of the same pastoral nomadic social group as residents of copper producing sites in Faynan, we would expect that this would be reflected in their ceramic wares. As discussed above, ceramic technical traditions are taught and shared within social groups (Lave and Wenger 1991; Roux 2016, 2019; Wenger 1998). As such, the identification of a similar chaîne opératoire, identified through typological and petrographic parallels, at KAJ and sites in the Negev would suggest a shared social affiliation between Iron Age sites in the two regions. Similarly, the identification of parallels between KAJ and sites in Moab or elsewhere would be cause for further study of exchange with those regions.

Hypothesis 4: Long-distance exchange served as a catalyst of social complexity at Khirbat al-Jariya and Iron Age Faynan

Test Implication 1: Evidence of imported, high-quality foodstuffs are present in elite contexts at Khirbat al-Jariya but not other parts of the site.

Test Implication 2: Imported, high-quality ceramics are present in elite contexts at Khirbat al-Jariya but not other parts of the site.

The fourth hypothesis tested is that long-distance exchange of copper played a significant role in the development of social complexity in Faynan during the early Iron Age. The excavation of the largest extant structure at Khirbat al-Jariya, Building 2 in Area B, was intended to shed light on social organization and political control of copper production at the site. The preliminary results of excavation, not considering ceramic evidence, were inconclusive (Liss et al. 2020). However, as discussed above, ceramic analysis has the potential to shed light on the presence of elites at the site. Ceramic evidence can also provide evidence on the development of social complexity and inequality.

The fossilization of inequality depends on the ability of elites to continually legitimize their authority, which can be done through ideology and a process of interpellation of individuals into the system as subjects (Althusser 1971; Habermas 1975: 96). In the context of Iron Age copper production sites, we can interpret this two ways. First, the practice of crafting often takes on ideological significance as a sort of magical power realized through ritual (Helms 1993; Arnold 1987; Inomata 2001). This likely applied to copper smelting in Faynan, as elites' ability to extract valuable copper from ore legitimized their status and connection to supernatural forces (Ben-Yosef 2010: 20-23; cf. Budd and Taylor 1995; Sapir-Hen et al. 2018). This approach toward understanding inequality in Faynan relies on the role of production (cf. Hirth 1996), and the role of technological development in social complexity in the region has been well-studied (e.g. Ben-Yosef et al. 2019; Hauptmann 2007; Levy 2006; Levy et al. 2014). Second, elites in Faynan may have leveraged their exclusive access to exchange networks to reify and reinforce their status. The study of the ceramics of KAJ provides insight into foodways, allowing us to test this hypothesis. Elites may have imported rare or expensive foods as consuming these foods in highly-visible consumption ceremonies could have the effect of naturalizing their status (Appadurai 1981; Dietler 1981; Turkon 2004). This can be tested through the identification of ceramic vessels used to store or prepare such foods in elite contexts. Furthermore, elites may have exploited exchange networks for access to fine imported serving vessels, which could also be used in consumption ceremonies as a tangible reinforcement of elite status (Clark and Blake 1994; Garraty 2000). These imported serving wares can also be identified as a test implication through a combination of typological study—serving vessels often open, burnished or slipped fine-ware forms with flat bases (Smith 1983; Rice 1987:236-240; Singer-Avitz 2016: 508)—and petrographic analysis to examine the provenance of the vessels. Through these correlates, the hypothesis of whether or not elites in Faynan leveraged trade for their own aggrandizement can be addressed.

Chapter 6: Aerial Survey

6.1 Introduction

Low-altitude aerial photography (LAAP) is a powerful technique for obtaining new perspectives on sites.When applied in tandem with other techniques such as Image-Based Modeling (IBM) and GIS, LAAP can help develop new understandings of archaeological sites as well. These methods facilitate the high-resolution mapping of features at sites at levels of precision and accuracy that are otherwise challenging to obtain. As such, these methods can be used to produce new maps of sites, increasing their comprehensivity and quality. In this study, combined LAAP, IBM, and GIS-based mapping methods are applied to archaeological sites in the Faynan region in order to more fully understand the spatial extent of the remains of Iron Age society, regional copper production systems, and trade networks.

6.2 Low-Altitude Aerial Photography

LAAP is a technique with a long history in archaeology, dating as far back as 1906 when Lieutenant P.H. Sharpe took the first archaeological images from the air of Stonehenge from a war balloon (Capper 1907). Also notable was the early use of a balloon to image the site of Megiddo by P.LO. Guy in the 1930s (Guy 1932). In recent years, LAAP has been increasingly applied as a tool to obtain new perspectives on sites or to map them as archaeologists have again realized the need for cheap, efficient, and versatile methods of seeing their sites from above. More specifically, LAAP-derived imagery can be used for survey purposes, intra-site mapping, or producing high-quality publication photos (Reeves 1936; Crawford 1924; Verhoeven 2009; Bewley 2003; Musson et al. 2013; Myers and Myers 1992). Both oblique and vertical image styles can be useful to archaeologists. Oblique aerial images provide excellent overviews of sites and are well-suited for publication (Renfrew and Bahn 2000: 82-3). Vertical photography, on the other hand, can be useful for making measurements, acquiring publication-quality detailed shots for displaying relationships between archaeological contexts and, more importantly, for serving as the basis for drawing a top plan (Renfrew and Bahn 2000: 83). Vertical images, once georeferenced, are excellent bases for tracing or digitizing loci or architectural features (Sterud and Pratt 1975). This method of plan creation can drastically reduce the time needed to create top plans with traditional methods of drawing, which can take several weeks to produce and potentially months to digitize (Schlitz 2004; Levy and Smith 2007). Digitizing directly from georeferenced images can also simplify the workflow of creating top plans while retaining or improving accuracy and comprehensiveness of the plans (Quartermaine et al. 2013; Levy and Smith 2007). As such, digitization of features from georeferenced aerial images can represent an all-around methodological advance from traditional methods of top-plan generation in terms of efficiency, accuracy, and precision.

There are many viable platforms for capturing aerial images (Verhoeven 2009). Kites, balloons, and unmanned aerial vehicles (UAVs) are all applied in archaeology today as lift mechanisms for cameras. Kites have been a viable platform for LAAP since its early days (Deuel 1973: 33) and remain so today. Many types of kites specifically designed for aerial photography under different wind conditions exist, along with various systems for manipulating the kite and recalling it once photography is performed (Anderson 2001). However, the use of kites does depend on appropriate wind conditions, ideally 15-40 km/h (Aber and Aber 2002; Aber 2004). Lack of wind rules out kite aerial photography as an option, and inconsistent wind can result in an unstable platform and the potential for a costly crash.

UAVs/drones have been a popular option for LAAP in recent years (Hill et al. 2014; Hill 2019; Meyer et al. 2016; Smith et al. 2014). Many commercially-available UAVs today allow for automated flight in preplanned patterns, meaning that acquiring images at precisely the needed elevations and locations is a simple process, a significant advantage for LAAP. Tightly regulated flight patterns also facilitate the acquiring of images suitable for photogrammetric purposes (Eisenbeiss et al.

2005). However, UAVs also suffer from a number of limitations. UAVs may be limited or prohibited depending on the local legal jurisdiction (Hill 2013). UAVs usually cannot fly for longer than about 30 minutes without a battery change or recharge (Sauerbier and Eisenbeiss 2010). Furthermore, most affordable UAVs do not have customizable camera mounts or have limited payloads, though drones capable of carrying high quality cameras are increasingly available (Everaerts 2008; Campana 2017). While small yet high-resolution cameras are increasingly available, true digital single-lens reflex (dSLR) cameras are still impractical to mount on most UAVs. Additionally, UAVs often raise dust during take-off, landing, or flying at low altitudes, which may introduce unwanted dust into the attached camera. This issue requires specific countermeasures to avoid and may restrict LAAP at the lowest levels of flight over a site (Eisenbeiss et al. 2005). Finally, and perhaps most significantly, using UAVs involves a substantial risk of complete failure. UAVs are prone to crashing, especially at low altitudes (Everaerts 2008; Eisenbeiss et al 2005). These crashes can potentially damage or destroy the camera attached to the system, and may be extremely costly, both financially and in terms of opportunity in the field. However, despite these potential drawbacks, UAVs are becoming ever more cost-effective. This type of platform has become the gold standard of low-altitude aerial photography for archaeology even for projects with lower budgets (Wernke et al. 2014; Campana 2017; Hill 2019; Waagen 2019) and UAVs continue to be effectively used for archaeological purposes (Smith 2014; Homsher et al. 2017; Hill and Rowan 2017).

Another viable option for archaeological LAAP is the use of balloons. Balloons designed for LAAP come in varying shapes and sizes depending on use, from small weather balloons to large blimps (Aber 2004). Balloons can be flown and taken down with relative ease and can operate in the absence of wind. These systems also have the additional advantage of a level of fine manipulation not possible with kites, though lacking the precision in flight plans of UAVs. Balloons have no minimum elevation at which they can be flown (Myers and Myers 1992), meaning that the resolution of the imagery they can acquire is not limited by the system, but rather by the camera attached to the system, as the camera can be lowered to within inches of the ground. Balloon photography has become more viable since the efforts of Guy in the 1930s (Myers and Myers 1992) and has only become more practical with the development of digital photography and lightweight equipment. Today's memory cards can potentially store thousands of high-definition images, and digital photography means that images can be taken without regard to the cost of film. Furthermore, balloons can also remain in the air taking photographs for a period of up to several days (Aber 2004), a substantial advantage that means that any given flight session is only limited by the size of a memory card. These advantages of balloon photography give it a versatility and practicality that is unmatched by other forms of LAAP. Balloons are often less tightly regulated and are subject to fewer legal restrictions than UAVs. However, balloon photography suffers from limitations imposed by the cost and availability of helium, which may eliminate helium balloons as a viable option (Aber 2004). As a result, one must consider the logistical challenge of acquiring a supply of helium before selecting a balloon-based system. As mentioned above, balloons also lack the precision in flight-planning and image capture of UAVs, and may be more unwieldy to transport or deploy. However, ELRAP has effectively used a balloon on several field projects, taking advantage of the platform's advantages in camera quality/image resolution, flight time, and the limited risk of a crash.

6.3 Image-Based Modeling

6.3.1 Introduction

Image-based modeling (IBM) is a method of three-dimensional data collection based on the collection of many photographs taken of a target object from multiple directions. This technique applies principles of digital photogrammetry in order to produce 3D models from photographs. IBM is not the only technique for 3D data collection applied at archaeological sites; however, it is likely the most applied by archaeologists. The ubiquity of IBM on archaeological projects reflects its main attributes, especially its cost-effectiveness, efficiency in field recording, and ease of use (De Reu et al.

2014; Doneus et al. 2011: 84; Forte 2014: 13; Jorayev et al. 2016; Lambers et al. 2007; Magnani and Schroder 2015; Magnani et al. 2020; Quartermaine et al. 2014; Reshetyuk and Mårtensson 2016; Roosevelt 2014; Sapirstein 2016; Verhoeven 2011). Data collection for IBM requires only a basic digital camera and software and enough photographic data to produce a model can be collected in a manner of minutes (Olson et al. 2013; Lerma et al. 2010: 500; Magnani et al. 2020). Costs for cameras and computers can add to the overall price of using IBM, but often archaeological projects already have these technologies for other purposes, meaning that additional costs may be limited to the cost of the IBM software package (Howland et al. 2014). IBM software can also be very simple to use (Kjellman 2012: 23). The technology is usually not as precise or accurate as laser scanning but can be when carefully applied (Doneus et al. 2011: 84–5).

In addition to the generation of near-photorealistic 3D models, users of IBM software can also generate two-dimensional, GIS-compatible datasets such as digital elevation models (DEMs, digital representations of elevation across a landscape) and orthophotographs (vertical photographs corrected for lens and elevation distortion) (Lo 1973). These GIS datasets are enormously useful for archaeologists given the fundamentally spatial nature of the field. Ironically, archaeologists have been prone to preferring 2D spatial datasets over the 3D datasets they are derived from (Garstki 2020; Verhoeven 2017). Orthophotos provide a more accurate basis for digitization of architectural features than do georeferenced photos (Verhoeven et al. 2012). Orthophoto-based vectorization can produce extremely accurate and detailed top plans through the reduction of human error that takes place in measuring and hand-drawing features at a site or the reduction of lens or elevation distortion from uncorrected vertical images (Olson et al. 2013; Howland et al. 2014a; De Reu et al. 2014; Prins et al. 2014; Quartermaine et al. 2014; Peng et al. 2017). DEMs also provide a useful basemap for contextualizing sites and can be used to create contour lines within ArcGIS or other GIS software. IBM allows for the rapid (ca. 10 hours) production of high-resolution (ca. 5-10 cm) DEMs that would otherwise take days or weeks of valuable field time to produce with traditional methods of EDM survey, requiring hundreds or thousands of points (cf. Louhaichi et al. 2003; Harrison-Buck et al.. 2016). These datasets are also far higher resolution than satellite imagery, which is one of the few viable alternatives for the acquisition of sitewide GIS raster datasets like orthophotos and DEMs. The centimeter-level resolution of sitewide orthophotos compares very favorably to the ca. 35-50 cm resolution available from high-resolution satellites (Parcero-Oubiña et al. 2016; Pavelka et al. 2018). IBM-produced DEMs outperform satellite competitors by an even more drastic margin, as ca. 5-10 cm DEMs are an order of magnitude more precise than, for example, the 30 m resolution ASTER GDEM (Tachikawa et al. 2011). LiDAR-derived DEMs are more competitive on resolution but can be prohibitively expensive in areas where LiDAR coverage is not freely available (Howland 2018). As such, IBM can be an excellent method for archaeologists to produce high-quality GIS datasets for their sites.

6.3.2 Uses of Image-Based Modeling

The many use cases of IBM can be simplified, for the sake of discussion, into three essential categories: terrestrial, aerial, and artifact-based. (cf. Howland et al. 2014b; Olson et al. 2013; Roosevelt et al. 2015; Magnani et al. 2020). The former two will be discussed here; the third, applied to ceramics for this project, will be discussed below. Terrestrial applications of IBM often relate to the modeling of excavation units or specific contexts at archaeological sites (De Reu et al. 2013, 2014). Archaeologists have applied IBM for recording of excavation units because of the temporal efficiency of this approach and its benefits for accurate recording of archaeological features. These advantages mean that IBM can provide highly-accurate results without overly interfering with the hectic pace of many excavations (Olson et al. 2013; Howland et al. 2014a; De Reu et al. 2014; Roosevelt et al. 2015; Badillo et al. 2020). Generating 3D models from images taken from the ground is also likely the most cost-effective method of generating 3D data (Haukaas and Hodgetts 2016). The production of 3D models at various stages of excavation fulfills some of the important responsibility archaeologists have to record the maximum amount of information during fieldwork to ensure this information is not lost

(Magnani et al. 2020). The production of 3D models of excavated contexts results in an entirely new category of documentation of excavation documentation (Garstki 2020). Meeting this responsibility provides additional incentive for archaeologists to apply IBM for the generation of 3D models during excavation. However, importantly, IBM-based recording of 3D models should be considered a useful complement to traditional recording rather than a replacement for these methods (Campana 2017). In addition, archaeologists have often applied terrestrial IBM for the generation of orthophotographs suitable for the vectorization of features for top plan drawing, similar to the method of digitization based on georeferenced vertical imagery described above (Quartermaine et al. 2014: 115–7; Levy and Smith 2007: 53). Given these advantages, terrestrial IBM has become a popular approach toward documenting archaeological sites during active excavation (Olson et al. 2013; Howland et al. 2014a; De Reu et al. 2014; Peng et al. 2017; Roosevelt et al. 2015; Badillo et al. 2020). In total, terrestrial IBM can be seen as an important methodological advance for field recording, though not a paradigm shift for how we understand and interpret the ancient world (Howland 2018).

Aerial IBM, or the combination of techniques of LAAP and IBM, provides an even more exciting avenue of data collection at archaeological sites. By using LAAP to obtain a new perspective on excavation units and sites, archaeologists can produce 3D models at scale and resolution that are otherwise extremely challenging to achieve, as discussed above. Aerial applications of IBM are more often performed at a sitewide scale, where researchers have used the technique to collect sitewide orthophotos and DEMs for overall site mapping (Hill and Rowan 2017; Howland et al. 2014, 2015; Liss et al. 2020; Verhoeven et al. 2012) in addition to 3D models approaching photorealism (Olson et al. 2013; Quartermaine et al. 2014; Verhoeven et al. 2012). The GIS datasets at unprecedented resolution produced through these methods provide unique opportunities for intra-site GIS-based spatial analysis or volumetric analyses (Howland et al. 2018; Magnani and Schroder 2015; Jaklič et al. 2015; Fulton et al. 2016). Importantly, the sitewide models and GIS datasets produced through aerial IBM feature both coverage of entire sites and levels of detail facilitating the vectorization of individual stones or even sherd scatters (Howland et al. 2015; Parcero-Oubiña et al. 2016; Orenga and Garcia-Molosa 2019). Thus, the use of LAAP and IBM provides an incredible basis for site mapping and intra-site analysis.

6.3.3 Image-Based Modeling Methods

The exact approach of data capture for IBM must necessarily be adapted to the size and shape of the object of interest in each case, but the basic principles are similar regardless of exact approach. IBM requires that many (ranging from tens to thousands) photos be taken of the target and that each image share a considerable overlap with adjacent images (the user's manual for Agisoft Photoscan, one IBM program, suggests >60% overlap between images; Agisoft 2020). This is due to the fact that reconstruction of the object occurs through identification of the same point in multiple images. As such, any part of the object or area of interest must be present in at least two images in order to be reconstructed (Agisoft 2020). Quality reconstructions of objects or areas of interest depend on the acquisition of detailed images with comprehensive coverage of the target; however, expensive equipment is not required for generating viable 3D models. Best practices for data capture would include a DSLR camera with a fixed focal length lens shooting in RAW format, but results are also achievable with setups as simple as a cell phone camera or inexpensive point-and-shoot. Whatever the camera arrangement, acquiring comprehensive overlapping coverage is the most important factor in generating a complete and detailed model.

Once the photos are taken, processing IBM models typically consists of three or more main steps. First, an algorithm identifies "feature points" across multiple images by comparing their intensity and nearby points. By comparing these points with Exif data from the photograph, SfM software triangulates the location of points — as well as that of the camera — when the photograph was taken in arbitrary space. This process is known as results in the creation of a sparse point cloud. This stage is known as Structure from Motion (SfM; Ullman 1979). A dense point cloud, consisting of substantially more points, may be developed as a subsequent stage. In the second main step of IBM processing, the point cloud is used as the basis to form a mesh, a continuous 3D model constructed of polygons. In the last stage of model development, the images used to create the model are mosaicked or averaged onto the mesh to create a more-or-less photorealistic 3D model. IBM software packages typically contain one or all of these processing capabilities, with some programs also offering additional features such as the ability to edit models between stages or georeference the 3D model. The latter option is crucial for the use of IBM for production of GIS datasets.

6.4 ELRAP Low-Altitude Aerial Photography/Image-Based Modeling Campaign

6.4.1 ELRAP Low-Altitude Aerial Photography Methods

The application of low-altitude aerial photography (LAAP) on the Edom Lowlands Regional Archaeology Project (ELRAP) provides a case study of one method of data collection well-suited to creating a photorealistic, three-dimensional record of archaeological sites. Over the course of several field seasons, the ELRAP project developed a balloon system primarily intended to capture high-quality single images and a limited quantity of stereo pairs (Figure 6.1; Levy et al. 2010, 2014a: 40). This system was upgraded for the 2012 and 2014 field seasons of ELRAP as photography was now intended for the purpose of image-based modeling and photogrammetric mapping of these sites. During these seasons, members of the team conducted a campaign of balloon photography in order to capture high-resolution photography of many of the archaeological sites in Faynan, especially Iron Age sites. Sites recorded using these methods included Iron Age sites Khirbat en-Nahas, Khirbat al-Jariya, Khirbat al-Ghuwayba, and Khirbat Faynan, as well as Middle Islamic Period site Khirbat Nuqayb al-Asaymir, Neolithic site Wadi Fidan 61, and Nabatean site Petra (Howland et al. 2014a, 2014b, 2015, 2018; Levy et al. 2013; Liss et al. 2020; Burton et al. 2021). The team used either a 1-ply Kingfisher Aerostat K14U-SC balloon, with dimensions of ca. 3.6 m x 3.0 m, volume of ca. 21.0 m3, and lift of ca. 13.6 kg when fully inflated and a 1-ply Kingfisher Aerostat K10.5U-SC balloon, with approximate diameter of 2.29 m, height of ca. 1.56 m, volume of ca. 4.23 m^3, and lift of ca. 3.39 kg when fully inflated (Figure 6.1). In both cases, the balloon was tethered to a reel by 800-lb. strength Spectra fiber line and manipulated by a ground-based operator. In order to perform low-altitude aerial photography, the balloon was outfitted with a custom frame capable of holding a high-resolution (15.1 megapixel) Canon EOS 50D Digital Single-Lens Reflex (DSLR) camera equipped with an 18mm lens. This DSLR was also applied independently of the balloon rig to record sites in a number of different ways and resolutions.

Figure 6.1: The balloon in flight over Khirbat al-Jariya (Photo: T.E. Levy, UC San Diego Levantine Archaeology Laboratory)

Photographic data collection was oriented towards creating high-quality 3D models using Image-Based Modeling (IBM), a procedure that updates and uses traditional photogrammetric techniques to create a three-dimensional model from points of similarity between photographs of the same object taken from different angles. To that end, the team applied custom, individualized strategies to each site recorded. Generally, these strategies took two forms. For the collection of photographic data sufficient to produce a 3D model at the scale of an entire site, the ELRAP team manipulated the balloon in transects across sites at an elevation of ca. 100-150 m with approximately 50-75% overlap between adjacent transects—an ideal capture strategy for SfM documentation of sites, developed through trial-and-error. Each site was fully photographed (ca. 300-600 images per site) in approximately 1-2 hours (Figure 6.2). At several sites from other periods, lower-altitude photography was performed frequently on each of the excavation areas investigated during the 2012 and 2014 seasons in order to 3D model and map these areas. A similar capture strategy of transect-based photography was adopted for each of these areas, with an altitude of 10-15m, ca. 90% overlap between images and ca. 50-100 photographs collected per model (Figure 6.3). These characteristics were chosen as appropriate for the creation of a high-resolution dataset of a smaller area. The application of these methods to all sites investigated on the ELRAP project in recent years has allowed for the creation of an excellent collection of GIS data for sites in Faynan, well-suited to the mapping of these sites. These efforts have resulted in the 3D modeling and mapping of many of the major Iron Age sites in Faynan involved in copper production and trade. The collection of IBM-suited data for these sites is a useful resource for 3D modeling, mapping, and spatial analyses at these sites.

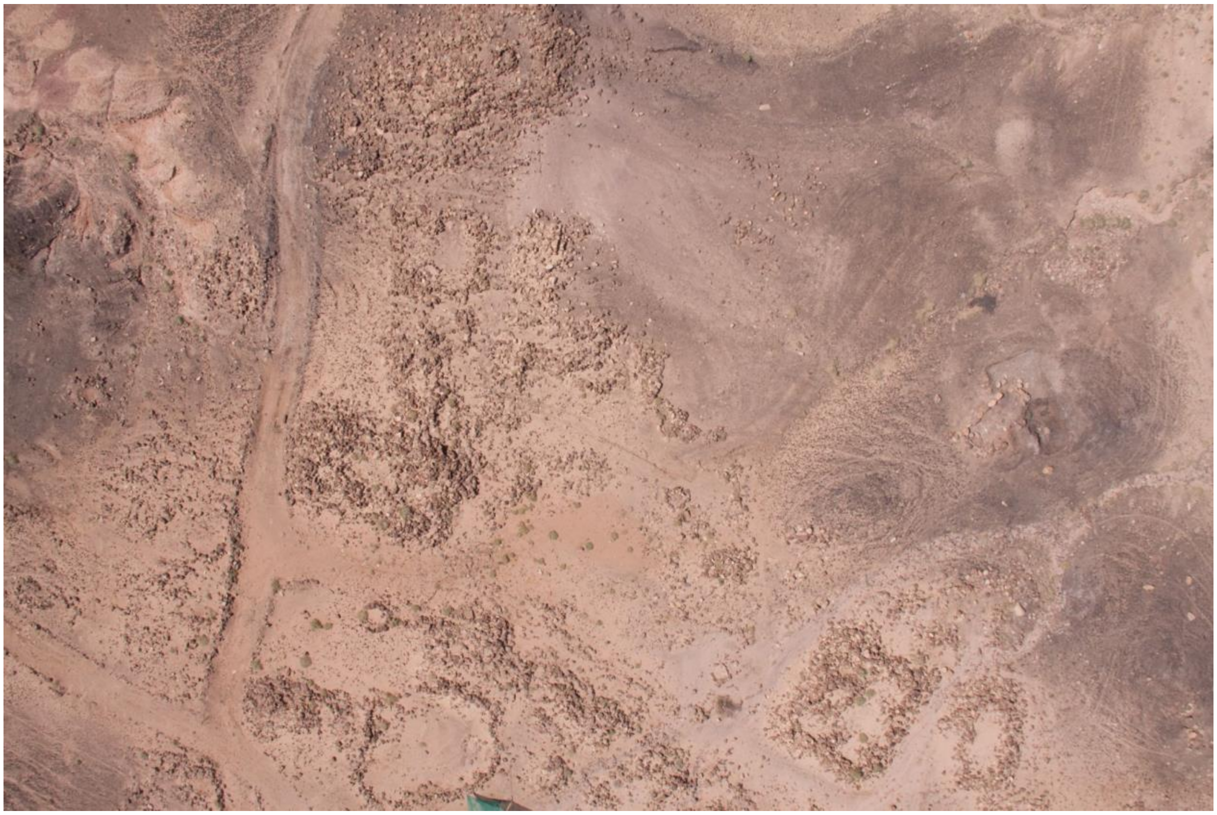

Figure 6.2: A typical photograph captured from the balloon at Khirbat al-Jariya for the purpose of sitewide modeling with image-based modeling. Area A is visible at the right side of this image.

Figure 6.3: A photograph captured from the balloon at Khirbat al-Jariya for the purpose of modeling the excavation area in Area B. This image shows Building 2 near the end of excavation. The author, manipulating the balloon using a tether, is also visible in this image.

6.4.1 ELRAP Image-Based Modeling and Mapping Methods

Nearly all of the comprehensive LAAP survey conducted on ELRAP's 2012 and 2014 seasons was conducted with IBM in mind as a primary use case for the resulting photographic datasets. As such, the datasets collected through these aerial survey efforts are well-suited to the creation of 3D models, orthophotographs, and DEMs at the scale of entire sites and of individual excavation units. Processing these datasets into fully-realized 3D models and GIS datasets took place in three main stages: field data collection, field data processing, and lab data processing.

In order to generate models that are appropriately spatially-referenced and therefore suitable for the generation of GIS data such as orthophotographs and DEMs, it is necessary to have data sufficient for linking the images captured with their location in space. ELRAP's approach to acquiring this data was to mark ground control points (GCPs) at each site and excavation area of interest prior to taking photos of the site. These GCPs were strategically placed across each area of interest to ensure that ca. 6 or more points were present and well-distributed around each area. Even distribution of points is necessary to avoid any distortion of the data when it comes to spatially referencing the model. Though it isn't necessary to have at least one point visible in each photograph of the site, ideally the GCPs are often seen throughout each photographic dataset. In order to record the locations of each GCP, the ELRAP team used a total station to collect the points' coordinates. The collection of these points were ultimately used later on in the model processing workflow to georeference the models, an essential stage of processing for archaeological purposes.

While in the field, with limited computational resources and a need for top plans and new perspectives on sites on a daily basis, ELRAP developed a system in which many models would be produced with limited processing specifications. ELRAP used the IBM software Agisoft Photoscan (now called Agisoft Metashape) to process models, both in the field lab in Jordan and in the lab in San Diego. Agisoft, at each stage of processing, from generating a point cloud, to a dense point cloud, to a mesh, to a textured model, allows users to adjust the processing specifications on a scale from Lowest to Very High. Models processed at High or Very High specifications have the highest fidelity to the real scene that can be achieved given the photographic data collected. However, processing models at these higher specifications can take days, weeks, or be impossible depending on the computational resources available. While models of the highest accuracy are naturally desirable for archaeological analysis, they are not necessarily feasible to produce in a fast-paced field environment that may lack the computational power of a lab setting. For that reason, ELRAP adopted a two-fold approach toward processing models at low-to-medium specifications. First, early on in field seasons, ELRAP team members processed site models at lower specifications in order to generate GIS data to help contextualize survey efforts at the site and guide excavation decisions. Second, the ELRAP team processed models of excavation areas on lower specifications on a daily basis in order to generate up-to-date top plans using the most recent GIS data. Overall, these datasets, though lacking the highest-level of precision and accuracy, provide a very helpful framework to aid fieldwork decisions.

Once back from the lab, however, ELRAP is less limited by issues of computational resources and time urgency. As such, there is time to process all of the quality models taken in the field at higher specifications. Reprocessing many models and processing some models for the first time at high specifications is an important stage in the overall process of data analysis and publication. While models processed in the field are important for informing timely decisions, models and GIS datasets processed in the lab are preferable for publication and analysis. The highest quality models can facilitate the taking of linear and volumetric measurements, allowing for the generation of new data without returning to the site. Similarly, the production of orthophotos at ELRAP sites at high quality allowed for mapping site and excavated features with correspondingly high accuracy and precision. Though ground truthing is an important phase in site mapping, good orthophotos can aid in the accuracy of site mapping efforts and aid in their comprehensivity. There are similar benefits of producing high quality, accurate DEMs. As discussed above, the sitewide DEMs produced through an aerial IBM strategy, like orthophotos, can reach a much higher resolution than datasets available through other means, such as satellite imagery. High-resolution DEMs of ELRAP sites have facilitated intra-site spatial analysis (Howland et al. 2018). Overall, the re-processing of 3D models and corresponding GIS datasets is a worthwhile endeavor as it increases the quality of datasets that can have a wide variety of uses.

High-resolution orthophotographs and Digital Elevation Models (DEMs) are useful foundations for high-resolution site mapping. On the ELRAP project, vectorization is conducted within the GIS software ArcGIS, which allows for the vectorization of individual stones (Levy and Smith 2007). The resolution of sitewide orthophotos produced through LAAP-IBM methods is sufficient to record features at this level (Howland et al. 2014a, 2015). However, on ELRAP, individual stones are typically vectorized on the basis of higher-resolution and locally-georeferenced models of a particular excavation area (Howland et al. 2014a, 2014b). This process is conducted on a daily basis during excavation (Howland et al. 2014a). For mapping of an entire site, wall lines, slag concentrations, and other archaeological features are vectorized based on the sitewide orthophoto, allowing for a more holistic perspective on the distribution of anthropogenic features across the site (Howland et al. 2015; Liss et al. 2020).

6.5 Results: Old Maps and New

As a result of the LAAP-IBM campaign described above, many of the key Iron Age sites in Faynan were recorded in three-dimensions and mapped. The total list of sites recorded includes Iron Age sites Khirbat en-Nahas, Khirbat al-Jariya, Khirbat al-Ghuwayba, Khirbat Faynan, and several mines in the Wadi Khalid north of Khirbat Faynan. Also recorded were Middle Islamic Period site Khirbat Nuqayb al-Asaymir and Neolithic site Wadi Fidan 61. The recording and analysis of these sites can be categorized into two main aspects. First, all of the sites were recorded via LAAP and IBM in order to produce not only 3D models but also orthophotos and DEMs. Second, each site was mapped in ArcGIS through precise vectorization of architectural features The two sites most relevant to analysis of Early Iron Age ceramics from Faynan, Khirbat al-Jariya (KAJ) and Khirbat en-Nahas (KEN), serve as a case study of the usefulness of these techniques for mapping the sites.

By applying the combined LAAP-IBM methods described above, ELRAP team members were able to generate a sitewide 3D model of KAJ sufficient for the production of high-resolution orthophotos and DEMs. The orthophoto, at a spatial resolution of 2cm, was sufficient for high-resolution GIS-vectorization of architecture and metallurgical remains at the site. Similarly, a sitewide DEM at 15 cm resolution facilitated the production of highly-accurate contours reflecting the topography of the site. Two Both sites had previously been mapped; the efforts presented here represent re-mapping efforts intended to improve the comprehensivity and accuracy of the maps.

In the case of Khirbat al-Jariya, the site had previously been mapped by Glueck (1935: Pl. 3; Figure 6.4) and by ELRAP using traditional methods including total station survey (Levy et al. 2003; reproduced in Ben-Yosef et al. 2010; Figure 6.5). Despite the surveyors' best efforts, these maps unfortunately fail to comprehensively document the archaeological remains at the site (Howland et al. 2015). Glueck's (1935: Pl. 3; Figure 6.4) map conveys the general layout of the site but features a few errors that limit its usability. The map distorts the route of the Wadi al-Jariya and the contours representing slopes at the site are artistic rather than accurate. More significantly, the map only gives a general sense of the distribution of slag across the site and does not indicate the difference between slag mounds and concentrations of crushed slag. Gluck's map also oversimplifies architectural remains at the site. Levy's (et al. 2003: Fig. 12; Figure 6.5) is somewhat more detailed and reflects the route of the wadi through the site more faithfully. However, the map suffers from a number of similar errors as that of Glueck, including poorly reflecting the spatial distribution and type of slag deposits at the site—a critical flaw given the context of ongoing archaeometallurgical research at the site. Furthermore, many extant stone features at Khirbat al-Jariya are not to be seen on this map (Figure 6.5), and indeed some features — such as the large oval feature at the northwest edge of the latter map— are not found at the site. The contours depicted on the map, though illustrating more precision in the elevation across the site, are largely inaccurate due to the lack of comprehensive elevation data used to produce the map. Thus, these maps are useful for understanding the layout of the site in general but are limited in their ability to accurately depict important metallurgical remains at KAJ.

Khirbat en-Nahas had also been surveyed previously and was mapped by Frank (1934: Plan 16; Figure 6.7), Glueck (1935: Pl. 4; Figure 6.8), Levy (et al. 2003: Fig. 12; Figure 6.9) and Hauptmann (2007: Fig. 5.33b; Figure 6.10). Each of these admirable mapping efforts gives a sense of the layout and scale of the site. However, these maps also lack a level of precision and detail that can be useful when interpreting the spatial distribution of material culture. Frank's map (1934: Plan 16) depicts many of the key excavated areas at the site, though dozens of structures visible on the surface of the site are not depicted. Moreover, like Glueck's map of KAJ, the contours are artistic only and slag deposits at the site are not accurately depicted. Glueck's map (1935: Pl. 4) features the same flaws while also oversimplifying what architecture it does depict. The latter two maps, published by Levy (et al. 2003: Fig. 12; Figure 6.9) and Hauptmann (2007: Fig. 5.33b; Figure 6.10) represent the metallurgical remains at the site fairly well, especially Hauptmann's, which differentiates between slag mounds and accumulations of crushed slag. Levy (et al. 2003) also has a more careful representation of the architecture at the site, as compared to KAJ. However, these maps also fail to precisely and accurately reflect slag deposits and types at KEN and tend to oversimplify architecture as well. In general, changes at the site and/or depositional processes do not explain the differences between the remains at KAJ and KEN and these maps. Rather, to blame for the difference in comprehensivity is a lack of a perspective and the inherent difficulty of identifying significant stone features when — for lack of a better phrase — standing in the middle of a large pile of rocks.

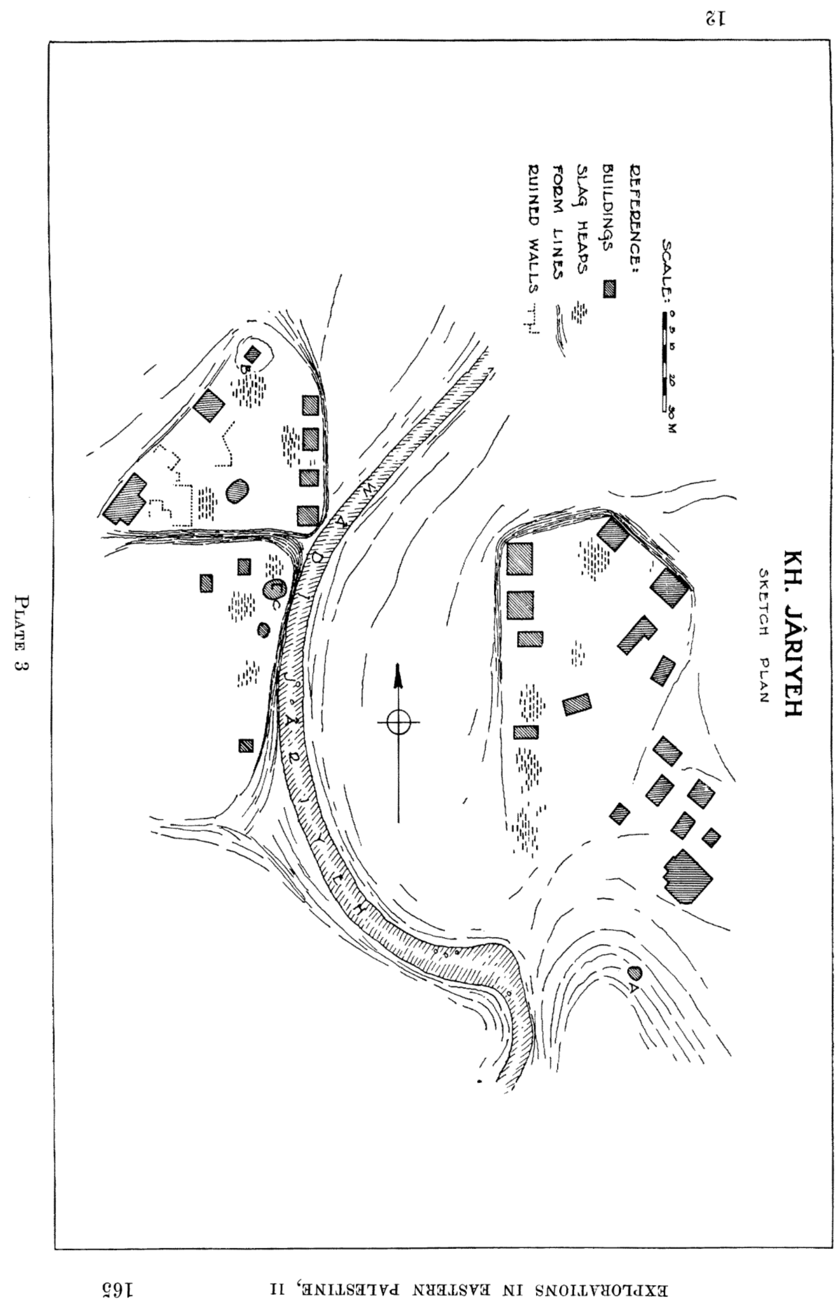

Figure 6.4: Glueck's (1935: Pl. 3) map of Khirbat al-Jariya. This map lacks detail of slag concentrations at the site, oversimplifies architectural remains, and distorts the layout of the wadi.

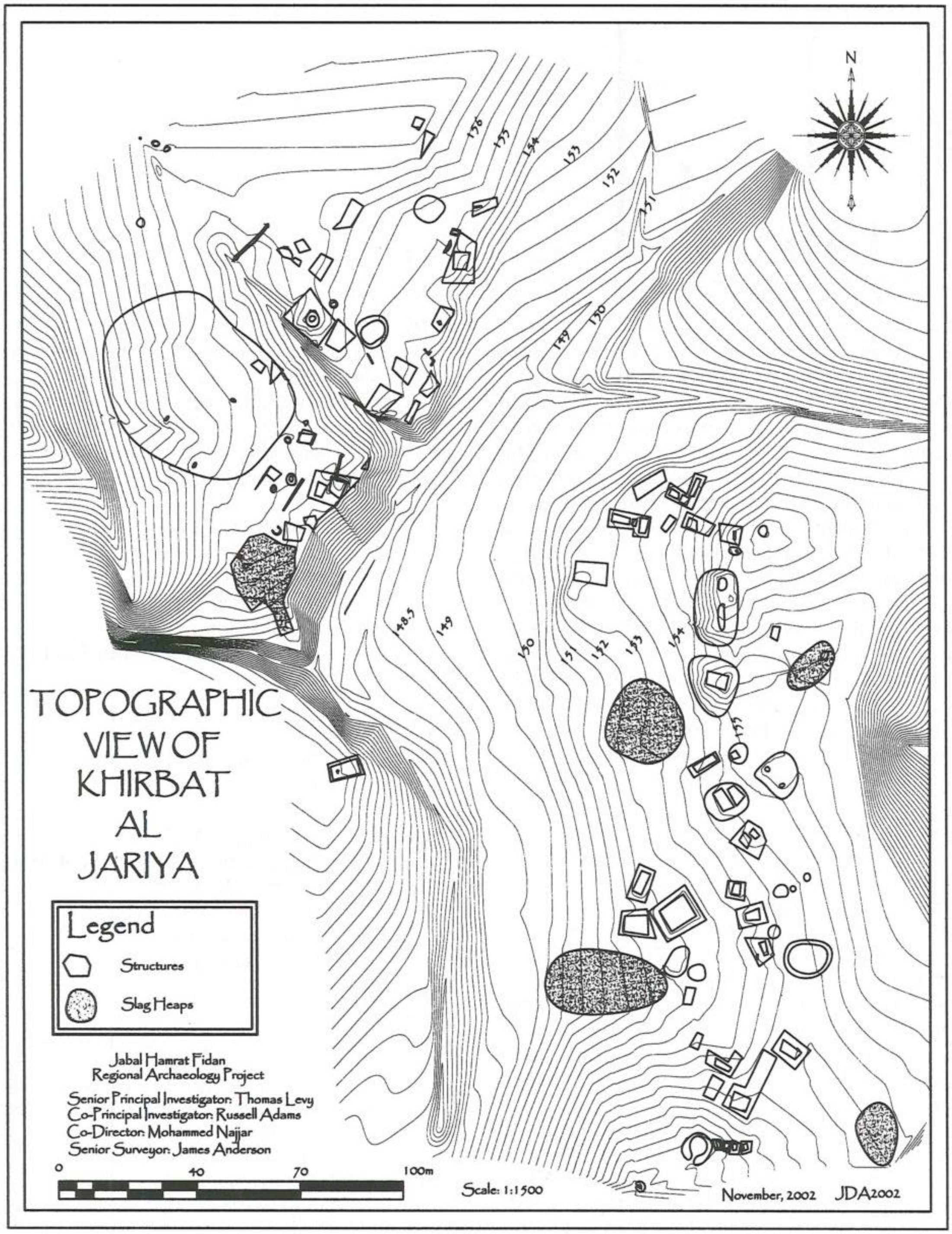

Figure 6.5: Levy et al.'s (2003: Fig. 16) map of Khirbat al-Jariya. This map features inaccurate topographic lines, omits several slag concentrations including crushed slag deposits, and depicts structures that do not exist.

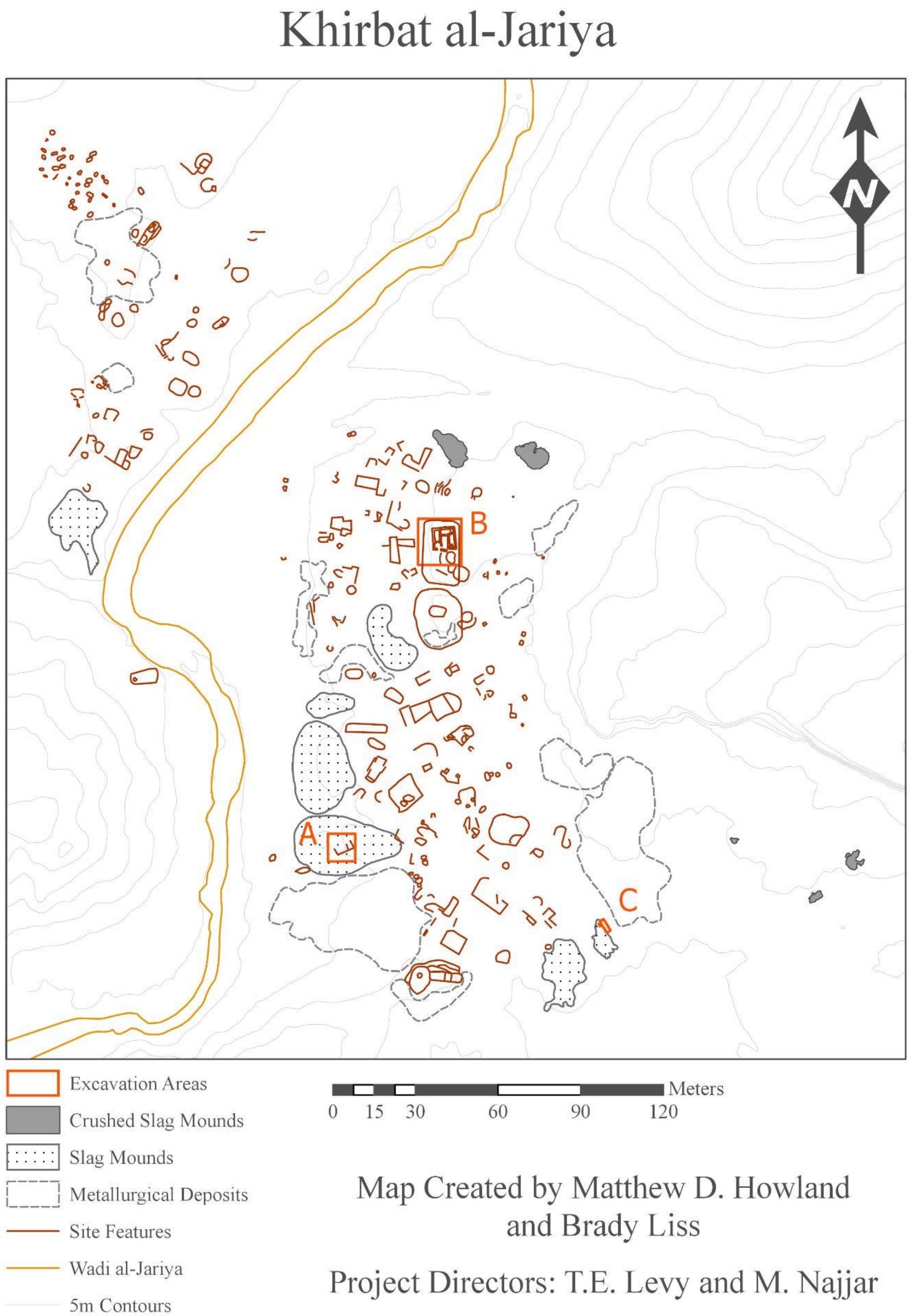

Figure 6.6: New map of Khirbat al-Jariya (Howland et al. 2015; Liss et al. 2020). This map is more comprehensive in its depiction of slag concentrations at the site and faithfully reflects surface architecture at the site.

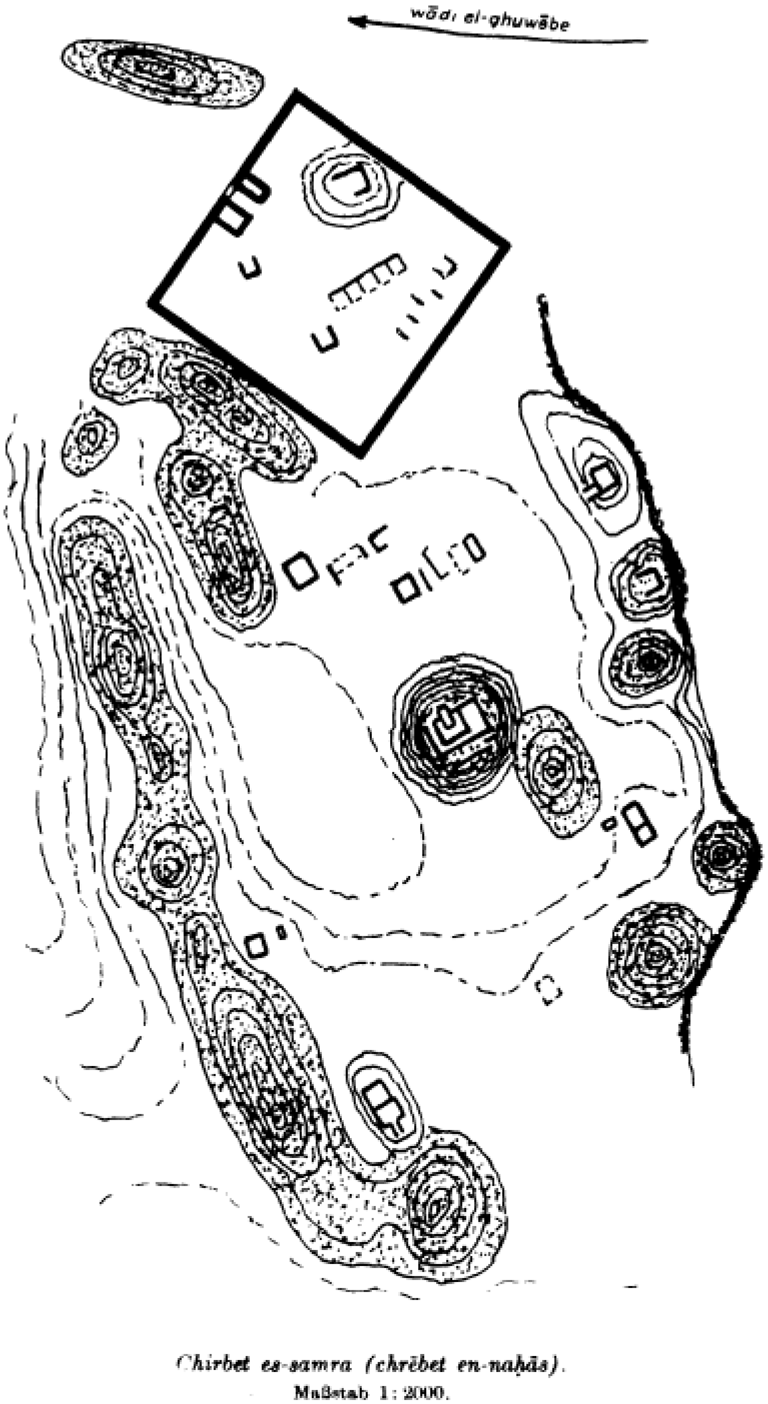

Figure 6.7: Frank’s (1934: Plan 16) map of Khirbat en-Nahas. This map omits dozens of architectural features visible on the surface of the site.

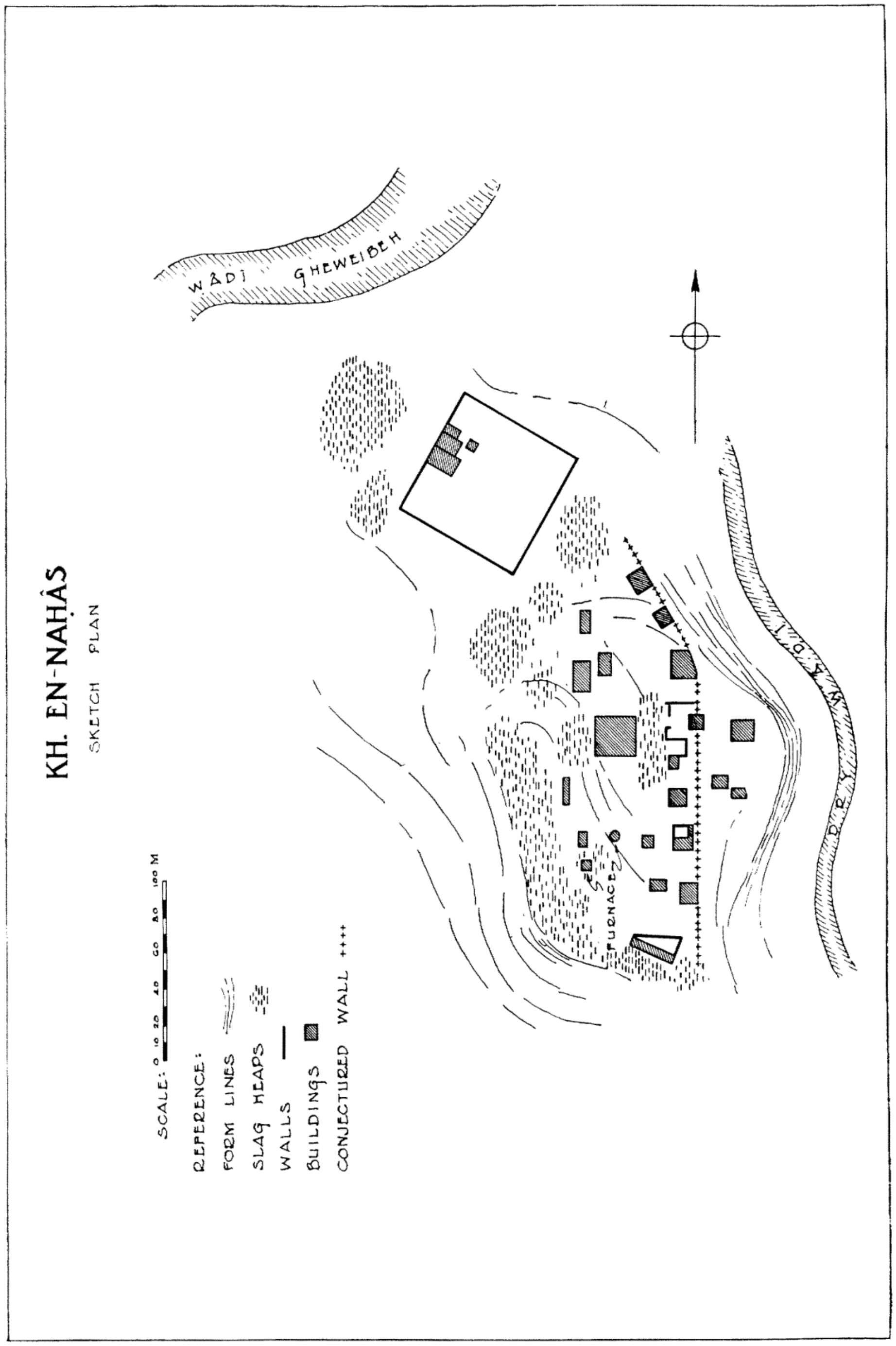

Figure 6.8: Glueck's (1935: Pl. 4) map of Khirbat en-Nahas. This map omits dozens of architectural features visible on the surface of the site and oversimplifies the architecture it does depict.

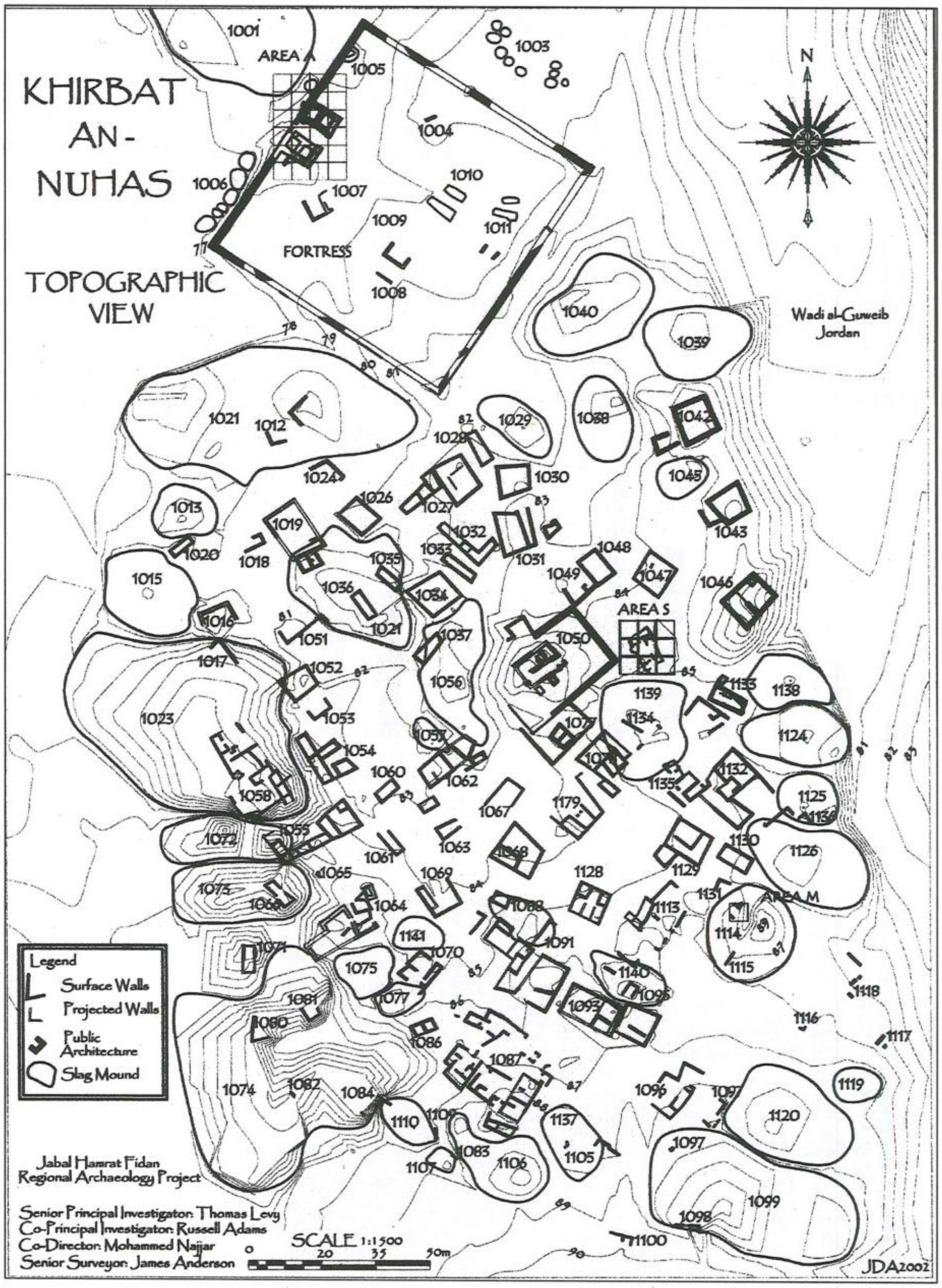

Figure 6.9: Levy et al.'s (2003: Fig. 12) map of Khirbat en-Nahas. This map is fairly comprehensive but certain details such as site contours and architectural remains at the site are either inaccurate or oversimplified.

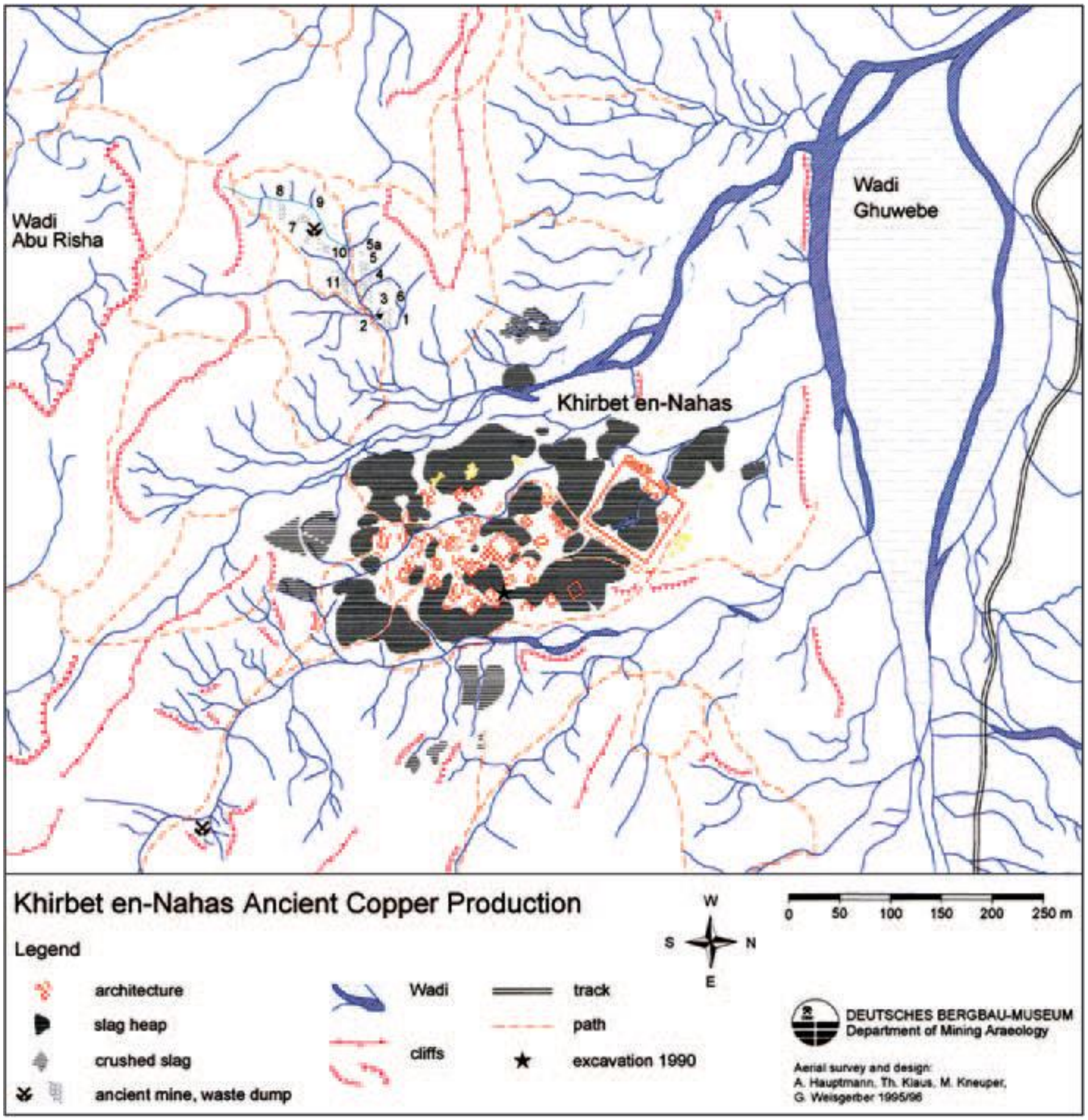

Figure 6.10: Hauptmann's (2007: Fig. 5.33b) map of Khirbat en-Nahas. This map, due to its scale, faults to illustrate the architectural remains at the site in good detail. The detail of other landscape features is admirable but detracts somewhat from the clarity of the map. Slag deposits are also oversimplified and aggregated on this map.

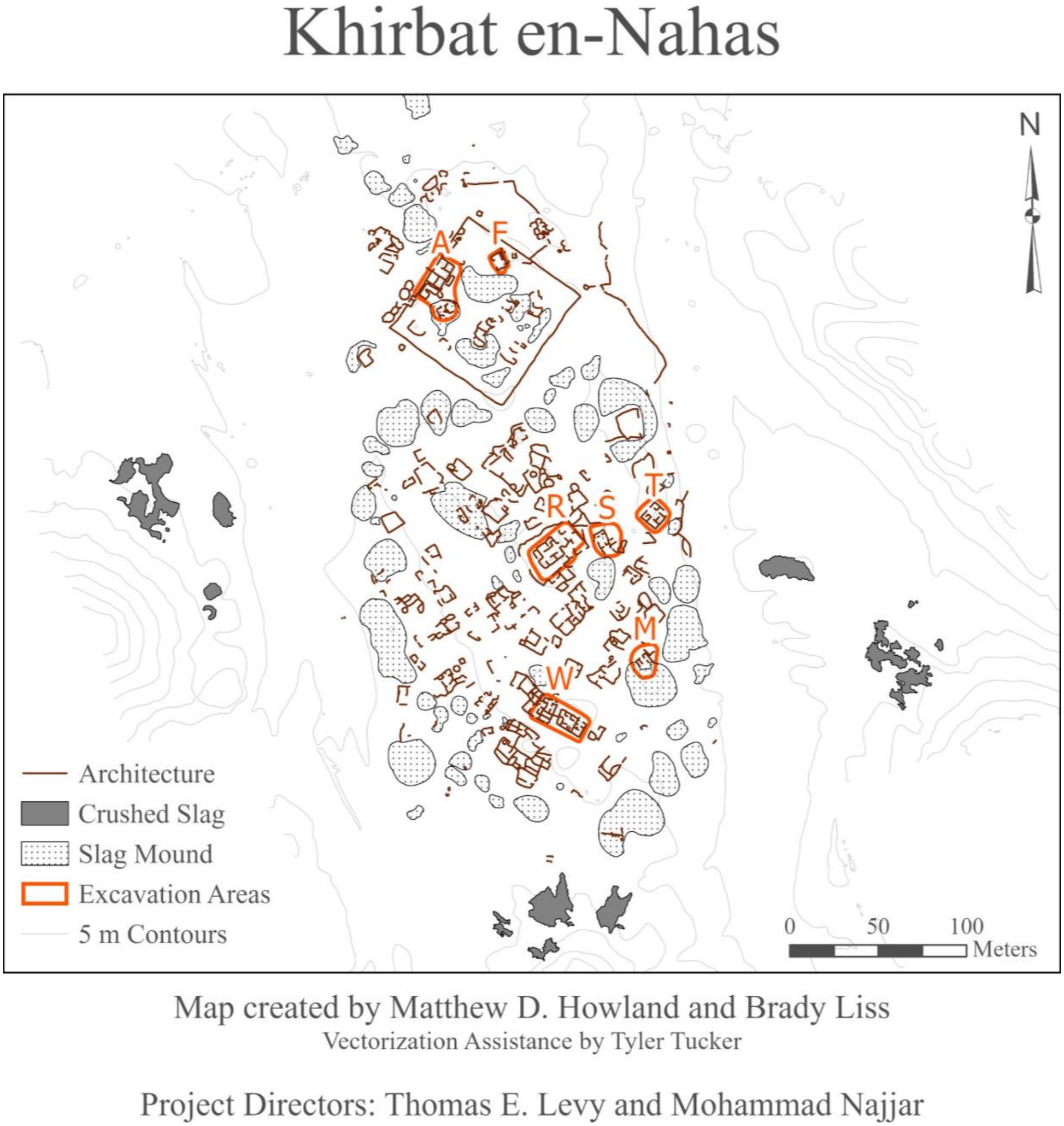

Figure 6.11: New map of Khirbat en-Nahas. This map differentiates between slag mounds and crushed slag and features a more comprehensive and accurate depiction of surface architecture.

The new maps produced through these methods provides a new, nuanced understanding of the spatial distribution of copper slag at Khirbat al-Jariya (Figure 6.6) and Khirbat en-Nahas (Figure 6.11). The 2003 map of KAJ (Figure 6.5) shows five "slag heaps," undifferentiated by type of slag or its density. The LAAP-IBM-produced orthophoto has allowed for the precise mapping of 24 metallurgical deposits, each separately recorded as a slag mound (7 mounds), crushed slag mound (6 mounds), or slag scatter (11 scatters) based on density and type, each verified by ground truthing. Of these, the six mapped crushed slag mounds are especially significant. These mounds, covering a combined area of ca. 205.5 sq. m at KAJ, had been completely absent from the older map of the site. Furthermore, previous research (Ben-Yosef 2010; Ben-Yosef and Levy 2014a; Hauptmann 2007) refers to similar mounds of crushed slag at the nearby Iron Age copper production site of Khirbat en-Nahas as being unique to the period and the area. These crushed slag mounds at KEN are mapped in limited detail by Hauptmann (2007: Fig. 5.33b), but the new KEN map (Figure 6.11) produced through the methods described above have facilitated mapping these remains in great detail. The perspective and resolution of the orthophoto produced by LAAP-SfM methods have made it possible to clearly identify and digitize the deposits of crushed slag as these dark spots on the landscape are quite clearly identifiable against lighter bedrock and soil. As such, the combination of new mapping methods and the ever-critical process of ground-truthing have enabled the ELRAP team to spatially quantify the extent of crushed slag debris at Khirbat al-Jariya for the first time (Howland et al. 2015; Liss et al 2020). This is an important step forward in relating the history of copper smelting at the site to that of the larger industrial area at Khirbat en-Nahas, as well as in continued efforts to reconstruct the chaîne opératoire of copper production in the early Iron Age. The application of new LAAP-IBM methods at KEN has also provided the impetus for a comprehensive remapping of the site, placing an emphasis on mapping architecture as visible on the surface rather than on hypothesized structure plans (Figure 7.9). In remapping these two important and contemporaneous copper producing sites, ELRAP has provided important context regarding the spatial extent of Iron Age society in the region against which to frame analyses like the ones discussed below.

Beyond site mapping, these datasets also facilitate more advanced GIS-based spatial analyses of sites. For example, ELRAP LAAP-IBM survey produced GIS data for the Middle Islamic period site Khirbat Nuqayb al-Asaymir (Jones et al. 2012) sufficient for a study of the impacts of erosion on archaeological remains at the site (Howland et al. 2018). This study began with site mapping, similar to that conducted at KAJ and KEN. The mapped remains at the site were then subjected to hypotheses derived from ethnographic analogy in order to estimate the areas of densest artifact deposition during the period of occupation of the site. These hypothesized deposition areas were subject to cost-path analysis based on the LAAP-IBM DEM in order to estimate how erosion would affect the distribution of artifacts, especially ceramics, at the site (Howland et al. 2018). Furthermore, the DEM facilitated a soil science-based study of erosion risks, providing an estimate regarding the rate of erosion across the site (Howland et al. 2018). This analysis serves a case study and a model for future intra-site analysis that can be conducted based on the GIS data produced with the combined LAAP and IBM methods described above.

Chapter 6 contains published material co-authored by Thomas E. Levy, and Falko Kuester and published in Mediterranean Archaeology and Archaeometry 14(4) 2014 and Near Eastern Archaeology 77(3). The dissertation author was the primary author of this material.

Chapter 7: Excavation at Khirbat al-Jariya 2014

7.1 The 2014 Excavation

The ceramic evidence analyzed in this study to test hypotheses related to long-distance exchange and the presence of elites at Khirbat al-Jariya derives from a 2014 excavation season at the site, conducted by the author and an ELRAP team (Liss et al. 2020). This work followed up on the small 2006 ELRAP excavation at the site and aimed to clarify the political control and organization of copper production at KAJ. Prior investigation at the site led excavators to believe that the site had initially been used by local nomads opportunistically producing copper—"more ephemeral use of the site" —rather than as part of an organized system of production (Ben-Yosef et al. 2010). New excavations at the site in 2014 intended to test this hypothesis and shed further light on how copper production was controlled at the site and the trajectory of production by excavating two areas with stratigraphic methods and close chronological control. The ELRAP team chose to excavate the largest structure visible from surface remains at the site (Area B), which was hypothesized to be an elite context at the site, perhaps an administrative or residential structure (Figure 7.1). Excavating this area would allow for ELRAP to investigate the issue of whether or not elites were present at the site and understand the extent to which they exercised control over production or exchange of copper. Furthermore, the timeline of the presence of elites at the site would provide evidence for the development of social complexity at the site, and test the hypothesis that the earliest phases at the site represented opportunistic and ephemeral copper production rather than an organized effort to develop the copper industry at KAJ. In addition to the large structure in Area B, the team also decided to excavate a slag mound, Area C, at the southern end of the site with a small probe. Excavation in this area was intended to corroborate evidence from the Area A slag mound excavations in 2006 (Ben-Yosef et al. 2010) and understand the trajectory of copper production at the site. Studying the rate of copper production at KAJ over the course of the use and occupation of the site would allow for further testing of the idea that initial production at the site was limited in scale and scope rather than organized and substantial. Beyond testing these hypotheses through excavation, the 2014 project also involved the comprehensive LAAP and IBM program described above as well as a program of botanical analysis to generate new information about provisioning for subsistence and fuel at the site.

Figure 7.1: An orthophotograph of Area B prior to excavation. Area B consists of the mound depicted here at the northern edge of Khirbat al-Jariya. Excavation in the northern part of this mound revealed Building 2. The southern part of the mound, left unexcavated, may contain another building. Visible on the surface of this image are circular animal pens, constructed in recent times.

7.2 Methods of Excavation

Generally speaking, ELRAP excavates with a unique cyber-archaeology workflow, using several digital tools for recording of spatial and contextual data. Excavation takes place within the framework of a single-context recording system (cf. Museum of London 1994). At the 2014 excavations, the ELRAP team applied a custom cyber-archaeology workflow called the on-site digital archaeology (OSDA) 3.0 system (Levy et al. 2010). The OSDA applies both off-the-shelf and custom-developed hardware and software in an integrated system specifically designed to answer research questions and test hypotheses in archaeology and cultural heritage. The OSDA is fundamentally rooted in spatial and contextual recording, and the 2014 excavation season applied this system so that the archaeological remains uncovered through excavation could be spatially-recorded and documented at the highest possible spatial resolution in three dimensions. The ELRAP team used three main recording systems during the 2014 season. First, for spatial recording, the team used a Leica TS02 total station linked to a custom data interface software, ArchField, that provides real-time data recording and review within a Geographic Information Systems (GIS) framework. ArchField facilitates the spatial recording of loci and point data, while also allowing for the input of some descriptive data of these recordings. ArchField also allows for the generation of real-time top plans (Smith and Levy 2014). To record spatial data, ELRAP also applied the custom-developed contextual recording software OpenDig, which allows for the recording of descriptions of loci directly into a digital format, reducing time and later transcription errors (Vincent et al 2014). Following field data collection, spatial data linked with artifacts were processed through ArchaeoSTOR, another custom application allowing for the categorization and sorting of artifacts in the field and in the lab, along with spatial visualization and statistics applications (Gidding et al. 2011; Gidding et al. 2014). In total, by applying each of these digital technologies for field and lab recording, ELRAP used a comprehensive paperless cyber-archaeology recording workflow for excavation at KAJ.

7.3 Area B

The primary focus of the 2014 excavation was the relatively large structure in what became known as Area B. At the outset of the excavation, the structure in this area appeared as the largest set of remains visible on the surface of the site. The area occupies a prominent position in the north-central part of the site and perched on a bedrock outcrop. As mentioned above, the ELRAP team chose to excavate in Area B in order to test the hypothesis that the structure, named Building 2, was an elite context, potentially a residential or administrative context similar to Areas R and Y at Khirbat en-Nahas (cf. Levy et al. 2014). Initial interpretations suggested that the structure did not bear similarity to these areas, instead primarily serving an industrial use for slag crushing, potentially with ceremonial significance (Liss et al. 2020). However, analysis of ceramics recovered from Building 2 in 2014, discussed below, has shed additional light on the building's purpose.

Over the course of excavation, the majority of the structure was exposed down to its bedrock floors, revealing a one-floor ca. 7.5 x 7.5 m structure with between 4 and 7 rooms (Figure 7.2). Since the eastern side of the structure was not fully excavated, it was difficult to clarify the relationships between rooms in that part of the building. The building's entrance on its south side connected the structure's interior to an alley separating Building 2 from another large, unexcavated, structure immediately to its south. These two buildings presumably served related purposes as part of a larger complex at the site, located centrally overlooking the majority of the site.

Figure 7.2: An orthophotograph of Building 2 in Area B after excavation was completed, illustrating the different rooms in the structure. A fine grinding installation is visible on the left side of Room 3.

Within Building 2, excavators identified seven strata representing unique phases of the building's occupational history. The first stratum, B2c, represents the initial construction and occupation of the building, with all of the major walls of the building adjoining, indicating that they were built at the beginning of the stratum. The structure was built directly on the bedrock of the site, which also likely served as a floor through much of the occupational history of the site. Material remains relating to Stratum B2c are extremely limited as the bedrock floor of the stratum remained in use and was likely continuously cleaned during subsequent occupations. As such, the only physical remnants of Stratum B2c are to be found in the architecture of the structure and in the unexcavated eastern part of the structure. Ceramics and groundstone artifacts recovered from the floor of the structure have been interpreted to relate to Stratum B2b, given the assumption that the floors were kept clean over the course of occupation in Stratum B2c. As such. understanding the initial purpose use of the structure during Stratum B2c is difficult given the lack of remains that concretely relate to the phase. However, it is likely that Building 2 was used for industrial purposes, including ceremonial slag processing activities that seemed to have occurred in later strata. Stratum B2c went out of use with the blocking off of the entrances to Rooms 4, 6, and 7 (Figure 7.3).

Figure 7.3: Blocked doorways in the central wall in Building 2 preventing access into the eastern rooms. As the doors were blocked at the level of the bedrock, it is likely that the occupation phase following the blockages also used the bedrock floors.

The next phase of Area B's occupation is Stratum B2b. The stratum began with the blocking of entrances to the eastern part of the structure. The base of these blockages is on the bedrock, indicating that the bedrock surface of the structure was still in use at the time the entrances were blocked. As such, this stratum represents the second phase whose inhabitants used the bedrock as a floor. Presumably, the bedrock floor was cleaned over time during the occupations represented by Strata B2c and B2b, so most of the artifacts found in association with the bedrock in Building 2 should relate to Stratum B2b rather than B2c. In addition to using the bare rock as a floor surface, in Rooms 1, 2 and 3, patches of clayey beaten earth were found directly above the bedrock. These patches suggest that the inhabitants of this occupation layer made use of a floor surface directly above the bedrock. The many artifacts that were found immediately above the bedrock in the structure, primarily ceramics and groundstone tools, should be associated with this stratum. Particularly common in this level were hammerstones and grinding slabs of varying quality. In Room 3, a grinding installation including a high-quality grinding slab with a grinding stone was found, deliberately placed in the center of the room (which itself is centrally-placed within the building) and spatially differentiated from the rest of the room by an upright stone slab. On the other side of this slab was a possible bedrock mortar containing some evidence of crushed slag. This potential mortar paralleled other bedrock mortars found around the site, many of which had clear evidence for slag crushing activities. Also found in Stratum B2b in the northwest corner of Room 3, just above the bedrock surface, was a crushed slag surface. This layer, potentially a floor or accumulation on the floor, most likely relates to the combined grinding installation consisting of the fine grinding slab and stone, the upright stone, and the bedrock mortar, though it is not immediately contiguous. These slag crushing features found on the bedrock suggest that slag crushing was an important activity performed in the building from its early phases. Slag crushing at the site may have had a ceremonial significance based on the central location of the crushing installation in the structure and Building 2's central and elevated position at the site. Some fine pottery was also found in Stratum B2b, which is discussed below. A semicircular stone installation faced with mudbrick of unknown purpose was also found in the eastern side of Room 1 relating to this Stratum. Ultimately, the end of Stratum B2b is marked by the accumulation of a sediment fill above the bedrock. As it is challenging to differentiate this fill accumulating from a continuous occupation of the bedrock surface of Stratum B2b or a new occupation phase, the fill directly above the bedrock in the structure is attributed to Stratum B2a/b.

The next discernible Stratum in Building 2, Stratum B2a, also represents the structure's final ancient occupation phase. The stratum is identifiable by a relatively dense layer of ceramics in the west side of the building in Room 2 in a layer on top of the fill of Stratum B2a/b. A small wall, running north-south and dividing Room 1 in two was also found at a similar level in this stratum. In terms of material culture beyond the ceramic evidence, grinding slabs and hammerstones remained common at this stratum. Ultimately, the end of Stratum B2a can be seen in a layer of wall collapse and aeolian sediment, signifying that Building 2 went out of use.

The strata immediately following the end of occupation of Area B consist of wall collapse, some of which is embedded in aeolian sediment (Stratum B1b and B1c). The excavation of this collapse revealed the architecture delineating the walls of Building 2 both within and surrounding the standing architecture. The top stratum at the site, Stratum B1a, relates to 20th century construction of circular features (potentially animal pens) built using collapsed stone on top of the structure. Overall, the non-ceramic remains from Area B do not paint a clear picture of the purpose of the building besides suggesting some degree of slag processing. As such, study of the ceramics is crucial for understanding the overall purpose of the area in ancient times.

7.4 Area C

The test probe in Area C represents a small but significant part of the 2014 excavations at Khirbat al-Jariya. The unit, despite being only 1 x 1 m in area, was extremely helpful in clarifying the history of copper production at the site. In particular, excavation in this area was critical for understanding the intensity of the industry at the beginning phases of the site (Liss et al. 2020).

The earliest identified stratum in Area C, Stratum C3, represents the virgin soil present at the site prior to any occupation in the Area. The first stratum representing actual activity at the site is Stratum C2d, which consists of ca. 80cm of layers of crushed slag. This relatively thick layer of metallurgical remains found at the first phase of occupation in this area suggests that the site may have experienced a more rapid trajectory of settlement and production than previously thought. Stratum C2d also contained some limited ceramic remains, discussed in further detail below. After this initial phase of slag processing, the area seems to have served a residential purpose, represented in Stratum C2c. In this layer, a higher density of ceramics, charcoal, and burnt bones, along with a stone installation, seem to indicate its residential or non-industrial purpose. After this potentially residential phase, the area apparently returned to industrial use, as a thin layer (Stratum C2b) above featured fragments of technical ceramics. The industrial use of Area C reached its peak in the subsequent Stratum C2a, which contained ca. 50 cm of large tap slag fragments embedded in a layer of ashy sediment (Liss et al. 2020). This layer likely represents the peak of industrial copper production at the site and may also indicate a development in the copper production chaîne opératoire, given that these slag remains were not crushed. Ultimately, the small excavation in Area C, along with the corresponding radiocarbon dates, were very helpful in understanding occupation, use, and abandonment of the site.

7.5 Radiocarbon Dating

As part of the 2014 excavation season, ELRAP chose ten samples of organic matter to use for C14 dating. By tying the excavation results to an absolute chronology, excavators were able to link the results from KAJ to those of other sites, including KEN, and understand the overall occupation and industrial trajectory of the site. To acquire an appropriate distribution of samples from well-stratified contexts, the ELRAP team selected dating material from the Area B building excavation and from the Area C slag mound probe. These ten new samples, along with nine from the 2006 excavation, bring the total number to 19 from KAJ. Overall, these dates help to clarify both the absolute chronology of individual strata at KAJ and the overall occupation of the site.

Interpretation of the radiocarbon dates with regard to the stratigraphy of the site is necessary for understanding the overall chronology of KAJ's occupation and use, but also for clarifying the initial use of the site. The dating of the site can be discussed from three perspectives: overall, vis-à-vis radiocarbon dates from the 2006 excavation at Area A, dating Area B, and dating Area C. First, the overall range of new dates from the site (Table 7.1) suggest that the site was initially settled in the mid-11th century BCE before being abandoned in the mid-to-late 10th century BCE, being occupied for ca. 100 years (Liss et al. 2020). This corroborates evidence from Area A, where nine radiocarbon dates suggested that the site was occupied from the mid-11th century CE to the second-half of the 10th century CE (Ben-Yosef et al. 2010). The story from Area B is somewhat more complex. Though most of the dates from Area B would at first glance indicate a date for the construction of Building 2 in the early 10th century BCE, two factors suggest an earlier date for the building's origin. First, as discussed above, the building's architectural stratigraphy suggests that multiple occupation phases (Strata B2c and B2b) occurred on the same bedrock floor of the structure, based on the blocking of doorways at the level of the bedrock (Figure 8.2). Presumably the floors of the structure would have been cleaned over the course of the first two phases of the structure's use, indicating that artifacts and dates found in association with the bedrock should be associated with the end of the later Stratum B2b, rather than the foundation of the structure at the beginning of Stratum B2c. Secondly, one radiocarbon sample from the structure, Sample KAJ3 found in Room 4, provides an additional line of evidence for an earlier date for the structure. Sample KAJ3 is from the eastern side of the structure, which — though not fully excavated — likely went out of use following the blocking of the doors providing access to these rooms. As such, evidence from this part of the building probably relates to the first phase of the building's occupation (Stratum B2c) prior to the door blockage. The sample itself, dated to 1118–1027 B.C.E. with 68.2% probability, reflects this line of thinking. Taken together, stratigraphic concerns and radiocarbon dating from Area B suggest that Building 2 was founded in the mid-11th century rather than the early-10th century BCE. This difference has important implications for the trajectory of KAJ's use and occupation. The construction of relatively substantial architecture in a central location of the site at the start of occupation of the site provides evidence against the hypothesis that initial settlement was opportunistic and ephemeral. The radiocarbon dates from Area C provide another line of evidence for the trajectory of KAJ's development. The excavation of the slag mound in Area C was initially intended to corroborate evidence of the dating and intensity of production from Area A. The range of radiocarbon dates from Area C indicate that the area was used from the mid-11th century BCE to the late 10th century BCE (Liss et al. 2020), lining up with the overall chronology of dates from Areas A and B. The earliest stratum in the area (C2c) dating to the time period of the foundation of the site provides additional insight into the intensity of production from the outset of settlement at KAJ.

Table 7.1: New radiocarbon dates from Khirbat al-Jariya 2014 (modified from Liss et al. 2020)

Sample	**Area**	**Room**	**Locus**	**Stratum**	**Species**	**Date (1σ)**
KAJ1	B	3	543	B2b	*Phoenix dactylifera*	970–844 B.C. (68.2%)
KAJ2	B	6	554	B2a	*Phoenix dactylifera*	1009–927 B.C. (68.2%)
KAJ3	B	4	544	B1c	*Phoenix dactylifera*	1118–1027 B.C. (68.2%)
KAJ4	B	2	542	B2a	*Phoenix dactylifera*	979–901 B.C. (68.2%)
KAJ5	B	2	545	B2b	*Phoenix dactylifera*	1009–924 B.C. (68.2%)
KAJ6	B	1	565	B2b	*Phoenix dactylifera*	1026–931 B.C. (68.2%)
KAJ7	B	3	561	B2b	*Phoenix dactylifera*	978–895 B.C. (68.2%)
KAJ8	C	N/A	533	C2a	*Tamarix sp.*	932–832 B.C. (68.2%)
KAJ9	C	N/A	535	C2c	*Phoenix dactylifera*	1054–940 B.C. (68.2%)
KAJ10	C	N/A	549	C2d	*Retama raetam*	1111–1005 B.C. (68.2%)

7.6 Results

Overall, the 2014 excavations at KAJ helped to clarify the occupational and industrial trajectory of the site. While radiocarbon dating corroborated the overall time period during which the site was occupied, stratigraphic considerations in Areas B and C resulted in some new developments in our understanding of the site (Liss et al. 2020) and useful information for evaluating hypotheses regarding the sites initial use and occupation. In particular, while the earliest dates from Areas B and C are similar to that of Area A, both B and C have more substantial remains dating to the earliest phase of the occupation of the site. In Area B, the earliest stratum, B2c, likely dates to the mid-11th century BCE. As this stratum relates to the construction of Building 2, these results indicate that initial settlement at the site was significant enough to justify the construction of substantial stone architecture. The remains from Area C tell a similar story. The earliest occupation phase, Stratum C2d, contains ca. 80cm of crushed slag dating to around the mid-11th century BCE, suggesting fairly intensive and/or sustained production from early on in the occupation of the site (Liss et al. 2020). These lines of evidence suggest that the initial use of the site was not ephemeral but rather fairly substantial. Construction and use of a relatively large structure and substantial copper production from the earliest days of occupation at KAJ also suggest that rather than opportunistic exploitation of copper resources at KAJ during its first phases, the site may have been settled as a part of a centrally-coordinated effort, likely as an outpost from KEN. KAJ may have been intentionally settled in order to take advantage of the copper ores further up the Wadi al-Jariya, north of the site. Ultimately, the site was home to fairly substantial copper production for ca. 100 years until its abandonment in the mid-late 10th century BCE. Contemporaneous with KEN, it is likely that KAJ served as part of a regional network of copper production active in the Iron Age. This is corroborated by similar material culture at the site as well as the publication of paleobotanical remains by Liss and colleagues (2020), suggesting local provisioning of workers at the site from orchards nearby, perhaps at Khirbat al-Ghuwayba. In general, the results of the 2014 excavation provide evidence against the hypothesis that the site was initially used for opportunistic copper production, instead suggesting that KAJ was subjected to substantial production in an organized manner. The analysis of ceramic evidence from Area B, discussed below, can also shed light on the potential role of elites at the site in organizing production and exchange of copper.

Chapter 8: Ceramic Analysis – 3D Modeling

8.1 Introduction

The analysis of the ceramic assemblage from Khirbat al-Jariya (KAJ), Jordan, is crucial for understanding a number of issues, including the organization and stratification of society in Faynan and the extent to which occupants of the site engaged in interregional exchange networks. To address these topics, a threefold approach toward the study of ceramics recovered from KAJ has been applied. The first method of ceramic study uses Image-Based Modeling at the artifact level to record each of the diagnostic sherds recovered from KAJ. Though the analysis of complete vessels would be preferred for most ceramic analyses (Smith and Levy 2014: 303), sites in Faynan specifically and Edom more generally typically feature few of these fully-preserved ceramics (Hart 1989; Smith and Levy 2014: 305; Oakeshott 1978). In lieu of studying the full form of a vessel, it is necessary to study diagnostic rim sherds, on the basis of which the form of the vessel can be extrapolated. The recording of 3D models of these ceramic fragments can help facilitate the automatic production of plate illustrations of the sherds. These illustrations are standardized depictions of ceramic vessels and as such, help to mitigate the scarcity of complete vessels, while also providing a standardized form of interpretation. The 3D recording of ceramics serves two additional purposes. First, recording the sherds as near-photorealistic 3D models provides documentation of the original form of each sherd. This is important given the destructive analysis conducted for petrographic study. Finally, producing digital 3D models of sherds opens possibilities for Open Data and public archaeology endeavors conducted within digital frameworks, as discussed below. As such, the production of 3D models provides a baseline for the study of ceramics in order to shed light on Iron Age society and exchange in Iron Age Faynan.

8.2 Image-Based Modeling for Artifacts

The use of Image-Based Modeling (IBM) for recording ceramic sherds can be situated within the broader categories of the use of the technology. Alongside terrestrial and aerial uses, a third application of the technology is for recording artifacts in three dimensions (cf. Olson et al. 2013; Roosevelt et al. 2015; Magnani et al. 2020). Collecting 3D data of artifacts can be useful for the preservation of their form and appearance, to facilitate illustration, or to analyze typology, each discussed below. However, scholars recording artifacts in 3D should remember that producing 3D models of artifacts, like taking photographs, is an interpretive process rather than an objective one (Garstki 2018). Furthermore, archaeologists should take care that the use of and interaction with 3D models doesn't overshadow more multi-sensory interaction with artifacts, which can lead to greater understanding (Eve 2018). 3D models can also be challenging to publish and preserve (Caraher 2016). Despite these cautionary notes, the recording of artifacts in 3D can have great potential for analysis and even preservation.

IBM for artifact modeling should be considered alongside the use of 3D artifact scanners, which have been effectively used for recording 3D artifact models, especially of lithics (White 2015; Kai-Browne et al. 2016; Bretzke and Conard 2012; Wachowiak and Karas 2009; Smith et al. 2012; Means et al. 2013; Counts et al. 2016; Magnani et al. 2014). The NextEngine scanner is one popular option applied by many scholars (Means et al. 2013; White 2015). However, the cost of 3D scanners (often costing many thousands of dollars in hardware and software costs) can make their purchase prohibitively expensive for projects with less funding. The NextEngine 3D Scanner Ultra HD, for example, costs $2,995, for example (NextEngine 2020). An IBM-based workflow can be much more cost-effective, not requiring the purchase of specialized scanning equipment (Magnani et al. 2014; Porter et al. 2016). This is especially true if camera and IBM software and processing costs are already integrated into a project for other purposes. When compared to 3D scanners, IBM methods can be comparatively accurate depending on the characteristics of the artifact and choices made in data capture and processing (Kersten and Lindstaedt 2012; Koutsodis et al. 2013; Clini et al. 2016; Gallo et al 2014; Marziali and Dionisio 2017; Molloy et al. 2016; Quattrini et al. 2017; Rodríguez-Martín 2020). Beyond price, the primary advantages of choosing IBM over artifact scanners are the flexibility and simplicity of the IBM system (Kersten and Lindstaedt 2012).

Aside from the choice of methods, scholars have successfully applied 3D modeling software to study ceramics in particular been a successful endeavor (Chow and Chan 2009; Zapassky et al. 2006; Fecher et al. 2020; Karasik and Smilansky 2008, 2011; Gilboa et al. 2013; Grosman et al. 2014; Di Angelo et al. 2021; Eslami et al. 2020). The application of 3D modeling to quotidian ceramics provides an important development in the use of 3D modeling technology, which has largely been applied to "particularly interesting objects" or "exceptional cases" (Molloy and Milić 2018). The uses of these programs to study ancient ceramics in three-dimensions can be divided into three main categories. First, sherd models can also be useful for analyzing fragile sherds, as models preserve a form of the sherd at the time of its capture (Garstki 2017; Grosman et al. 2014; Olsen and Placchetti 2015). This can be especially important for digital preservation of the artifact in the case of damage to the artifact (Olson and Placchetti 2015). Some artifacts are so fragile that mere exposure to air will cause them to disintegrate; in such cases 3D preservation can provide a record of their original appearance (Grosman et al. 2014) Moreover, destructive sampling of sherds was planned and conducted, so 3D documentation of the sherds' form would be able to preserve the form and appearance of sampled sherds as digital models.

Second, 3D modeling can be used to automatically produce illustrations of ceramic sherds and vessels (Gilboa et al. 2013; Wilczek et al. 2018). Ceramics are traditionally illustrated as two-dimensional line drawings, sometimes with multiple views of the same vessel. These illustrations typically illustrate a cross-section of the vessel with the details of the interior of the vessel on the left side and exterior surface treatment on the right side (Adkins and Adkins 1989; Collet 2012; Griffiths et al. 1990; Shirvalkar 2016; Wilczek et al. 2018). These perspectives help to give perspective on the overall shape of a vessel, even when only a diagnostic sherd exists. However, manually producing these illustrations is a painstaking and labor-intensive process that can be the primary factor in delaying the publication of a site by months or years (Gilboa et al. 2013). Fortunately, archaeological projects have developed solutions for the automated rotation and illustration of 3D models of ceramics (Gilboa et al. 2013; Kampel and Sablatnig 2003; Karasik and Smilansky 2008; Wilczek et al. 2018). Producing figures by using 3D models can improve the efficiency and accuracy of the resulting illustrations, while also helping to objectivize and standardize illustration styles (Gilboa et al. 2013). However, this can be a challenging technical issue based on a lack of rotational symmetry (Karasik and Smilansky 2008). The work of Karasik and Smilansky (2008) producing the Pottery3D program provides one prominent example of custom-built software that automatically repositions and illustrates diagnostic rim sherds providing a more efficient and accurate system of sherd illustration. In addition to serving as the basis for drawings, 3D model-based illustrations can also supplement traditional hand-drawn illustrations, combining the advantages of each technique (Fecher et al. 2020).

A third, more sophisticated use of 3D models of ceramic sherds or vessels aims to use the digital datasets as the basis for classifying these artifacts into types based on their similarity of attributes (Kampel and Sablatnig 2007; Koutsoudis et al. 2010; Di Angelo et al. 2017; Maiza and Gaildrat 2005; Smith et al. 2012). This approach toward analysis is appealing, as ceramic form analysis can be quite subjective, as discussed below, and digital methods provide great potential for objectifying this type of study. These processes, though exciting, typically assume that sherds represent a rotationally-symmetrical vessel (Roosevelt et al. 2015). Furthermore, the technical processes of classifying sherds represent a challenging, multi-faceted problem (Di Angelo et al. 2021). Such analyses can sometimes be limited to the use of complete vessels (Di Angelo et al. 2017; Koutsoudis et al. 2010). A related form of analysis uses digitized plate illustrations for automated classification of vessels into types, exemplified by Gilboa et al.'s (2004) pioneering work, later built on by Karasik and Smilansky (2011; Grosman et al. 2014). One project that combines the automated classification of 3D models of sherds with classification of published plates is the Pottery Informatics Query Database (PIQD; Smith et al. 2012). The PIQD was developed as part of ELRAP by Neil Smith (et al. 2012) and building on the work of Karasik and Smilansky (2011). In short, the PIQD creates "digital ceramic content" from either a 2D scan of a pottery plate drawing or a 3D scan of a sherd. These datasets are converted into a vector profile of the sherd, which can be used to publish a plate drawing or used to quantifiably categorize sherds (Smith et al 2012: 218-20). The PIQD also serves as an online database of vessel types for comparative analyses (Smith et al. 2012). Overall, the PIQD and other related methods illustrate the vast analytical potential of 3D ceramic data.

8.3 3D Models and Public Archaeology: Sketchfab

The recording of artifacts in 3D facilitates their sharing on digital platforms. These platforms can provide engaging and informative experiences to interested members of the public. Care should be taken when presenting such digital objects given the general lack of familiarity audiences have with digital objects and their relationship to objects (Garstki 2017). Like a photograph, 3D models are inherently the result of biases of data capture, processing, and display strategies, which isn't always clear to viewers (Garstki 2017). However, despite their derivative nature, interaction with virtual models of artifacts may actually allow for greater understanding of objects and their purposes than viewing the originals (Di Franco et al. 2015). As such, there are huge advantages to publishing appropriately-contextualized 3D models, and these models are becoming increasingly popular due to the rise in the recording of sites, areas, and artifacts in 3D for research purposes. Unfortunately, the open sharing of these datasets is often an afterthought (Scopigno et al. 2017).

Several platforms for sharing 3D models online exist, including Sketchfab, Autodesk Smithsonian X3D, 3DHOP, and others (Potenziani et al. 2015; Scopigno et al. 2017). Of these, Sketchfab is likely the most widely-used and is the “de-facto standard for publishing 3D content on the web” (Scopigno et al. 2017: 3). Sketchfab can be used for free, though paid account tiers also exist (Sketchfab 2020). The platform also has been successfully used for publishing and sharing 3D models of archaeological artifacts and sites (Baione et al. 2018; Means 2015; Scopigno et al. 2017). Two institutions that have successfully used Sketchfab as the basis for public outreach projects based around 3D recordings of archaeological artifacts and sites are the British Museum (https://sketchfab.com/britishmuseum) and CyArk (https://sketchfab.com/CyArk). Sketchfab allows for the annotation of models, meaning that scholars can provide a certain level of contextualization or interpretation along with their model (Scopigno et al. 2017). Sketchfab also provides virtual reality functionality, which can provide a more immersive experience for users (Ellenberger 2017). The digital publication of archaeological data should be seen as part of a larger movement toward supplements and alternatives to traditional site reports. These digital platforms can combine 3D models and contextualization in ways that facilitate open sharing of data. In particular, a recent digital publication by Garstki (et al. 2020a, 2020b) makes extensive use of Sketchfab for publicly sharing archaeological data. Despite the excellent opportunities offered by new, digital approaches toward publication, archaeologists should proceed cautiously. For ceramics, 3D models cannot be considered to be a replacement for traditional illustration given the comparative difficulty in viewing an entire assemblage potentially composed of hundreds of sherds as 3D models rather than as simple illustrations (Molloy and Milić 2018: 99). Thus, publishing frameworks that provide multiple levels of detail, from 2D illustrations to 3D models, along with archaeological contexts, may provide the optimal experience for interested users. One example of such a platform is discussed below.

8.4 Methods

The ceramic assemblage recovered from Khirbat al-Jariya (KAJ) in the 2014 excavation consists of a total of ca. 1,551 sherds. Recording all of these sherds in 3D using IBM is not feasible or necessary given the lack of analytical utility of body sherds, which represent the vast majority of the total. As such, a subset of the total was chosen for 3D modeling based subjectively on diagnostic potential. The sherds selected consisted primarily of rim fragments, which are most useful for both standard illustration practices and analysis of vessel forms. Nearly all rim sherds in the assemblage were chosen to be modeled; the few exceptions include sherds too small to capture using standard methods or be of analytical value. Also included in the collection of sherds to be modeled are a few fragments of vessel bases, chosen particularly because of their diagnostic utility. These include fragments of "Handmade Arabah Ware"/"Negebite Ware," discussed in further detail below. Ultimately, 47 sherds were chosen for modeling. These sherds represent the full range of diagnostic ceramics recovered from the site, providing an excellent basis for both automated illustration and publishing of 3D models.

In order to produce 3D models of the sherds, it was necessary to construct a custom photogrammetry rig (cf. Porter et al. 2016). Such a rig is necessary for multiple reasons, including holding the camera, positioning the artifact, lighting the artifact, providing a consistent backdrop, and rotating the artifact to capture multiple, overlapping angles. Though rotating the artifact is not optimal practice for IBM recording, it can be a necessary compromise for practicality (Porter et al. 2016). The rig used to collect data sufficient for the IBM modeling of ceramic artifacts consisted of many parts, each experimented with and chosen to solve specific issues within the modeling process. In total, the photogrammetry rig consists of several parts, the majority of which are either low-cost or repurposed from equipment previously available in the UCSD Levantine Archaeology Laboratory (Figure 8.1). A Manfrotto Magic Arm costing $153.99 represents the single most expensive part of the rig (other than repurposed items). This arm functions to clamp onto a table and allows for the positioning of the camera at appropriate angles and distances from the sherd to capture high-quality, in-focus images. Other relatively expensive items that were able to be repurposed from other lab activities include a Canon 50D DSLR camera and lenses, also used for aerial photogrammetry, as discussed above, and two lightboxes. The camera, of course the most essential piece of equipment for image-based modeling, was equipped with either a 50mm lens or a macro lens, depending on the size of the sherd being modeled. The use of either lens impacted the photo collection strategy accordingly. The lightboxes, set up alongside the camera, provided indirect but steady lighting to the front of the sherd. As such, the lighting limited the amount of shadows on the artifact that would potentially negatively affect model quality. In order to hold the sherd in one location while images were being taken, a custom tripod with a three-prong clamp was developed. This tripod clamp was intended to hold the sherd against the background with minimal surface area of the sherd obscured by the clamp. The clamp is also painted white to blend into the background and ease later masking procedures. The tripod clamp sat on a rotating cake stand, which allowed for multiple views of the sherd without adjusting the rig at all beyond making a small rotation to the stand. Finally, the rig also features a backdrop with clips allowing for the swapping in and out of different colored paper or cloth in order to provide a solid colored, contrasting backdrop.

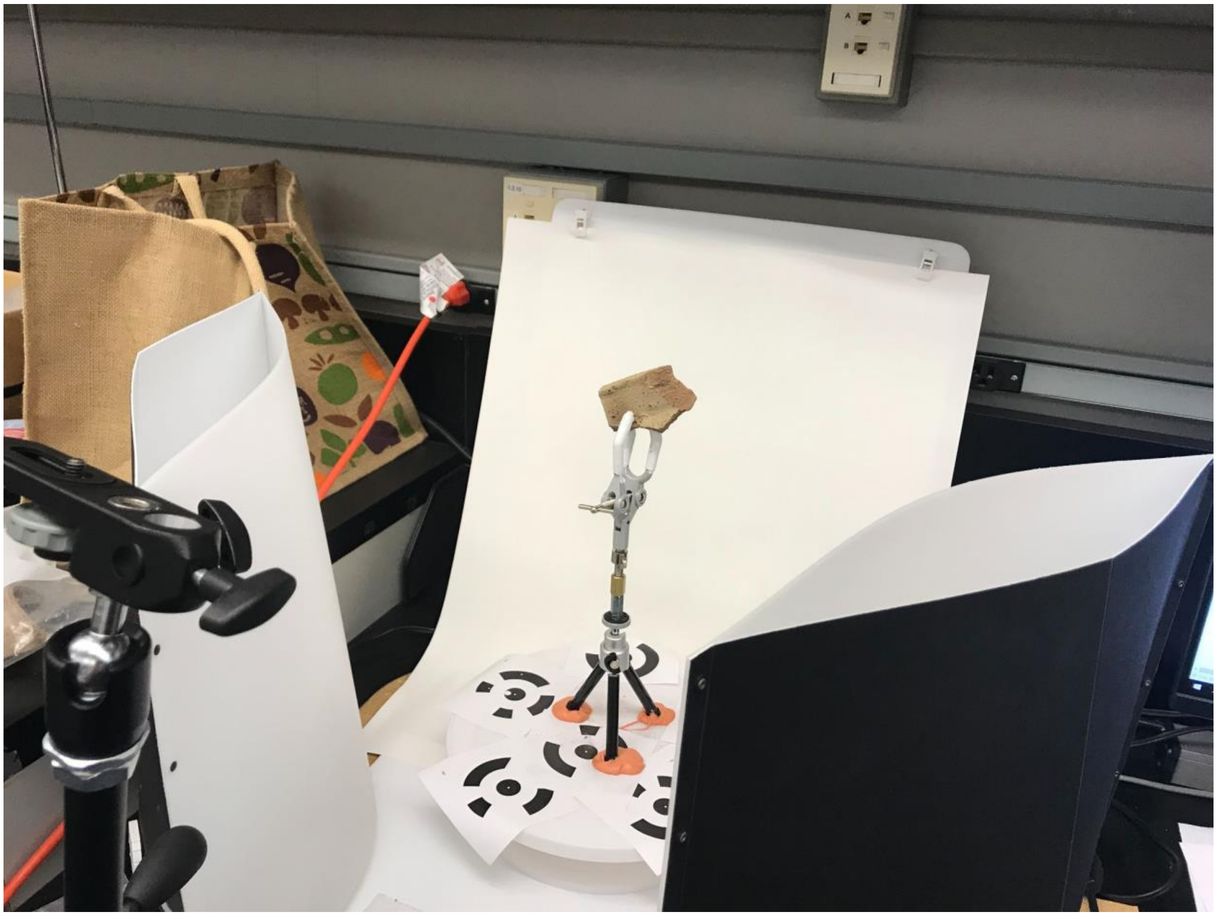

Figure 8.1: A view of the IBM rig. At left is the Manfrotto Magic Arm, which holds the camera while the rig is in use. At left and right are two lightboxes that provide indirect light to the front of the sherd. At center is the custom tripod/clamp, holding a sherd from KAJ, placed atop a rotating cake stand. At the back of the image is a customizable backdrop.

The data collection procedure for capturing photographs of each sherd sufficient to create 3D models was relatively straightforward. First, the sherd was placed in the three-prong clamp and the lights were turned on and adjusted as necessary to ensure that the sherd was fully-lit from the front without shadows. Next, a lens was chosen for the camera. The default lens was the 50mm lens, while smaller sherds necessitated use of the macro lens. The macro lens is sufficient but not optimal for the production of models given the limited depth of field provided by the lens. Equipped with a lens, the camera was mounted on the arm, which itself was adjusted in order to frame the sherd in focus. The camera settings were adjusted in order to capture images of the sherd that reflected its true color while maximizing depth of field, as having all parts of the sherd in focus is crucial to modeling a sherd. With settings and focus adjusted properly, images could be taken in RAW format to maximize data collection (Figure 8.2). After each photograph was taken, the cake stand was rotated ca. 5 degrees upon which another image would be taken until the circle was complete, continually adjusting focus to ensure a clear image. The collection of so many images provided a high degree of overlap, which is an important factor for the successful completion of a model as discussed above. In addition, the collection of images in 360 degrees in a plane around the sherd allowed for overlap on each end of the photographic sequence, as the first image and the last image should feature 95%+ overlap, like any other sequential pair of images.

Figure 8.2: A typical example of one image used to create 3D models of artifacts.

However, collecting images in one plane around the sherd is not enough to produce a model. As such, after one ring of images was completed, the sherd needed to be adjusted two or three times in the three-prong clamp with another set of images taken after each adjustment (Figure 8.3). The purpose of the adjustment is two-fold. First, adjusting the sherd is necessary in order to capture all angles of the artifact with relatively even coverage, ensuring that every feature of the object is visible in at least one set of images. Second, the three-prong clamp covers part of the sherd during each photo sequence. As such, areas obscured during one set would need to be captured in a subsequent set, meaning that the clamp's position on the sherd would need to be moved. Ensuring that the clamp didn't cover a specific part of the sherd in multiple image sets was one of the biggest challenges in collecting good quality image sets. Overall, three to four complete photo rings collected would be enough data to produce a high-quality model. In total, approximately 200-250 images were taken of each sherd.

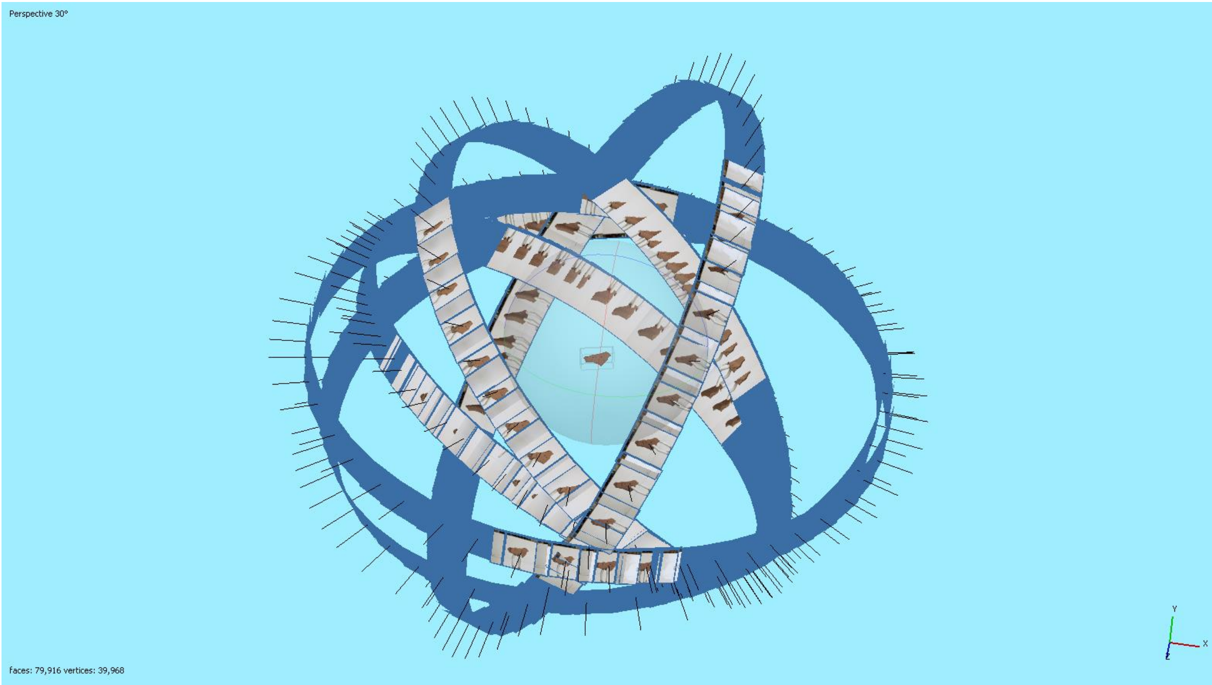

Figure 8.3: A screenshot of Agisoft Metashape, showing a processed sherd model surrounded by rings representing the locations of photographs taken. In this case, five sets (rings) of photos were taken, an unusually high amount.

After images were collected, they were sorted, named and processed from RAW format into TIFFs using the software Adobe Photoshop Lightroom. The production of TIFFs allows for straightforward processing within Agisoft Metashape (formerly Agisoft Photoscan). Within Agisoft, images would also have to be masked, meaning that the background and clamp would be removed from consideration for the 3D model. Most often, the images were masked using an automated method by which unwanted areas could be removed by their color. With images masked, the model could be processed according to the steps described above. In some cases, resetting and re-aligning photos would help to correct misalignments as the Agisoft software is not always able to deal with the similarity of unmasked background or clamp shown in images. Models were typically processed on High specifications. With a model processed satisfactorily, the model could be spatially-referenced, giving it a true size rather than existing in abstract space. Models were spatially referenced through using digital calipers to measure the distance between two prominent points on the sherd, and using the "scale bar" feature within Agisoft to reference that distance (Figure 8.4). In total, these steps were sufficient to produce high-quality 3D models with sub-millimeter levels of accuracy (as reported by Agisoft). These models also feature near-photorealistic textures as well.

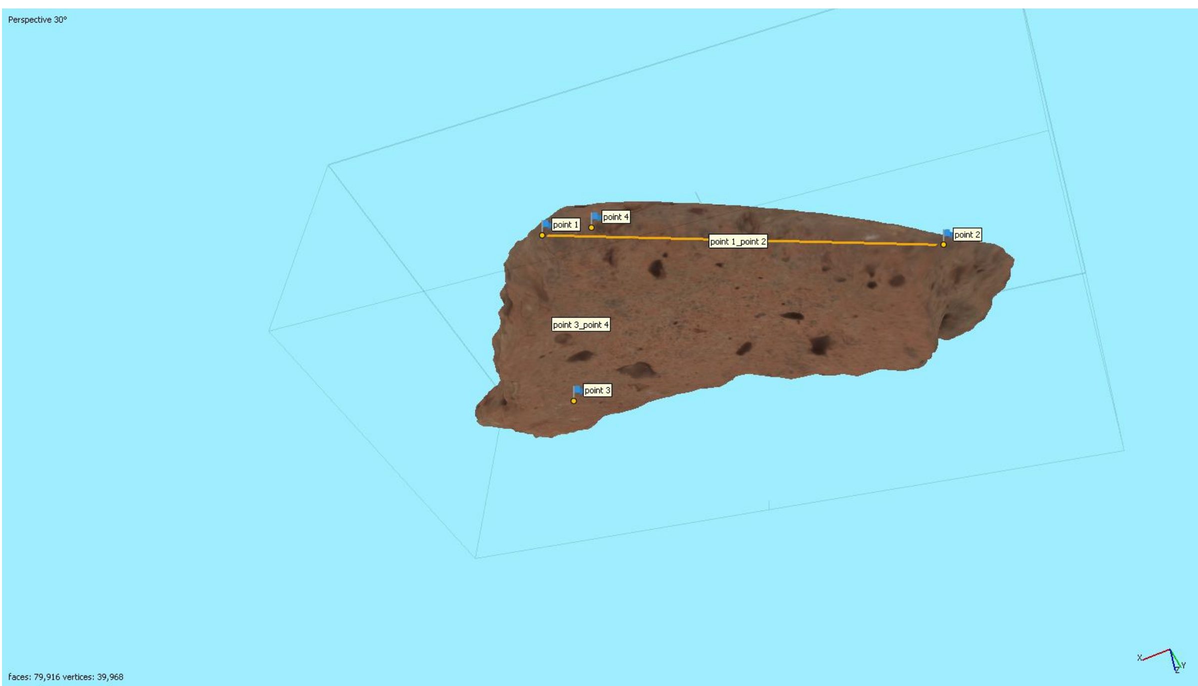

Figure 8.4: A processed sherd model with a yellow line representing the "scale bar" feature used to spatially reference the model. The small blue flags with labels represent the prominent points on the sherd selected as the ends of the scale bar, measured with calipers.

As discussed above, 3D models of ceramic sherds can be an excellent basis for the automated illustration of ceramic sherds. The program Pottery3D, generously provided by Dr. Avshalom Karasik. Pottery3D automatically reorients and illustrates sherds for use in this study, and provides for the customization of each illustration (Karasik and Smilansky 2008). Prior to using Pottery3D, the models were re-scaled and preliminarily oriented in the free software Meshlab in order to optimize automated orientation and illustration results. Subsequently, in Pottery3D, plate illustrations of each of the sherds modeled were produced. A model of each sherd was uploaded to the Pottery3D software, which is able to process and illustrate the sherd in a manner of minutes. In some cases, incorrect initial alignment required some manual adjustment. However, overall, the automated illustration of sherds through this method saved a great deal of time/money and provided a more objective standard of illustration for the sherds. The illustrations produced through this method are presented below. Automated classification of sherds into types (e.g. Karasik and Smilansy 2011; Smith et al. 2012) was not performed in this study as manual classification of the ceramics was preferred due to the relatively small size of the assemblage.

Each of the 3D sherd models was also uploaded to the author's Sketchfab account, providing detailed geometric and textural Open Data (Figure 8.5). The publishing of the sherds in this way provides an important supplement to the traditional-style profile illustrations of the sherds, though potentially lacks a full description of spatial context. As such, these models were also published to two ArcGIS StoryMaps for fuller description and contextualization. The 3D models of the sherds are presented along with their spatial context in one StoryMap and presented along with the 2D illustrations in another StoryMap, as discussed below. As such, these platforms directly address two of the main flaws of publishing 3D data, lack of contextualization and the difficulty of absorbing information about many artifacts in quick succession.

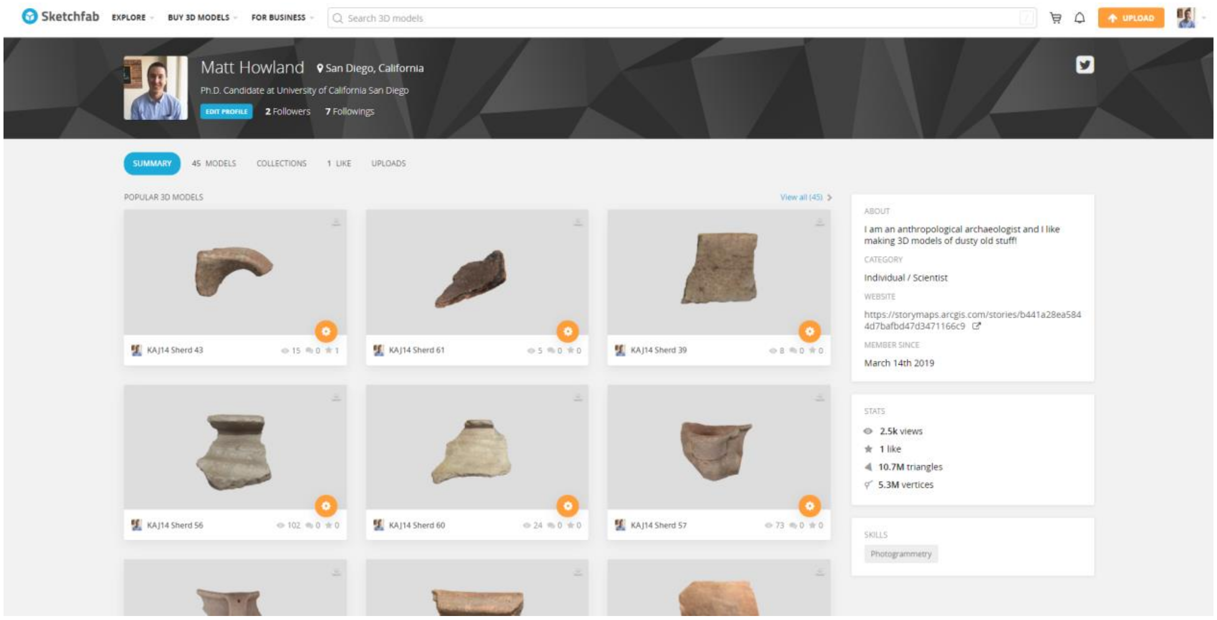

Figure 8.5: A screenshot of the author's Sketchfab account, displaying several of the 3D models posted there.

8.5 Discussion

The production of 3D models is an important step in addressing the hypotheses presented here regarding the development of social complexity at Khirbat al-Jariya and the engagement of occupants of the site in interregional exchange networks. By modeling sherds in 3D, it is possible to automatically produce plate illustrations of diagnostic ceramics. These plate illustrations, which are relatively standardized black and white two-dimensional illustrations of ceramic profiles (Adkins and Adkins 1989; Collet 2012; Griffiths et al. 1990; Shirvalkar 2016; Wilczek et al. 2018), convey the overall shape of the vessel even in cases when only a diagnostic rim sherd exists. Thus, the production of these plate illustrations helps to mitigate the lack of complete vessels at KAJ—representative of a broader trend in Edom (Hart 1989; Smith and Levy 2014: 305; Oakeshott 1978). The plate illustrations, presented below, also facilitate direct comparison between the ceramics from KAJ and assemblages from other sites and regions, which are near-universally published in the same format.

Thus, the production of diagrams showing the forms of the ceramics from KAJ helps draw parallels to vessels from other sites. This process, in turn, is useful for examining the extent to which occupants of KAJ operated in a similar social sphere with or interacted via exchange networks with residents of other sites. The results of these typological comparisons and their significance is discussed in further detail below.

8.6 Conclusion

The work conducted here represented the third avenue of IBM use, in addition to aerial and terrestrial applications. The 3D modeling of ceramic sherds is a relatively straightforward task with a multitude of benefits. First, the production of 3D models of sherds provides a record of the original form of the artifact. This can be valuable in case the sherd deteriorates or is subject to destructive analysis. In this study, the majority of recorded sherds were thin-sectioned for petrographic analysis, giving the 3D models increased significance. The production of 3D models has also allowed for the automated illustration of sherds through the Pottery3D program, producing another record and interpretation of the form of each artifact. Once models are created, their automated illustration provides a straightforward and more objective way to illustrate the sherds in traditional style. The depiction of these artifacts in this style provides a strong basis for comparison with other published assemblages. The illustrations of sherds provided below were produced using the Pottery3D software, demonstrating the utility of this approach for producing these drawings. 3D models of ceramics also serve as an excellent basis for digital open data sharing, on platforms such as Sketchfab and ArcGIS StoryMaps, as discussed below. In total, the recording of ceramics in 3D provides multiple benefits for scholars interested in documenting and conducting analyses on their assemblages.

Chapter 9: Ceramic Analysis – Classification and Typology

9.1 Introduction

The second avenue of ceramic analysis applied to the ceramics of Khirbat al-Jariya (KAJ), Jordan, is a study of the form of the assemblage. Ceramics, as some of the best-preserved remnants of ancient society, are a critical line of evidence for understanding the past. Form analysis of ceramic assemblages is a critically important method for interpreting the past as ceramics are often some of the best-preserved artifacts found at a site and they played many roles in the social fabric of communities (cf. Braswell 2014; Kramer 1985; Rice 1987). Moreover, analysis of ceramics from household contexts can shed light on status and identity at a site (Goldstein 1993). Form analysis of ceramics is a key method for addressing many of the hypotheses tested through this work. More specifically, the assumption that Building 2 at KAJ represents an elite context is tested through study of the distribution of serving and cooking vessels across the site, as well as through examining the presence or absence of finewares and ceramics associated with imported "elite" foods (cf. Brumfiel 1987; Garraty 2000; Gumerman 1997; Hirth 1993; Turkon 2004; Smith 1987). This hypothesis is also addressed through comparison of the ceramics from Area B at KAJ to those of elite areas (e.g. Areas R and T) at the nearby site of Khirbat en-Nahas (KEN). Comparative analysis of the assemblages of these two sites also allows for the testing of the hypothesis that copper production and society at KAJ and in Iron Age Faynan was locally controlled. Shared technological traditions in ceramic production as seen through homogeneous assemblages are reflective of a community of practice, which can be studied through ceramic analysis (cf. Roux 2016; Lave and Wenger 1991; Wenger 1998). The hypothesis that copper produced in Faynan was primarily exchanged westward through the Negev rather than through other routes is tested through comparison of forms found at KAJ and those from Negev sites and examination of imports, possibly reflecting social affiliation or trade connections. Finally, the proposal that elites at KAJ wielded exclusive control over long-distance exchange, catalyzing increased inequality, is tested both through comparison of the quality of ceramic forms and presence of fine tablewares from Building 2 vis-à-vis other parts of the site. As such, the typological analysis of sherds from KAJ conducted here sheds light on many of the important issues tested here.

9.2 Form Analysis

Despite the importance of studying ceramics, classifying and interpreting typology is a somewhat fraught venture. Typological classifications in the past have suffered from the use of naming schemes that are not consistent or potentially misleading (Hendrix et al. 1996). These classifications have also been criticized as overly subjective (Amiran 1969). In addition, pottery classifications can be considered *emic* or *etic* (for a review of the significance of these terms in anthropology, see Harris 1976; Jorion 1983). In *emic* classifications, a typology should relate to how the vessel was conceived of by its maker or user in the past. This style of classification necessitates a theoretical or ethnographic approach allowing classifiers to understand the contemporary cultural significance of the vessel type (Albero et al. 2016). Alternatively, an *etic* classification attempts to take a more scientific approach in recognizing that present-day scholars will have a very challenging time relating to the technological, social, and ideological context in which the vessels were used. As such, many scholars avoid attempting to recreate the cultural milieu in which the vessels were formed and instead attempt to devise more objective classification criteria based on measurable elements of each vessel (Albero et al. 2016). Etic approaches, though abstracted from the original context of artifacts' use, are arguably more useful to archaeologists because of their ability to make useful distinctions not made by the society in which the object was used (Hayden 1984). Etic schemes are the most common among archaeologists and the resulting systems of grouping are known as *devised classifications* (Rice

2015; Albero et al. 2016) (as opposed to emic *folk classifications*). Unfortunately, moving away from an emic typology to an etic classification opens a veritable Pandora's Box of attributes to choose from, rather than being limited to those that are culturally or socially relevant to a folk classification. In fact, the number of attributes of any given vessel is potentially infinite, given the many possibilities for measuring and contextualizing ceramics (Hill and Evans 1972; Rice 1987). These attributes can be morphological (considering the shape characteristics of a vessel), decorative (considering its appearance), technological, compositional, or even contextual (factoring in the find-spot of a vessel, its age, and perceived function; Rice 1987). The infinite possibilities for classification criteria have logically resulted in overly subjective and inconsistent schemes of organizing ceramic forms. To address this issue, some scholars differentiate between classifications, based on taking a scientific approach to grouping vessels based on chosen attributes, and typology, a classification with theoretical grounding and well-established and practiced rules (Hayden 1984; Rice 1987; Whittaker et al. 1998; Albero et al. 2016). Interestingly, as true typologies were developed, they became intertwined with attempts at seriation, stratigraphic context, and cultural affiliation. The aggregate of these three aspects of typology is a system in which the identification of specific vessels or vessel types can serve as an important identifier of the presence and activity of a particular cultural group (Albero et al. 2016). While this paradigm of ceramic analysis was superseded — or at least developed on — by Processual and Post-Processual theoretical development, to a large extent it still plays a central role in Levantine ceramic typologies. Drawing on these prior studies, the precise application of terminology is essential in ceramic analysis. Here, the general morphological categories of ceramics (e.g., bowls, jars, kraters, etc.) will be referred to as *forms*. More specifically, groupings of ceramics within these categories but without reference to an established typology will be referred to as *classes,* while those groupings that do relate to a theoretically-informed and established typology will be referred to as *types.*

9.3 Ceramic Typology in the Southern Levant

The creation of ceramic devised classifications and the subsequent development of typologies has a long history in the Levant. The work of Sir Flinders Petrie and Frederick Jones Bliss at Tell el-Hesi (incorrectly identified as Biblical Lachish at the time) in the early 1890s was instrumental in developing a classification, linking it to chronology through seriation, and, in turn, connecting that chronology to the archaeological record through stratigraphic analysis (Fargo and O'Connell 1978). These beginnings would establish a trend, continuing to this day, in Levantine archaeology of the primary importance of interpretation of ceramics through established and developing typologies. Following in Petrie's footsteps would be notable scholars such as Ruth Amiran (1969), Amihai Mazar (et al. 2001), and Seymour Gitin (2015), among many others. To a large extent, the typologies followed by these works follow an alphanumeric system (Smith and Levy 2014) that primarily categorizes vessels based on their morphology rather than on other possible attributes. Amiran in her classic (1969) work, for example, categorizes vessels in each chapter as one of the following forms: "Bowl, Chalice, Goblet, Krater, Cooking-pot, Pithos, Jar, Amphoriskos, Jug, Juglet, Pilgrim-flask, Pyxis, [or] lamp." This morphological classification carries strong ties to chronology (Iron I types, Iron IIA types, etc.) and cultural identity (Philistine, Israelite, Edomite, etc.). This can be clearly seen through the grouping and discussion of vessel types in comprehensive volumes such as those authored by Amiran (1969) and Gitin (2015). In the latter, for example, chapters are subdivided by time period and region (Gitin 2015). Amiran's typology explicitly argues for the usefulness of the link between ceramic forms and chronology, indeed "the whole conception and structure of [the] book is axed upon the chronological factor — considered by [Amiran] to be of primary importance" (Amiran 1969: 14). Comparison to standardized, established morphological typologies with chronological significance such as those published by Amiran (1969) and Gitin (2015) has been common practice in the Southern Levant, and has facilitated the comparison of newly-excavated vessels to well-known types. Well-known site-specific or regional typologies such as those published by Panitz-Cohen (2001, 2006), Herzog and Singer-Avitz (2004), and Herr (1997; and Trenchard 1996) also facilitate study of parallels.

However, despite their utility for cross-regional comparison, these standard typologies common in Southern Levantine archaeology seem to lack the theoretical development of processual archaeology, in which hypothesized use of a vessel would be of primary importance, or post-processual studies in which ceramic forms are a complex and intentionally-created reflection of their social and cultural milieu (Albero et al. 2016). For example, processual studies such as those conducted by Schiffer and Skibo (1987) or Woods (1986) provide functionalist perspectives on the use of ancient ceramics, analyzing the extent to which form and composition affect the physical properties and uses of the vessel. These analytical approaches are not typically seen in Levantine ceramic studies, as even compositional analyses tend to focus on provenance rather than technology (Badreshany and Phillip 2020). Post-processual studies, such as Hodder (1982), emphasize the symbolic importance of pottery rather than its technical function. In the southern Levant, critiques over the relationship between Philistine pottery and Philistine identity provide insight into the limited extent to which even this symbolic perspective has been a development over simplistic culture-historical ideas (Maeier and Hitchcock 2017). The popularity of standardized typologies tied to chronology incentivize scholars to focus primarily on defining their assemblages in comparable terms to these schemes rather than applying more developed theory (Badreshany and Philip 2020; Dessel and Joffe 2000). Moreover, the established typologies are generally established on the basis of sites in Israel and then applied to sites in Jordan and elsewhere (Philip and Baird 2000a). A preference toward interpreting ceramics from other regions in terms of these typologies based in Israel is sometimes made explicit (e.g. Finkelstein and Singer-Avitz 2009). This paradigm has reduced the likelihood of scholars undertaking study of the local variability of ceramics or more sophisticated ceramic analysis projects integrating ceramic petrography and chemical analysis to address issues such as ceramic production technology (Badreshany and Philip 2020; Philip and Baird 2000b). These types of projects are more widely-applied in the Aegean, where petrographic analyses are common (Sherratt 2011). However, in recent years, the integration of petrography to ceramic studies has become somewhat more common (e.g. Martin et al. 2013; Kleiman et al. 2017; Smith and Levy 2014; Smith et al. 2014a). This study aims to transcend the limitations of comparison to established typologies by complementing this type of comparison with analysis of how key classes display local variability, as well as the application of an integrated ceramic petrography study, discussed further below.

9.4 Ceramic Typology in Iron Age Edom

Limited knowledge of the diversity of ceramic assemblages in Jordan and over-reliance of Levantine archaeologists on established typologies primarily generated on the basis of collections from sites in Israel has historically hindered the ability of scholars to develop a nuanced understanding of ceramics from Ancient Edom. Excavations at Busayra (Bennett 1974, 1975, 1977, 1983), Tawilan (Bennett 1984; Bennett and Bienkowski 1995), and Umm al-Biyara (Bennett 1966), discussed above, were the initial basis of the first attempt at a systematic typology for the region's sites, produced by Oakeshott (1978). Oakeshott's (1978) typology proved to have staying power, becoming a crucial point of comparison for many studies of ceramics from ancient Edom (Smith and Levy 2014). However, flaws in Bennett's excavation and ceramic collection strategies of key Edomite sites have limited the usefulness of Oakeshott's typology (Smith and Levy 2014). Furthermore, based on incomplete evidence of Early Iron Age settlement in Faynan at the time of Oakeshott's work, the typology itself fails to consider the possibility of an earlier origin to the Edomite ceramic tradition (Oakeshott 1983). Other classifications conducted on Edomite ceramic assemblages suffer from similar issues. For example, Hart's (1989) studies relied heavily on the work of Oakeshott. Pratico's (1992) reinterpretation of the ceramics of Tell el-Kheleifah and Zeitler's (1992) study of ceramics from near Petra provide insight into the ceramic traditions of those areas but without offering an overall framework for which to understand assemblages from Edom. Given a lack of a comprehensive published typology for Edom, there was a need for a published ceramic schema based on both Early and Late Iron Age sites in both lowland and highland Edom. Fortunately, Smith and Levy (2014) addressed these issues by publishing a typology based on the assemblages (a total of 4,757 rim sherds) from KEN, KAJ Area A, RHI, and several sites in the traditional highlands of Edom. The preliminary version of Smith and Levy's (2008) typology was critiqued from several angles (Finkelstein and Singer-Avitz 2009; Tebes 2009). The primary criticism leveled by Finkelstein and Singer-Avitz (2009) was that the KEN assemblage had been inappropriately dated by radiocarbon rather than through comparison with established typologies from Israel. This critique suffers from some of the drawbacks of a focus on the relatively ossified typologies of Israel rather than allowing for regional and local variation from accepted schemes. Furthermore, the full publishing of the ceramic assemblage and excavation data from KEN in 2014 also laid to rest much of the debate over the dating of occupation and settlement at KEN and associated ceramic assemblage (Levy et al 2014; Smith and Levy 2014). As such, Smith and Levy's (2014) typology establishes a strong, detailed framework for which to compare other assemblages from Edomite sites.

However, the results and interpretations published by Smith and Levy were challenged again by Tebes (2021), who took the opportunity provided by an adjustment to the radiocarbon calibration curve (cf. Manning et al. 2018) to again challenge the ceramic evidence from the site. Only 17 of the 104 radiocarbon dates (Levy et al. 2014) were subjected to substantial adjustment by the new calibration (Tebes 2021), and few of these substantially affected the chronology of an Area. In some cases, chronological adjustments are made by disregarding certain dates due to their context rather than through calibration adjustments. For example, in Area R, the new calibration generally raises (i.e. makes older) the dates but Tebes' (2021: 20) analysis nevertheless lowers the foundation date of the structure by a century by ignoring three radiocarbon dates associated with the 10th century BCE from fill. Such an adjustment seems inconsistent with Tebes own suggestion that radiocarbon dates "are reliable indicators of the periods of time during which copper production was carried out there," even if not the only line of evidence that should be considered. On the basis of ceramic evidence, Tebes argues that some of the forms recovered from KEN are representative of the Late Iron Age and as such, the site was occupied in the late 8th-7th centuries BCE (Tebes 2021). This interpretation has no bearing on the peak of occupation at the site, which occurred during the 10th-9th centuries BCE on the basis of radiocarbon dating and ceramic evidence, which shows clear affiliation with the Early Iron Age. The full cultural significance of the early Edomite typology for Iron Age society in Edom has been discussed above and the relationship between this typology and new evidence from KAJ will be dealt with below.

9.5 New Ceramic Evidence from Khirbat al-Jariya

9.5.1 Classification and Typology

The ceramic assemblage from the 2014 excavations at Khirbat al-Jariya is relatively small, as one would expect from a site with a primarily industrial purpose. The assemblage from the 2006 excavations at KAJ (Ben-Yosef et al. 2010), already published by Smith and Levy (2014) is not re-analyzed here but rather treated as a closely-related assemblage for comparative purposes. Overall, the assemblage from KAJ 2014 consists of ca. 1,551 sherds. Of these, ca. 62 are diagnostic sherds that are able to be interpreted in terms of the form of the original vessel. Unfortunately, no complete vessels were recovered. Thus, rim fragments are analyzed and illustrated here given the lack of more complete forms. Moreover, given the small sample size, it is not appropriate to attempt to generate a new typology from the KAJ assemblage. Rather, the analysis here will generate a classification based on comparison with other well-established typologies from Edom and the southern Levant. This classification will also follow in the footsteps of many Levantine scholars by applying a combined alphanumeric naming system (Mazar et al. 2001; Smith and Levy 2014; Zimhoni 1997) and morphological classification strategy with links to chronology and culture, in the style of Amiran (1969) and Gitin (2015). Thus, ceramics will be divided into *forms* (e.g., bowls, jars, kraters, etc.) and then assigned alphanumeric *classes* (e.g., Bowl 1, Bowl 2). The ceramics of each *form* group will be treated differently, i.e. Bowl 1 has no inherent relationship to Jar 1. These classes will be compared to *types* (i.e., classes that are more theoretically-informed and established with clear guidelines, as part of a typology) from other contemporaneous sites in the Southern Levant. Sites considered will include Khirbat en-Nahas and other Edomite sites (Smith and Levy 2014), Beth Shean (Mazar 2006), Tel Gezer (Gitin 1990), Tel Arad (Singer-Avitz 2002), Tel Beersheba (Aharoni 1973, Herzog 1984; Singer-Avitz 2004), Lachish (Zimhoni 1997, 2004), Tel Masos (Fritz and Kempinski 1983), the Southern Ghor and Northern Arabah Survey (MacDonald 1992), Barqa el-Hetiye (Fritz 1994), Tell el-Qudeirat (Bernick-Greenberg 2007a, 2007b), Timna Site 30 (Rothenberg 1980) and Site 34 (Kleiman et al. 2017), many sites in the Negev (Cohen and Cohen-Amin 2004), Busayra (Bienkowski 2002), Tawilan (Bennett and Bienkowski 1995), Umm el-Biyara (Hart 1989), Tel Batash (Panitz-Cohen 2001, 2006), Qasile (Mazar et al. 1985), Tel ‘Ira (Beit-Arieh 1999), among others. A classification of the sherds and vessel classes recovered from KAJ in 2014 is important for providing a comparative base to other established typologies in Faynan, the Negev, Beersheba Valley, and Judah such as these. Detailed descriptions of parallels and illustrations are found in Appendix A.

Bowl 1: *Fineware bowl with rounded rim (Figure 9.1:1)*

Sample: KAJ34

Description: This is a small fineware round-sided bowl with a rounded rim.

Fabric: 3

Decoration: Red slip and uneven hand burnish on exterior (int./ext.)

Parallels: This bowl closely parallels *KEN* BL16a at *KEN* IV (pl. 4.1:22) and III-II (pl. 4.10:9). This is a red-slipped and hand burnished bowl, characteristic of the Iron IIA period. These vessels are most common in the 11th and 10th centuries BCE, initially developing in Philistia in the Iron I (Cohen and Cohen-Amin 2004; Mazar 1985: 33; 1997:160; 1998). Smith and Levy’s (2014) BL16a are characterized as “imports from the Western Negev.” Typological study suggests this bowl is also an import, this question is addressed in further detail below through petrographic analysis. Other parallels include *Tell el-Qudeirat* Bowl 1 (pl.11.1:1; 11.30:2), *Timna Site 34* (pl. 6:11), *Lachish 1997* Stratum IV (pl. 3.5:14); *Arad* Stratum XI (p. 6: 2); *Beersheba II* Stratum VI (pl. 26:18).

Bowl 2: *Fineware carinated bowl with band and thickened rim (Figure 9.1:2)*

Sample: KAJ35

Description: This thin-walled fineware bowl features a curved carination, a band above the carination, and a thickened rim.

Fabric: 3

Decoration: Red slip and burnish (int./ext.)

Parallels: KEN Bowl 24 (pl. 4.1:26); *Lachish 2004* Stratum IV (pl. 25.56:22) *Beersheba II* Stratum VII (pl. 21.5) features similar decoration though lacks carination. *Tawilan* (pl. 6.7:12) features a similar form but not decoration. This bowl, like Bowl 1, is also representative of the Iron IIA trend of red-slipped and burnished bowls, imported from the Negev.

Bowl 3: *Fineware bowl with flattened rim (Figure 9.1:3)*

Sample: KAJ17

Description: This is a fineware round-sided bowl with a flattened rim.

Fabric: 2

Decoration: None

Parallels: This is a generic fineware bowl with no distinctive parallels.

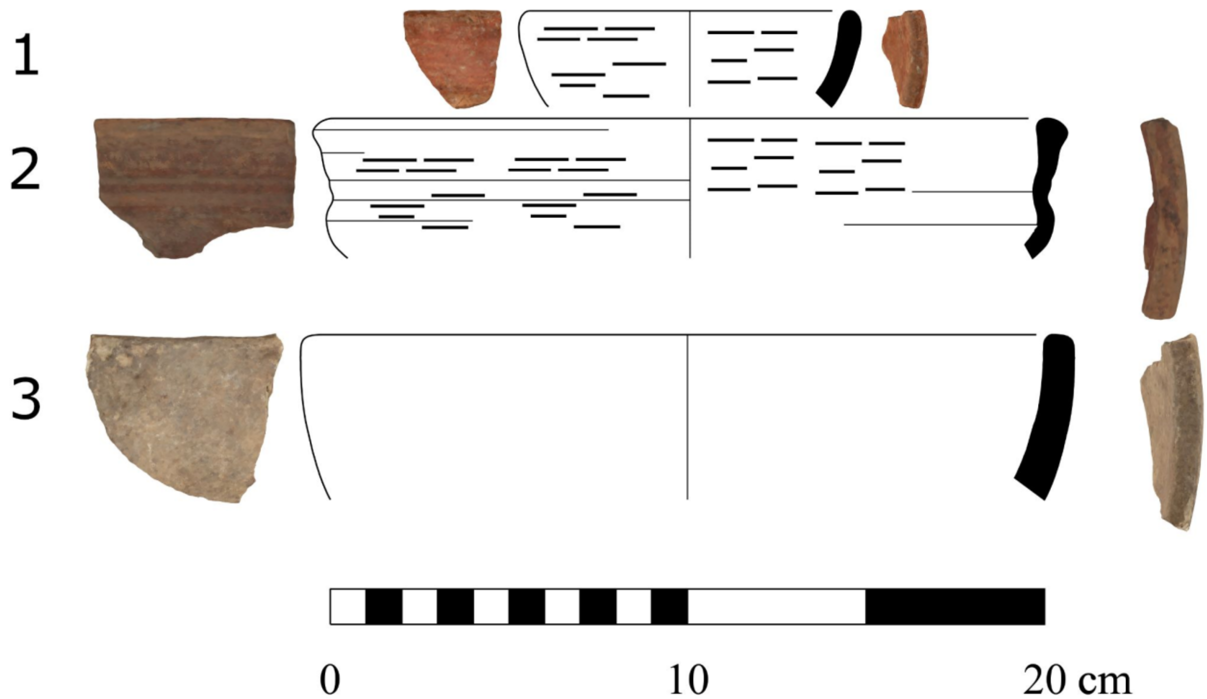

Figure 9.1: Bowls recovered from KAJ in 2014 excavations, details in Table 9.1.

Table 9.1: Bowls recovered from KAJ in 2014 excavations (Figure 9.1).

Image Num.	Sample Num.	Area/Stratum	Locus	Basket	Vessel Form	Class	Ware Group/ Subgroup	Description
1	KAJ34	B2b	561	10665	Bowl	1	3	Red slip and hand burnish (int./ext.)
2	KAJ35	B2b	561	10704	Bowl	2	3	Red slip and burnish (int./ext.)
3	KAJ17	B2b	543	10654	Bowl	3	2	

Jar 1: *Cup-spouted Jar (Figures 9.2:1, 9.10)*

Samples: KAJ18, KAJ55, KAJ57, KAJ58 (distinct rim sections: 1)

Description: This spouted storage jar has a long everted, rounded and thickened rim with a substantial grove on the middle of the lip, potentially to support a lid. This jar also features a cup-like spout that attaches to the everted rim and drains into the body of the vessel. The cup is bracketed by two small strap handles. The everted and grooved rim is similar to that of Jar 2.

Fabric: Unsampled by petrographic analysis but Fabric Group 1 based on macroscopic study

Decoration: None

Parallels: The cup-spouted storage jar is common in Judah and elsewhere in the Iron IIB (Herzog and Singer-Avitz 2015; Wilson 2017; Singer-Avitz 2019: 113-114). However, spouted storage jars also appear in the Iron IIA at a number of sites. Iron IIB types are more likely to have a spout that connects to the rim and shoulder of the vessel, while cup spouts in the Iron IIA are more likely to lie flush against the neck and shoulder of the vessel (Herzog and Singer-Avitz 2015: 217). The typical Iron IIB cup-spouted jar features three handles, spaced at even intervals around the mouth of the jar along with the cup spout, though examples with different handle configurations exist (Wilson 2017; Singer-Avitz 2019: 113-114). Examples of cup-spouted jars from the Iron IIB are found at Beth-Shean Stratum P-7 (Mazar 2006: pl. 38:1, 2), *Tell el-Qudeirat* Substratum 3a-b (pl. 11.33:11) and Substratum 3b (pl. 11.37:8), *Tel Gezer* Stratum VII (pl. 19:15) and VIA (Wilson 2017, Fig. 4.20:5; 4.23:7), Beersheba Stratum II (Aharoni 1973, pl. 58: 30-32; 65: 8), *Lachish* 2004 IV Stratum III (pl. 26.19:1; 26.22:1; 26.25:5; 26.34:9; 26.42:9), and *Tawilan* (pl. 6.31: 12), among many others. Iron IIA examples, featuring a cup spout flush against the shoulder of the vessel, can be seen at *Beersheba III* Stratum V (pl. 11.19:1; 11.20:12; 11.28:9) and Stratum IV (pl. 11.39:12; 11.45:1; 11.47:17; 11.49:5), *Arad* Stratum XI (pl. 5:7; 9:7), *Tel Masos* (possibly late Iron I, pl. 150:8), and SGNAS Survey Site 29 (MacDonald 1992 pl. 20:1, a survey find but dated by MacDonald to Early Iron II). Despite this general trend, examples from *Lachish 2004* Stratum IV (pl. 25.32:12; 25.33:14; 25.44:10) illustrate that the flush spout isn't always observed in Iron IIA cup-spouted jar vessels. Complicating the matter is that this example from KAJ features a cup spout bracketed by two small handles and two other handles; breaking from the three handle trend common in the Iron IIB and a layout for which there are no obvious exact parallels. The example from SGNAS Survey Site 29 (MacDonald 1992 pl. 20:1) and from KEN Phase IV (incorrectly published as Phase V) (JR 28, pl. 4.1:14) feature a handle adjacent to the cup, making these vessels, both dated to the Iron IIA (though somewhat tenuously), the closest parallels in handle layout. Finally, this example from KAJ also features a grooved rim not seen in other cup-spouted jars with the notable exception of that from SGNAS Survey Site 29, also in Faynan. The grooved rim is otherwise paralleled at *KEN* JR6 Integrated Phases (IP) V and II (pl. 4.1:13; 4.9:7), and *Tell el-Qudeirat* Stratum 4b (pl. 11.8:5). Overall, the relatively high frequency of cup-spouted jars in Early Iron Age Faynan (KEN IP IV JR 28, pl. 4.1:14; SGNAS Survey Site 29, Macdonald 1992 pl. 20:1; and, notably, *KEN* Figure 2.202, a decorated cup-spouted jar not previously published as a cup-spouted variety) and uniqueness of these vessels indicates they are the subject of local variation and significance.

Jar 2: *Jar with everted, grooved rim and shoulder ridges (Figure 9.2:2)*

Samples: KAJ19, KAJ59 (distinct rim sections: 2)

Description: This jar has an everted, rounded and thickened rim with a substantial groove on the middle of the lip, potentially to support a lid. The rim is similar to that of Jar 1. Jar 2 is differentiated by the presence of two ridges on the shoulder of the vessel.

Fabric: 1A

Decoration: Two ridges on shoulder of jar.

Parallels: Barqa el-Hetiye (pl. 10:7) is a close parallel; *KAJ06* (pl. 4.38:17) features a similar rim profile though lacking a groove in the everted rim (a shoulder ridge is present but not illustrated in

KAJ06). Parallels for the grooved rim can be found in JR6 at *KEN* V and II (Fig. 4.1:13; 4.9:7), as well as *Tell el-Qudeirat* Stratum 4b (pl. 11.8:5), which may also have a shoulder ridge.

Jar 3: *Jar with everted rim and shoulder ridges (Figures 9.2:3, 9.2:4)*

Samples: KAJ20, KAJ56, KAJ60, KAJ61 (distinct rim sections: 2)

Description: This jar has a rolled out rim, creating an overhanging rounded and grooved ledge. The jar also features two shoulder ridges.

Fabric: 1A

Decoration: White slip. Two ridges on shoulder of jar.

Parallels: Timna Site 30 (pl. 212:7), Nahal Boker (Cohen and Cohen-Amin 2004, pl. 8:2), and *Tell el-Qudeirat* Substratum 3b (pl. 11.37:2) provide close parallels with everted rims and at least one ridge on the shoulder. A handmade sherd from Mezudat Nahal ʻAqrav (Cohen and Cohen-Amin 2004, pl. 70:6) features a similar overall profile, though lacking shoulder ridges. The sherd also features a similarity in rim treatment to *KEN* II and RHI Sounding A type PT2 (pl. 4.15:12; 4.27:5), and *Lachish* Stratum III (pl. 26.22:8).

Jar 4: *Oval-mouthed jar with rolled out rim and ledge (Figures 9.2:6-7)*

Samples: KAJ29, KAJ30, KAJ53 (distinct rim sections: 1)

Description: This jar has a oval shaped mouth with a short sloping-in neck that leads to a rolled out, thickened rim, creating an exterior ledge that varies slightly in sharpness.

Fabric:

Decoration: White slip (ext.)

Parallels: RHI-A PT2 (pl. 4.27:5); (Cohen and Cohen-Amin 2004: Fig. 11:7); Nahal Yatir (Cohen and Cohen-Amin 2004, pl. 55:9); *Busayra* Type A2 (pl. 9.42:8, 15); *Tell el-Qudeirat* Stratum 4 (pl. 11.5:3), Stratum 3b (pl. 11.34:10)

Varia, Jars:

Sample: KAJ23 (Figure 9.3:1, distinct rim sections: 1)

Description: This jar has a short neck with a thickened, everted, and rounded rim.

Fabric: 1A

Decoration: White slip (ext.)

Parallels: This class occurs at *KEN* IV (pl. 4.3:1). *Busayra* Jar D (pl. 9.46:15); *Tell el-Qudeirat* Stratum 4b (pl. 11.22:6)

Sample: KAJ25 (Figure 9.3:2, distinct rim sections: 1)

Description: This jar has a thickened, beveled rim with a ridge on the interior of the vessel

Fabric: Unsampled by petrographic analysis

Decoration: Possible white slip (ext.)

Parallels: Nahal Lotz (Cohen and Cohen-Amin 2004, pl. 82:1)

Sample: KAJ32 (Figure 9.2:5, distinct rim sections: 1)

Description: This is a holemouth pithos with a folded over rim.

Fabric: Unsampled by petrographic analysis

Decoration: White slip (ext.)

Parallels: KEN PT10 (pl. 4.11:9); *Busayra* Type C2 (pl. 9.46:8)

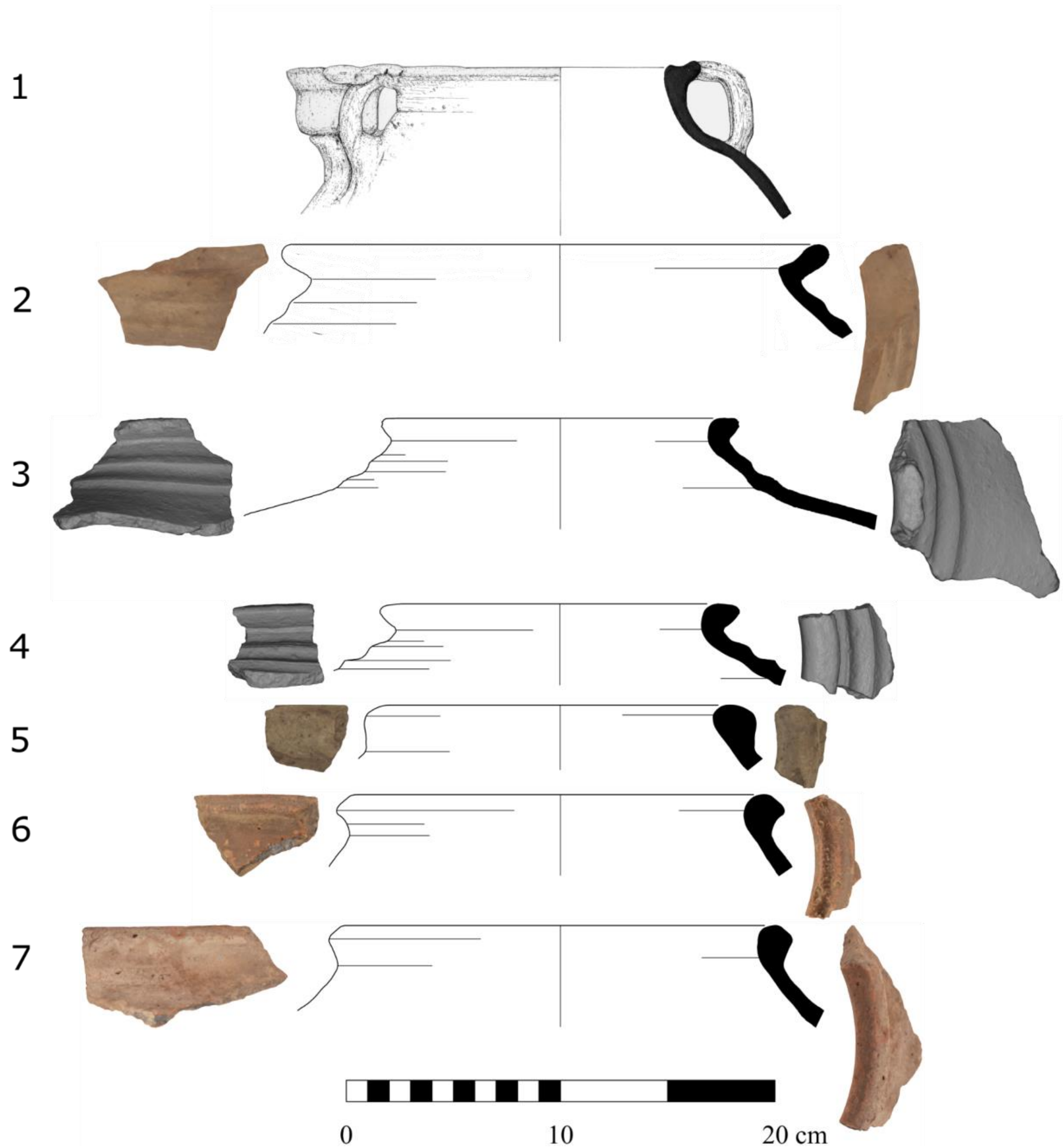

Figure 9.2: Jars recovered from KAJ in 2014 excavations, details in Table 9.2 (Illustration #1 by Donna Walker).

Table 9.2: Jars recovered from KAJ in 2014 excavations (Figure 9.2).

Image Num.	Sample Num.	Area/ Stratum	Locus	Basket	Vessel Form	Class	Ware Group/ Subgroup	Description
1	KAJ57*	B2b	543/561*	Multiple*	Jar	1		Cup-spouted jar with two handles adjacent to spout and two other handles.
2	KAJ19	B2a	542	10357	Jar	2	1A	
3	KAJ60	B2b	543	10408	Jar	3		
4	KAJ56**	B1c	541	10361	Jar	3	1A*	
5	KAJ32	B2a/b	548	10707	Pithos			
6	KAJ29***	B2a/b	537	10335	Jar	4	1B**	Oval- mouth vessel with variation in rim form around the mouth
7	KAJ53***	B2a/b	548	10707	Jar	4	1B**	Oval- mouth vessel with variation in rim form around the mouth

*: This illustration is based on the complete rim of the vessel, composed of sherds KAJ18 (Locus 543, Basket 10577), KAJ55 (L543, B10637), KAJ57 (L561, B10696), and KAJ58 (L543, B10575). This vessel is the only complete rim present in the assemblage.

**: Sample KAJ20, part of the same vessel as KAJ56, was studied petrographically

***: Sample KAJ30, part of the same vessel as KAJ29 and KAJ53, was studied petrographically. These sherds were both illustrated to display the variation in rim form across the vessel.

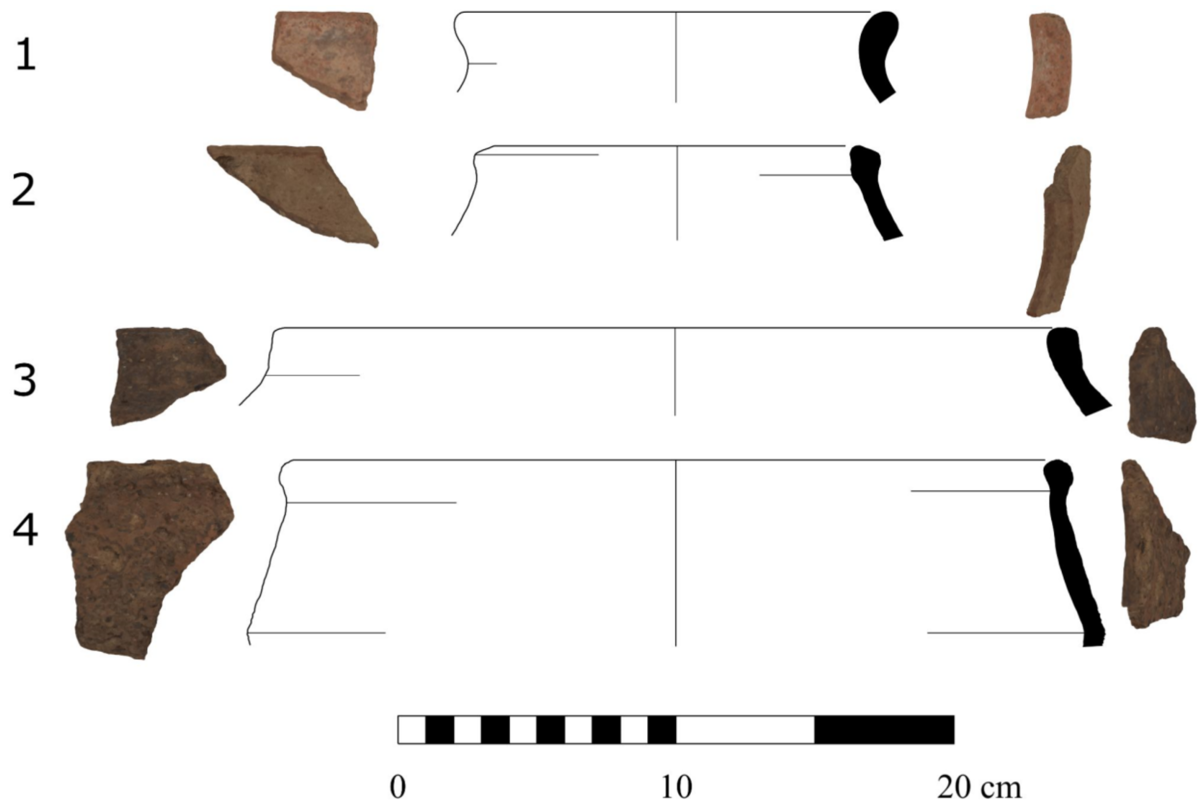

Figure 9.3: Jars recovered from KAJ in 2014 excavations, details in Table 9.3.

Table 9.3: Jars recovered from KAJ in 2014 excavations (Figure 9.3).

Image Num.	Sample Num.	Area/Stratum	Locus	Basket	Vessel Form	Class	Ware Group/Subgroup	Description
1	KAJ23	B1c	537	10335	Jar		1A	White slip (ext.)
2	KAJ25	B2a	542	10366	Jar			Possible white slip (ext.)
3	KAJ21	C2c	535	10419	Jar	Handmade	3	Handmade vessel with friable texture
4	KAJ28	C2c	535	10419	Jar	Handmade	1A	Handmade vessel with coarse texture and wheel-applied white slip (ext.)

Krater 1: *Krater with thickened, flattened rim (Figures 9.4:1-6)*

Samples: KAJ1, KAJ2, KAJ3, KAJ4, KAJ5, KAJ6, KAJ7, KAJ24, KAJ54 (distinct rim sections: 7, minimum number of vessels: 3)

Description: This is a krater with a thickened and somewhat flattened rim, creating an interior and exterior ledge and a short neck. The krater also features a handle attached at the rim of the vessel.

Fabric: 1A

Decoration: Possible white slip (int./ext)

Parallels: This class bears some similarity to *KEN* KR11. KR11 features a rounded, thickened rim with interior and exterior ledges of varying width. Some parallels, such as those from Tell el-Qudeirat, Tel Batash, and Lachish feature red surface treatment, though most of these examples from KAJ feature white fabric and sometimes possible slip. One example from KAJ with red fabric (Figure 9.4:4) features a white slip on the exterior, suggesting that a white appearance was preferred for this vessel class (this vessel also features a smaller rim diameter and may be a jar rather than a krater). Parallels can be found at *KEN* KR11a in Strata III and I (pls. 4.18:2; 4.20:1; 4.23:3); *KAJ06* A3 KR26 (pl. 4.38:9); *Tell el-Qudeirat* Substratum 4b Krater 1 (pl. 11.1:16-17); *Tawilan* (pl. 6.17:6); *Busayra* (pl. 9.22:7); *Lachish 1997* Stratum V (pl. 3.32: 1, 8); *Tel Batash* Stratum V (pl. 61:14) and Stratum IVB (pl. 4:2). Vessel (pl. 9.4:5), which features a more substantial folded-over rim treatment, is more closely paralleled by Lachish Stratum V-IV (pl. 25.55:5).

Krater 2: *Carinated krater with channel (Figures 9.5:1-3)*

Samples: KAJ8, KAJ9, KAJ11 (distinct rim sections: 3)

Description: This is a krater with upright walls, a thickened and slightly everted rim, and an inward carination in the upper quarter of the vessel producing a sharp ridge on the exterior of the vessel and a channel between the rim and the carination.

Fabric: 1A

Decoration: Possible white slip

Parallels: These kraters parallel some examples of *Qasile* BL 8, a carinated bowl with a "cyma" form, referring to its recurving rim. The cyma bowl type is common in the Iron I period and continues into the 10th century BCE (Mazar 1985). The cyma bowl is a type that has a fair amount of variation, though Mazar (1985) defines subtypes by the presence and style of handles on the vessel. Many cyma bowls have plain rims with a significant degree of eversion, a characteristic not seen in KAJ Krater 2. Rather, KAJ Krater 2 features an upright and thickened rim, while still featuring the channel and sharp carination seen in the cyma style. At Tell Qasile Stratum XII, the majority of these bowls have white surface treatment, while later strata predominantly feature red slip, burnish, and black decoration. The examples from KAJ do not feature surface treatment, except Sample KAJ9 (Figure 9.5:1) which may feature a white slip. Specific parallels include *Tel Qasile* BL 8 in Stratum XII BL 8 (pl. 16:15) and Stratum XI BL 8 (pl. 24:8), as well as *Lachish 1997* Stratum V B-17 (pl. 3.22:3), *Tell el-Qudeirat* Stratum 4b (pl. 11.17:1) and Substratum 3a-b (pl. 11.50:4).

Krater 3: *Krater with thickened, rounded rim (Figures 9.6:1-2, 9.6:5)*

Samples: KAJ10, KAJ12, KAJ13 (distinct rim sections: 3)

Description: This is a broader class for kraters with thickened, rounded rims and short necks.

Fabric: 1(A/E)

Decoration: None

Parallels: KEN KR8 Stratum R2b (pl. 4.2:13); Stratum S1 (pl.4.23:6-7); *KEN* Stratum S2a KR6 (pl. 4.21:11); *Qasile* Stratum IX (pl. 54:13); cf. Nahal Yatir (Cohen and Cohen-Amin 2004, pl. 55: 9); Tel *Masos* (pl. 156:6)

Krater 4: *Krater with everted, slightly thickened rim (Figures 9.6:3-4)*

Samples: KAJ15, KAJ16, KAJ39 (distinct rim sections: 3)

Description: This is a broader class for kraters with an everted, slightly thickened rim.

Fabric: Sample KAJ15 is 1A, KAJ16 is 1D, KAJ39 is unsampled for petrographic analysis

Decoration: Sample KAJ16 has a white slip (int./ext.), KAJ 39 is undecorated

Parallels: SGNAS (pl. 18:3); Ramat Matred (Cohen and Cohen-Amin, pl. 40:3)

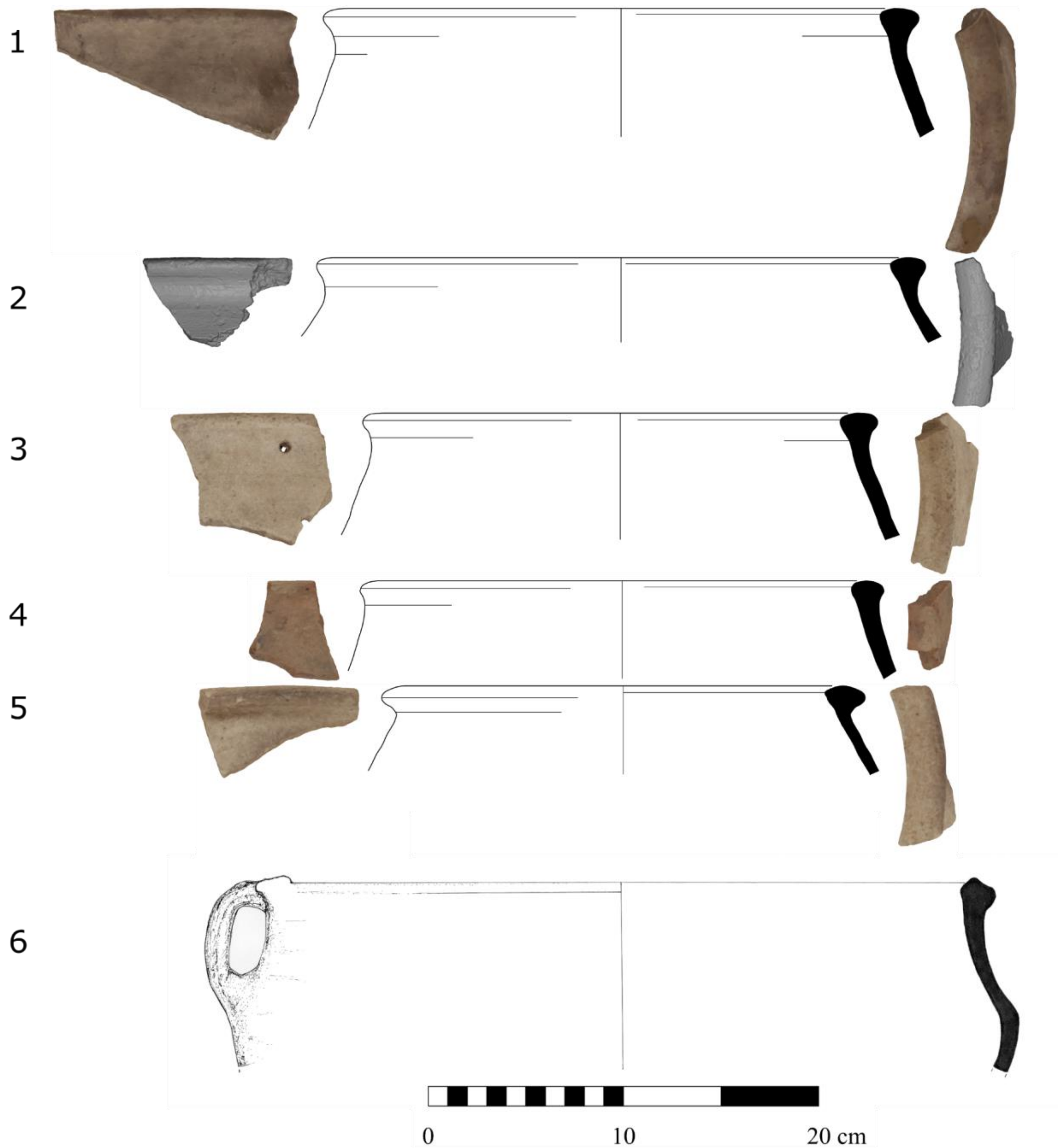

Figure 9.4: Kraters (Krater 1) recovered from KAJ in 2014 excavations, details in Table 9.4 (Illustration #6 by Donna Walker).

Table 9.4: Kraters (Krater 1) recovered from KAJ in 2014 excavations (Figure 9.4).

Image Num.	Sample Num.	Area/Stratum	Locus	Basket	Vessel Form	Class	Ware Group/Subgroup	Description
1	KAJ4*	B1b	520	10149	Krater	1	1A*	
2	KAJ2	B1b	520	10149	Krater	1		
3	KAJ3	B1c	571	10752	Krater	1		
4	KAJ24	B2b	543	10577	Krater	1	1A	
5	KAJ14	B2b	575	10827	Krater	1		
6	KAJ54	B1c	528	10256	Krater	1		
*: Sample KAJ5, part of the same vessel as KAJ4, was studied petrographically								

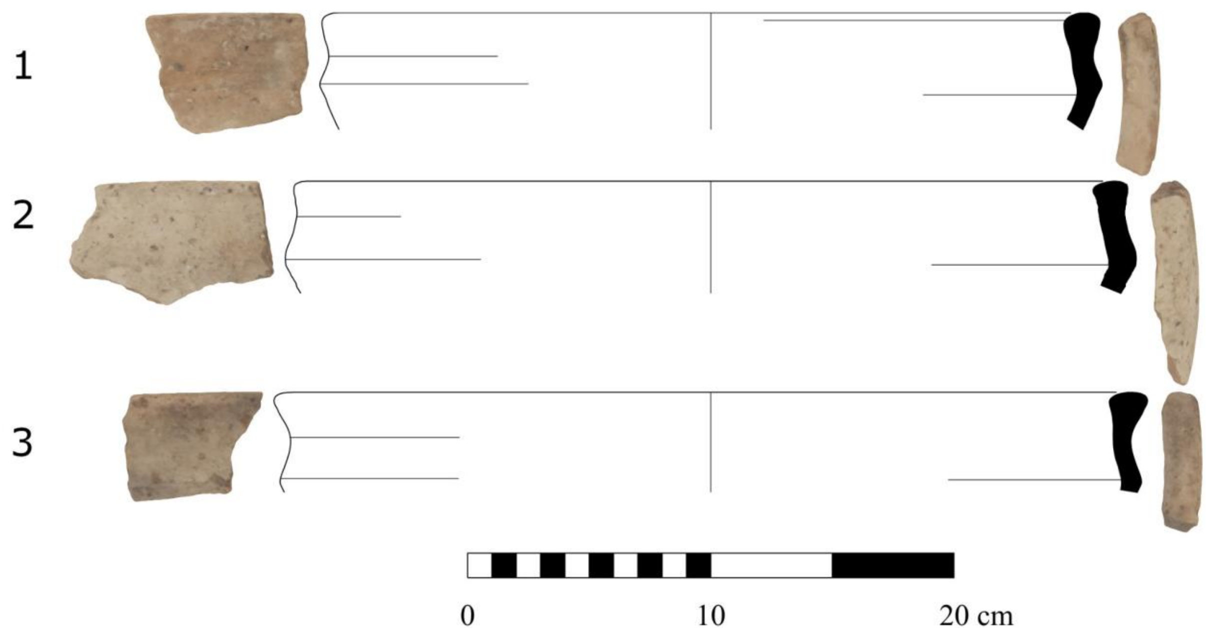

Figure 9.5: Kraters (Krater 2) recovered from KAJ in 2014 excavations, details in Table 9.5.

Table 9.5: Kraters (Krater 2) recovered from KAJ in 2014 excavations (Figure 9.5).

Image Num.	**Sample Num.**	**Area/Stratum**	**Locus**	**Basket**	**Vessel Form**	**Class**	**Ware Group/ Subgroup**	**Description**
1	KAJ9	B2a	542	10407	Krater	2	1A	White slip (int./ext.)
2	KAJ8	C2b	534	10385	Krater	2	1A	White slip (int./ext.)
3	KAJ11	C2a	529	10272	Krater	2	1A	White slip (int./ext.)

Figure 9.6: Kraters recovered from KAJ in 2014 excavations, details in Table 9.6.

Table 9.6: Kraters recovered from KAJ in 2014 excavations (Figure 9.6).

Image Num.	**Sample Num.**	**Area/Stratum**	**Locus**	**Basket**	**Vessel Form**	**Class**	**Ware Group/ Subgroup**	**Description**
1	KAJ12	B2a	550	10462	Krater	3	1A	
2	KAJ13	B2a	556	10613	Krater	3	1E	
3	KAJ16	B2a/b	548	10582	Krater	4	1D	White slip (int./ext/)
4	KAJ39	B2a	542	10421	Krater	4		
5	KAJ10	B2a	551	10579	Krater	3		
6	KAJ15	B2b*	518*	10123*	Krater	4	1C	White slip (ext.)

*: This sherd was recovered from excavation of a bedrock basin used for slag crushing in Area B outside of Building 2 and is tentatively assigned to Stratum B2b.

Jug 1: *Large jug with upright, slightly thickened rim (Figure 9.7:3)*

Sample: KAJ40 (distinct rim sections: 1)

Fabric: Unsampled for petrographic analysis

Decoration: None

Parallels: Qasile Stratum X Jar 1 (pl. 34:19); *KEN* II (pl. 4.15:7); *Tell el-Qudeirat* Stratum 4 (pl. 11.16:5); *Beersheba I* Stratum V (pl. 54:13); *Beersheba II* Stratum VII (pl. 22:11, 13); Cohen and Cohen-Amin 2004 (pl. 87:14; 76:3); *Tawilan* (pl. 6.30: 10); *Tel ʻIra* (pl. 4.33:5); Tel *Masos* (pl. 141:4; 144:7)

Jug 2: *Jug with slightly thickened rim and slight ledge (Figure 9.7:2)*

Sample: KAJ41 (distinct rim sections: 1)

Description: This jug has a thickened rim with a slight ledge on the exterior of the vessel.

Fabric: 1A

Decoration: White slip (ext.)

Parallels: KEN III-IV JG6 (pl. 4.10:21); *Qasile* Stratum XII (pl. 14:29); *Arad* Stratum XII (pl.1:7); Tel ʻIra Strata VI (pl. 6.67:23); *SGNAS* (pl. 19:4); *Tel Masos* (pl. 144:8)

Juglet 1: *Juglet with upright, rounded rum and handle attached at rim (Figures 9.7:1)*

Sample: KAJ43 (distinct rim sections: 1)

Description: This juglet has an upright, rounded rim with a handle attached to the rim.

Fabric: Unsampled for petrographic analysis

Decoration: White slip (int./ext.)

Parallels: KEN Stratum R3a JT1 (pl. 4.1.11); Strata A2b, S2a, and S1 JT3 (pl. 4.15:3; 4.21:17; 4.24:6). Other parallels are possible but not enough of the vessel remains.

Figure 9.7: Jugs/Juglet recovered from KAJ in 2014 excavations, details in Table 9.7.

Table 9.7: Jugs/Juglet recovered from KAJ in 2014 excavations (Figure 9.7).

Image Num.	**Sample Num.**	**Area/Stratum**	**Locus**	**Basket**	**Vessel Form**	**Class**	**Ware Group/Subgroup**	**Description**
1	KAJ43	C2a	529	10272	Juglet	1		White slip (int./ext.)
2	KAJ41	B2a	542	10366	Jug	2	1A	White slip (ext.)
3	KAJ40	C2a	529	10272	Jug	1		

Cooking Jug 1: *Holemouth Cooking Jug with thickened rim and short neck (Figure 9.8:1)*

Samples: KAJ36, KAJ37, KAJ38 (distinct rim sections: 1)

Description: This is a holemouth, closed cooking jug with a thickened rim and short neck

Fabric: 1C

Decoration: None

Parallels: KAJ06 IV-V CP20 (pl. 4.38:12); *Tell el-Qudeirat* Substratum 3c (pl. 11.28:14); *Lachish* Stratum IV (pl. 3.38:6)

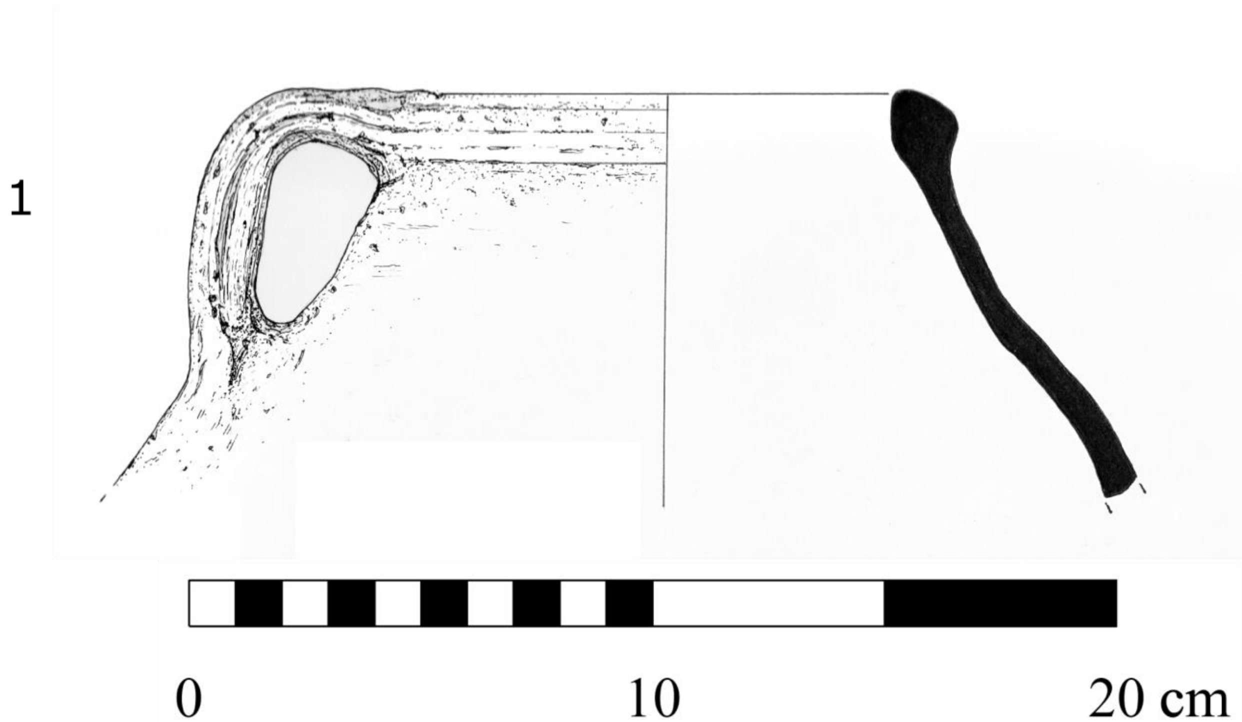

Figure 9.8: Vessels recovered from KAJ in 2014 excavations, details in Table 9.8 (Illustrations by Donna Walker).

Table 9.8: Vessels recovered from KAJ in 2014 excavations (Figure 9.8).

Image Num.	**Sample Num.**	**Area/Stratum**	**Locus**	**Basket**	**Vessel Form**	**Class**	**Ware Group/Subgroup**	**Description**
1	KAJ36*	B2a	542	10421	Cooking Pot	1	1C	
*: Sample KAJ37, part of the same vessel as KAJ36, was studied petrographically								

Handmade Ware:

Holemouth Jars: *Handmade, thin-walled holemouth jars (Figures 9.9:1-3)*

Samples: KAJ46, KAJ47, KAJ48, KAJ49, KAJ50, KAJ51, KAJ52 (distinct rim sections: 3)

Description: A handmade holemouth jar with a curved shoulder and little to no rim treatment

Fabric: 1D

Decoration: Some evidence for soot on the bottom of the vessels, either suggesting use for cooking or inconsistent firing. Lines (fingerprints?) from forming the vessel are visible on the body. One vessel features a raised bump near the shoulder.

Parallels: KEN III-IV (pl. 4.11:11); IP II (pl. 4.16:1); *Barqa el-Hetiye* (pl. 10:2)

Handmade Jars:

Sample: KAJ21 (Figure 9.3:3, distinct rim sections: 1)

Description: This jar has a slightly-thickened, slightly-rounded rim with a short neck curving out to the shoulder of the vessel.

Fabric: 3

Decoration: None

Parallels: This form bears similarity to a form found at *KAJ06* (pl. 4.38:14), though with a different fabric and wheelmade rather than handmade. This may be an example of Handmade Arabah Ware, though further study of this vessel and its provenance is needed.

Sample: KAJ28 (Figure 9.3:4, distinct rim sections: 1)

Description: This vessel has an upright, thickened and flattened rim, creating a slight ledge. The form features a ca. 5 cm neck before a carination.

Fabric: 1A

Decoration: Possible wheel-applied white slip

Parallels: This is a course ware vessel with no clear parallels. Its coarse fabric bears similarity to Handmade Arabah Ware, though the vessel appears to feature a wheel applied decoration.

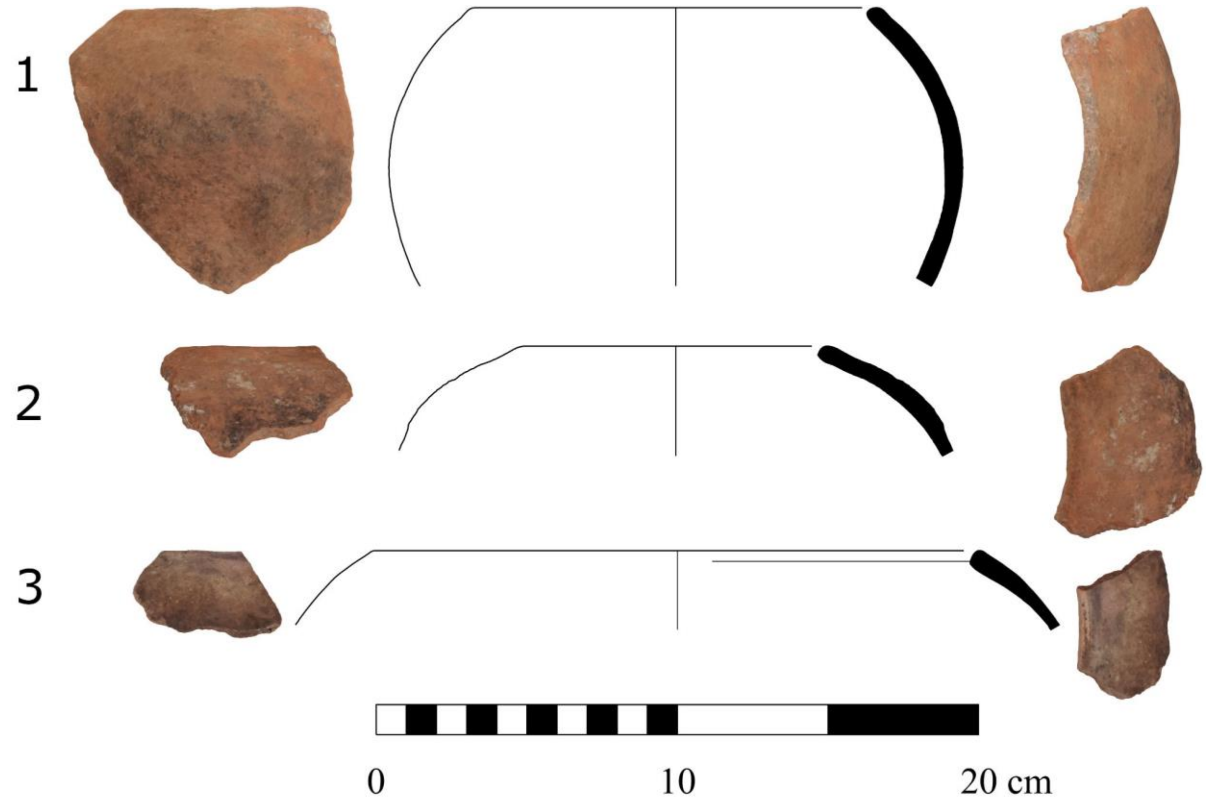

Figure 9.9: Holemouth Jars recovered from KAJ in 2014 excavations, details in Table 9.9.

Table 9.9: Vessels recovered from KAJ in 2014 excavations (Figure 9.9).

Image Num.	**Sample Num.**	**Area/Stratum**	**Locus**	**Basket**	**Vessel Form**	**Class**	**Ware Group/Subgroup**	**Description**
1	KAJ46	B2b	545	10529	HMJR			
2	KAJ49	B2a	550	10462	HMJR		1D	
3	KAJ50	C2b	534	10385	HMJR			

9.5.2 Quantitative Analysis

Considering the diagnostic sherds (n=62), the KAJ 2014 assemblage is made up of ca. 88% wheel-made ware and ca. 12% handmade ware. The rate of appearance of handmade ware is a useful metric for understanding the chronology of the site, its degree of interregional connections, and its use. A 12% rate of handmade ceramic forms for the 2014 excavations at KAJ is similar to the rate of handmade ware found at *KAJ06* (12.8%), indicating that the rate of handmade ware is consistent across areas of the site (Smith and Levy 2014). Generally, a rate of over 10% handmade ware is fairly high, though a rate of 12% correlates well with the rate of 14.6% handmade wares found at KEN (Smith and Levy 2014). These rates seem to have chronological significance when compared to highland sites investigated by Smith et al.'s (2014) L2HE project. None of these later Iron Age sites have a percentage of handmade ware over 4% (Smith and Levy 2014). While the percentage of wheel-made ware at KAJ is relatively high in comparison to later highland sites, other Arabah and Negev sites have much higher rates of handmade ware. RHI Sounding A, representing the Early Iron Age occupation at the site, has an assemblage made up of 58.7% handmade ware (Smith and Levy 2014). Timna Site 30 also features a very high rate of handmade ware, at 53% (Kleiman et al. 2017). Also featuring a high rate of handmade wares are the early Iron Age sites of the Negev Highlands, often referred to as the Negev Fortresses. These sites feature ca. 36% handmade ware, which is notorious as the coarse Negebite Ware, also known as Handmade Arabah Ware (Martin and Finkelstein 2013), discussed above. Tell el-Qudeirat's Stratum 4 assemblage is 45% handmade, while in Strata 3a-b, that figure increases to 80% (Bernick-Greenberg 2007b). Though KAJ lacks the extremely high rates of handmade ceramics seen at some of these sites, rates over 10% are substantially higher than those seen at sedentary sites and suggest a similarity between KAJ and other copper production sites, though care must be taken to factor in the small sample size from KAJ. The cultural and social importance of handmade vessels will be discussed below. Taking a different perspective, the predominance of wheel-made ware at KAJ also bears significance for use of the site. No evidence of ceramic manufacture has thus far been found at KAJ. As such, it is not clear whether the locally wheel-made ceramics were crafted on site at KAJ, nearby at KEN, or elsewhere in Faynan, though the petrographic analysis described below addresses this question to some extent. As we will see, the similarity between the classes of ceramics at KAJ and types found at KEN may corroborate the hypothesis that two sites were closely-affiliated in a regional network with shared provisioning strategies, including for wares such as ceramics.

Focusing primarily on the wheel-made assemblage from the 2014 KAJ excavations, a classification based on the methods described above has been developed (Table 9.10). Despite the small sample size, the percentage of each vessel form identified in the classification can be a useful frame of analysis. Here we will focus on a few aspects of the overall figures that prove most enlightening in comparison with other sites and regions. In general, some trends can be observed in comparison to Edomite and other copper-producing sites in the Wadi Arabah (Table 9.10). First, the KAJ assemblage has a low ratio of bowls (ca. 7.5%) compared to KEN and RHI Sounding A, which each feature bowls at around 36% of the overall assemblages at those sites (Smith and Levy 2014). Timna Site 34 also has a similar rate at 32.68% (Kleiman et al. 2017). The trend of low rates of bowls at KAJ was also seen in the Area A excavations in 2006, which featured only 18.6% bowls. These figures contrast sharply to the rate of bowls at later, highland sites, which are all at or around 50% (Smith and Levy 2014). However, the rate of kraters from KAJ 2014, at ca. 42.5%, is the highest of any of the sites discussed by Smith and Levy (2014). In the context of overall quantitative analysis, both bowls and kraters should be treated together given their potential association with domestic activities and the relatively subjective division between the two forms. However, qualitatively, larger bowls may suggest food preparation and consumption in larger groups, while smaller bowls may represent individual consumption (Blitz 1993). Smith and Levy (2014) argue that the major presence of bowls and kraters, in aggregate, indicate that both domestic and industrial activities were conducted in the same structures and rooms at copper production sites in Faynan. This meshes well with evidence from KAJ, as many grinding slabs and mortars were found in Building 2 alongside the bowls and kraters recovered. However, it is not clear whether these tools were used for slag processing or domestic purposes. As such, it is not clear whether food processing was conducted in the structure. One complicating factor to the question of whether or not domestic activity occurred alongside industry is the extremely low rate of cooking pots found at KAJ in 2014. Only one cooking pot was found, ca. 2.5% of the diagnostic assemblage. This low rate of cooking pots matches other early Iron Age sites in Faynan and at Timna. KEN and KAJ06 feature no more than 4% cooking pots, while Timna Site 34 only featured two possible examples for a total of 0.34% of the assemblage (Smith and Levy 2014; Kleiman et al. 2017). One possible explanation for this shortage could be that rather than using the traditional wheel-made cooking pot forms used by inhabitants of other regions, residents of Early Iron Age copper production sites in the Wadi Arabah and sites in the Negev may have used Handmade Arabah Ware for cooking purposes, as discussed above (Meshel 2002; Bernick-Greenberg 2007b). The presence of Handmade Arabah Ware at KAJ and the question of cooking at the site will be elaborated on below. Finally, with regard to form ratios, the rates of jugs/juglets (15.0%) and jars/pithoi (32.5%) fit almost exactly with the rates of these vessel forms at KEN and KAJ06. Considering the whole assemblage in comparison to KEN and Timna, based on ceramic rates, the 2014 KAJ assemblage is a typical one for an Early Iron Age copper production site in the Wadi Arabah, though the small sample size of the new assemblage from KAJ must be taken into account.

Table 9.10: The rate of each form of wheel-made ceramics from KAJ 2014 excavations. Multiple sherds from single vessels are not included in this calculation.

Wheel-made Ceramics by Form						
	Bowl	Jug/Juglet	Krater	Jar/Pithos	Cooking Pot	Total
%	7.5%	15.0%	42.5%	32.5%	2.5%	100%
#	3	6	17	13	1	40

9.5.3 Qualitative Analysis

9.5.3.1 Wheel-made Ware

A discussion of individual classes of the ceramics recovered from KAJ in 2014 and their implications for dating and regional connections can shed additional light on the interpretations facilitated by quantitative analysis of the assemblage. Several of the ceramic classes from KAJ warrant special discussion, though a detailed analysis of each type and associated parallels is below.

9.5.3.1.1 Jar 1 – A Cup-Spouted Jar

The first significant class from KAJ is Jar 1 (Figures 9.2:1, 9.10). Jar 1 is a spouted storage jar with a long everted, rounded and thickened rim with a substantial groove on the middle of the lip, potentially to support a lid. This jar also features a cup-like spout that attaches to the everted rim and drains into the body of the vessel. The cup is bracketed by two small strap handles. Sherds from this vessel were found in Loci 543 and 561 at KAJ, which both correspond to the context associated with the floor of Room 3 in Building 2. Room 3 is the central room in the structure and is otherwise significant for the presence of a finely-crafted grinding slab installation. Though the use of this vessel is uncertain, previous studies have hypothesized that the vessel was used for the storage and portioning of a valuable liquid such as olive oil (Amiran 1969: 243; Crowfoot et al. 1957: 193). Possibly the spout was used to hold a juglet, which would have drained any remaining oil back into the jar after use (Amiran 1969: 243; Crowfoot et al. 1957: 193). Olive oil was a valued substance subject to widespread contemporaneous production and export (Finkelstein and Langgut 2018). Residents of KAJ would have needed access to exchange networks in order to obtain olive oil. Thus, it should be seen as a potentially elite foodstuff, implying the status of residents given the need for its importation and portioning (cf. Turkon 2004). This hypothesis for the vessel's use should be tested through future residue analysis to shed further light on the issue (e.g. Charters et al. 1993; Heron and Evershed 1993; Mazow et al. 2018; Roffet-Salque et al. 2017). This potential use combined with the vessel's find-context likely indicates the presence of elites at the site who would have had access to well-crafted ceramics rather than the handmade ware typical of Negev sites.

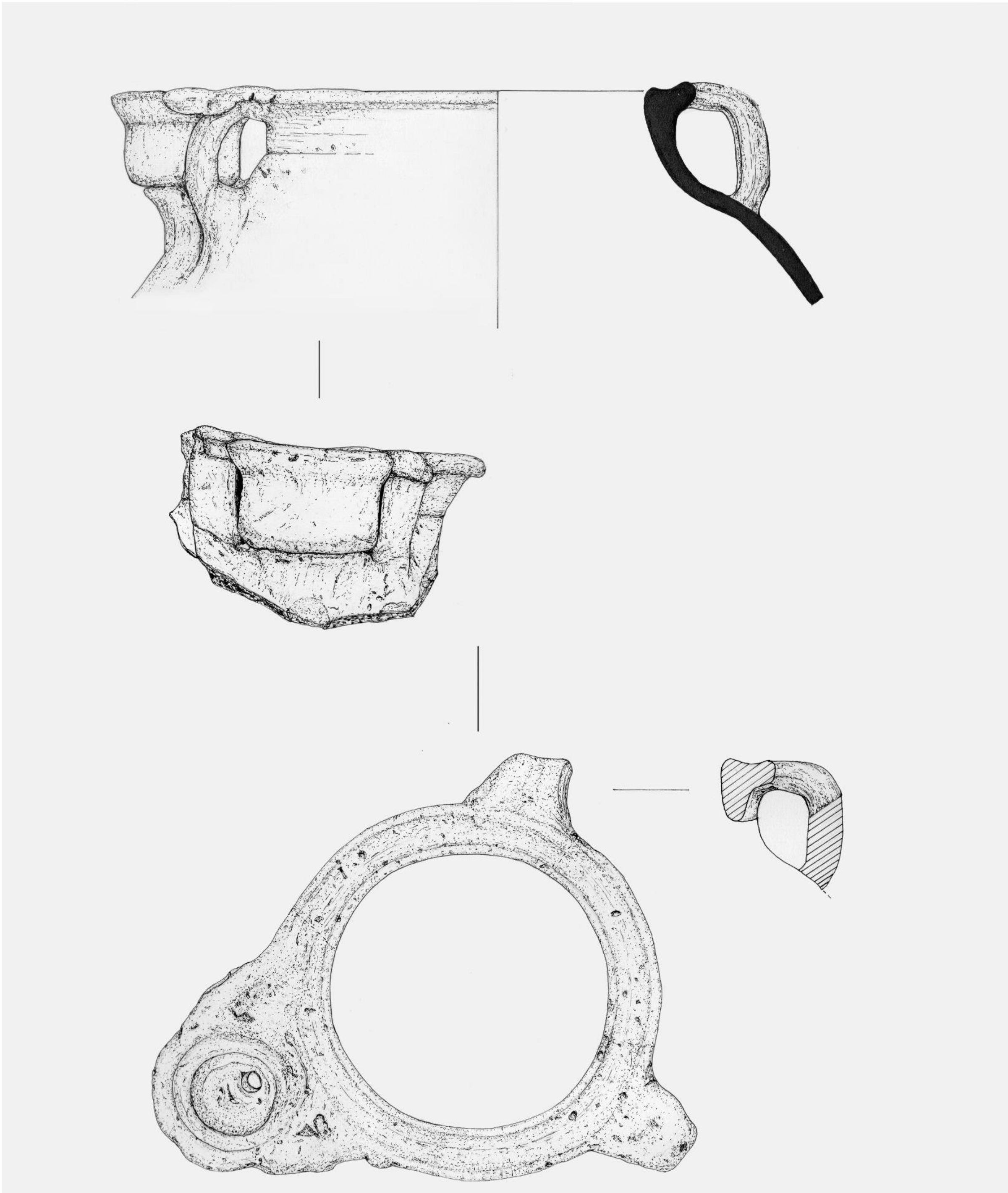

Figure 9.10: Jar 1, a cup-spouted jar recovered from KAJ Area B in 2014 excavations. See Figure 9.7 for scale, rim diameter ca. 10 cm (Illustration by Donna Walker).

In general, the cup-spouted storage jar is a well-known type in Iron Age Southern Levantine ceramic assemblages. In particular, this vessel family is common in Judah and northern sites in the Iron IIB (Gitin 1990: 137-140; Herzog and Singer-Avitz 2015; Singer-Avitz 2016c: 621; Wilson 2017). However, spouted storage jars also appear in the Iron IIA at a number of sites. Iron IIB types are more likely to have a spout that connects to the rim and shoulder of the vessel, while cup spouts in the Iron IIA are more likely to lie flush against the neck and shoulder of the vessel (Herzog and Singer-Avitz 2015: 217) (Figure 9.11). The typical Iron IIB cup-spouted jar features three handles, spaced at even intervals around the mouth of the jar along with the cup spout (Wilson 2017). However, examples with anywhere from one to four handles are known (Wilson 2017). Some particular examples of cup-spouted jars from the Iron IIB Levant are seen at Beth-Shean Stratum P-7 (Mazar 2006: pl. 38:1, 2), *Tell el-Qudeirat* Substratum 3a-b (pl. 11.33:11) and Substratum 3b (pl. 11.37:8), *Tel Gezer* Stratum VII (pl. 19:15) and VIA (Wilson 2017, Fig. 4.20:5; 4.23:7), Beersheba Stratum II (Aharoni 1973, pl. 58: 30-32; 65: 8), *Lachish 2004* IV Stratum III (pl. 26.19:1; 26.22:1; 26.25:5; 26.34:9; 26.42:9), and *Tawilan* (pl. 6.31:12), among many other sites. Iron IIA examples, featuring a cup spout flush against the shoulder of the vessel, can be seen at *Beersheba III (*type SJ-X) Stratum V (pl. 11.19:1; 11.20:12; 11.28:9) and Stratum IV (pl. 11.39:12; 11.45:1; 11.47:17; 11.49:5), *Arad* Stratum XI (pl. 5:7; 9:7), *Tel Masos* (possibly late Iron I, pl. 150:8), and SGNAS Survey Site 28 (MacDonald 1992 pl. 20:1). The example from Tel Masos is interesting with regard to its relative date, since the assemblage of Stratum II at that site can be seen as either Iron IB, IIA, or representing the transition between the two phases, as discussed above (Fritz and Kempinski 1983; Fantalkin and Finkelstein 2006). In either case, the Tel Masos Stratum II cup-spouted jar represents an earlier form than the Iron IIB types seen at many other sites.

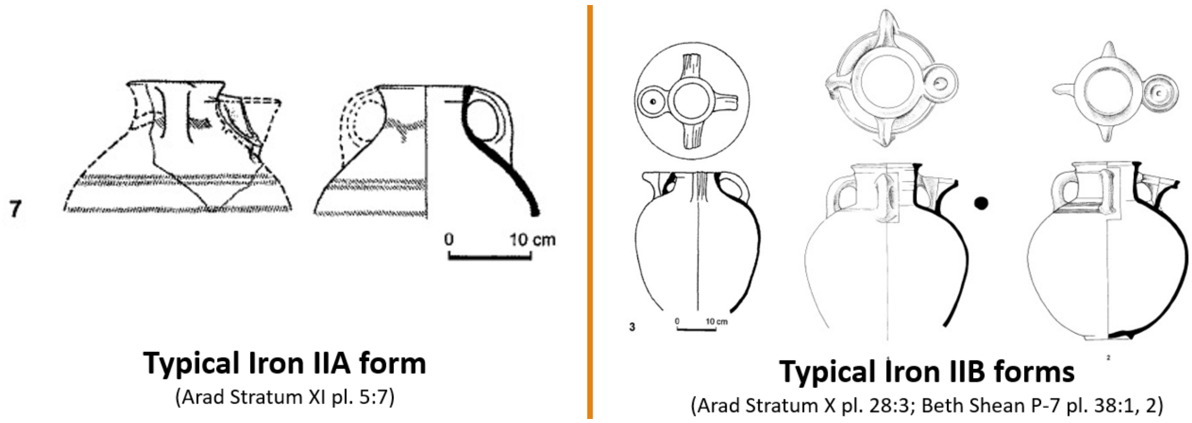

Figure 9.11: This figure depicts the typical form of the cup-spouted jar in the Iron IIA with cup-spout flush against the shoulder of the vessel (left) and in the Iron IIB with the cup-spout connecting at the shoulder and neck or rim of the vessel (right). Examples from Lachish and Faynan buck this trend. After Singer-Avitz (2002: Figs. 5:7; 28:3) and Mazar (2006: Pl. 38:1, 2)

The example from SGNAS Survey Site 29, which is located in Faynan, is of particular relevance here. MacDonald's (1992) Site 29 is described by the author as a heavy sherd concentration with robbed graves and some Chalcolithic/Early Bronze Age sherds, in addition to Iron Age remains. In fact, Site 29 is located on the northern slope of the site now known as RHI (Adams (1992), though representing the surface of the site rather than stratified excavation. In particular, MacDonald reports the collection of 21 sherds dated broadly to the Iron II and one sherd specifically dated to the Iron IIA. The cup-spouted jar from the site (pl. 20:1) is described by the author as Early Iron II in date (MacDonald 1992: 212). Despite the lack of clear context for this sherd, an Iron IIA date seems appropriate given that the cup spout lies flush against the vessel's shoulder, as is typical of Iron IIA cup-spouted jars. Beyond the dating of this sherd, it also is uniquely interesting as it is the only clear parallel of a cup-spouted jar that also features a grooved rim similar to KAJ Jar 1. In addition, the Site 29 sherd also features a handle adjoining the cup-spout, a layout not seen in the Iron IIB types but somewhat similar again to KAJ Jar 1, on which the cup-spout is bracketed by two adjoining handles.

Two other examples of Iron IIA cup-spouted jars warrant further consideration as comparative examples to KAJ Jar 1. First, three sherds from Lachish provide interesting counterexamples to the trend of how cup-spouts are positioned relative to the shoulder and rim of the vessel in the Iron IIA compared to the Iron IIB. At Lachish Stratum IVB, a Late Iron IIA stratum associated with the mid-9th century (Garfinkel et al. 2019) two examples of a cup-spout are found (Zimhoni 2004: Figs. 25.32:12; 25.33:14). These spouts, from cup-spouted jars, clearly did not lie flush against the shoulder of the vessel, as is typical of Iron IIA forms (whether this cup-spout attaches to the rim or neck of the vessel or not is unclear based on preservation). Secondly, another vessel from Lachish Stratum IV (Zimhoni 2004: pl. 25.44:10), also Late Iron IIA and associated with the 9th century, takes a more characteristic Iron IIB form with three handles and a cup-spout attached at the rim and shoulder of the vessel, rather than laying flush. Though these examples post-date settlement at KAJ, they provide an interesting counterexample to the general trend of cup-spout form in the Iron IIA and IIB periods.

The most relevant examples to our discussion of cup-spouted jars in Faynan are two vessels from Area R at Khirbat en-Nahas. One example was found at *KEN* Stratum R2b (pl. 4.1:14). Stratum R2b relates to Phase V (radiocarbon dated to 10th century BCE) in the integrated stratigraphy of the site (Table 4.1 describes the vessel as being found in Stratum R3a, however, it was found in R2b; Smith and Levy 2014). The example from KEN was found in the corner of Room 1 in the monumental structure in Area R. The structure in Area R is an elite residence, notable for its fine ceramics and an installation that may have served as a bench or throne for an elite official (Smith and Levy 2014). This structure also has been argued to have architectural parallels to the Negev Fortress sites of the Iron IIA (Levy et al. 2014). While the stratigraphy of Area R is fairly complex, an Iron IIA association for the vessel seems clear based on the overall picture of radiocarbon dates from the area. This vessel, like the SGNAS Site 29 parallel, also features a (broken) handle on the side of the cup-spout (Figure 9.12), in some similarity to KAJ Jar 1's two bracketing handles. Interestingly, despite the vessel's Iron IIA provenience, the cup-spout on the KEN vessel is connected at the rim and shoulder of the vessel, providing another counterexample to the general form trends of cup-spouted vessels from the Iron IIA and IIB.

Figure 9.12: A fragment of a cup-spouted jar recovered from KEN Stratum R2b (pl. 4.1:14, Smith and Levy 2014). Note the broken handle on the upper-left side of the fragment.

Another cup-spouted jar (Figure 9.13), a relatively complete decorated example, was found in Layer R1b at KEN, though not previously published as a cup-spouted jar (Figure 2.202, Levy et al. 2014). This parallel features geometric decorations, possibly relating to Qurayyah Painted Ware (Levy et al. 2014). The vessel, like the example from KAJ, also features a cup-spout not flush against the shoulder of the vessel. Moreover, the KEN R1b Jar also possesses two handles, though not evenly-spaced around the vessel as seen in the KAJ Jar, but rather at right angles to the cup-spout (spaced as if there were three handles but missing the third handle opposite the cup-spout). This handle layout is relatively rare but paralleled at Tell es-Safi and potentially Gezer in the Iron IIB (Avissar and Maeir 2012; Wilson et al. 2017). Layer R1b, in which this second example from KEN was found, is generally a 9th century BCE layer, though there is a strong possibility that artifacts from the layer in fact relate to the main use of the Area R structure, primarily occupied in the 10th century BCE (Levy et al. 2014b: 206). Overall, the relatively high frequency of cup-spouted jars in Early Iron Age Faynan (KEN IV JR 28, pl. 4.1:14; SGNAS Survey Site 29, Macdonald 1992 pl. 20:1; and, notably, *KEN* Figure 2.202, a decorated cup-spouted jar not previously published as a cup-spouted variety) may indicate some local significance to this class, perhaps as a prized possession among the local elite. The presence of these cup-spouted jars in Area R also draws a connection between that context and Area B at Khirbat al-Jariya. Cup-spouted jars, presumably holding valuable liquids, are connected to the presence of elites at Area R. The finding of a cup-spouted jar in Area B provides evidence of the presence of elites inhabiting this context as well.

Figure 9.13: Part of a mostly-complete cup-spouted jar recovered from KEN Stratum R1b (cf. Figure 2.202, Smith and Levy 2014). This vessel does not feature a third handle across from the cup-spout, a relatively rare layout, but paralleled at Tell es-Safi and potentially Gezer in the Iron IIB (Avissar and Maeir 2012; Wilson et al. 2017).

Considering these various parallels, three main characteristics mark KAJ Jar 1 as a unique form, likely representing a local tradition of ceramic manufacture: the handle layout, the spout form and type, and the grooved rim. The layout of handles on cup-spouted jars is the subject of some discussion and a small amount of variation. The prototypical Iron Age cup-spouted jar from Judean or Negev sites features three loop handles spaced at ca. 90 degree intervals around the rim of the vessel, with a cup spout taking the position of a fourth handle (Gitin 1990: 137-140; Herzog and Singer-Avitz 2015; Singer-Avitz 2016b: 496; 2016c: 621, 2019: 113-4; Wilson 2017: 97-100). Relatively few exceptions exist to this trend. The Iron IIA deviations from the trend seen at sites in Judah and the Negev are as follows. First, a vessel at *Beersheba III* Stratum V (fig. 11.28:9) is illustrated as only featuring two handles, though the fragment where a third handle would be located is missing. Another example from *Beersheba III*, in this case Stratum IV (fig. 11.49:5), features three handles but arranged at 120 degree angles, evenly around the vessel, with a cup-spout somewhat close but not adjacent to one handle. This layout is roughly paralleled by the example from *Tel Masos* Stratum II (pl. 150:8), which also features three handles but at equal angles around the rim. An example from *Arad* Stratum XI (pl. 5:7) is illustrated with only two handles perpendicular to the cup-spout, but this vessel likely had a third handle (Wilson 2017: 99). Other Iron IIA parallels, including from *Beersheba III* Stratum V (fig. 11.19:1), Stratum IV (fig. 11.39:12; 11.45:1; 11.47:17), *Arad* Stratum XI (pl. 5:7), and *Lachish 2004* (pl. 25.44:10) feature the standard handle layout. Thus, Iron IIA cup-spouted jars from Judah almost universally feature three handles and a cup-spout, spaced at 90 degree intervals. Similarly, Iron IIB examples from the Southern Levant predominantly display the typical pattern of three handles and a cup-spout, located at equal 90 degree intervals around the rim of the vessel, though some counterexamples exist. At *Beersheba III* Stratum II, a rare form (pl. 12.165:10) of a cup-spouted jar with only one handle, located opposite of the spout, is observed. At Tell el-Far'ah (North), a rare form with four handles is seen. A unique two-handled form is seen at Tell es-Safi, with the two handles positioned 90 degrees to the side of the cup-spout and across the cup-spout, with the usual third handle missing (Avissar and Maeir 2012: pl. 15.11:1). Finally, a local trend is apparent at Tel Gezer, where two to three (Wilson 2017: figs. 4.20:5 and 4.23:7; possibly Gitin 1990: pl. 19:15, cf. Wilson 2017) vessels feature only two handles located perpendicular to the cup-spout. Finally, one fragmentary vessel from *Lachish 2004* Stratum III (pl. 26.30:7) seems to feature a handle adjacent to the spout of the vessel, though the overall form of the vessel is unclear. The many other cup-spouted jars from the period in Judah and the north near-universally feature a standardized three-handle layout.

The situation in Iron Age Faynan is different, and the variation in handle layouts in the region seems to suggest a local variation of the form. The *SGNAS* parallel (pl. 20:1), as discussed above, features a handle adjacent to the spout, as does the example from KEN Stratum R2b (pl. 4.1:14, Smith and Levy 2014). KAJ Jar 1 features an unparalleled four handle layout (Figure 9.10), with two handles bracketing the cup-spout and two handles spaced at ca. 120 degree angles. A final cup-spouted jar from Faynan Smith and Levy 2014: Figure 2.202) features two handles roughly perpendicular to the cup spout, similar to the examples from Iron IIB Gezer and possibly Iron IIA Arad. However, overall, handles adjacent to the spout appears to be predominant among the cup-spouted jars of Faynan and nearly unheard of in other contemporaneous regions, with one possible exception at Lachish. This trend indicates that the cup-spouted jars in Faynan, though broadly similar to those found at sites in Judah and the Negev, are part of a different regional assemblage reflecting local production preferences.

The second characteristic in which these vessels from Faynan differ from those of other regions is the format of the cup-spout. As discussed above, generally Iron IIA cup-spouted jars feature a spout lying flush against the shoulder of the vessel, while Iron IIB cup-spouts connect at the shoulder and rim/neck (Herzog and Singer-Avitz 2015: 217). Some examples, however, buck this trend. As discussed above, three vessels from *Lachish 2004* Stratum IV, a Late Iron Age IIA layer, seem to have cup-spouts that do not lay flush against the shoulder of the vessel. On the other hand, an Iron IIB example from *Beersheba III* Stratum II (pl. 12.120:5) seems to feature a spout flush against the vessel. In Faynan, as discussed above, the seemingly Iron IIA *SGNAS* (pl. 20:1) vessel is on trend with a flush spout, but the Iron IIA examples from *KEN* (pl. 4.1:14) and KAJ Jar 1 do not feature flush spouts.

These vessels, with adjacent handles, may reflect local development in the form in which handles adjacent to the cup-spout provide structural support for a relatively freestanding spout.

A final aspect of Jar 1 from KAJ that provides insight into parallels and chronology for the vessel is the fairly-unique grooved rim seen on the vessel. As discussed above, the only clear example of an Iron Age cup-spouted jar with a grooved rim is the Iron IIA vessel from SGNAS Site 29. Other examples of grooved rims similar in appearance can be seen at *KEN* JR6 Integrated Phases (IP) V and II (pl. 4.1:13; 4.9:7), and *Tell el-Qudeirat* Stratum 4b (pl. 11.8:5), though these vessels are not cup-spouted jars. The Tell el-Qudeirat parallel shows similarity with regards to the upright neck and everted, rounded rim. Similarly everted rims without a clear groove can be seen at *Barqa el-Hetiye* (pl. 10:7) and *KAJ06* (pl. 4.38:17); these vessels also bear similarity to KAJ Jar 2.

Overall, Jar 1 is an interesting vessel due to its lack of exact parallels. While the cup-spout's attachment to the rim and shoulder of the vessel would normally suggest an association with the Iron IIB, Jar 1 has a different spout form and a substantially different, unique handle layout compared to the relatively standardized Iron IIB cup-spouted jar type. Non-flush cup-spouts from Iron IIA contexts are also attested at Lachish (Zimhoni 2004: pl. 25.32:12; 25.33:14; 25.44:10) and KEN (Smith and Levy 2014 pl. 4.1:14), while the closest parallel in rim and handle form appears at an Early Iron Age site in SGNAS Site 29. Taking all of the evidence into consideration, the most likely explanation for this vessel is that Jar 1 is a unique Iron IIA form, representative of the local development of ceramic traditions in the Faynan region. Given that the rim form and handle layout seem to indicate an Iron IIA affiliation and the cup form primarily associates with Iron IIB, though Iron IIA parallels exist, the preponderance of evidence suggests Iron IIA association for the vessel. The significance of this vessel for our understanding of Building 2 as a potentially elite context will be discussed further below.

9.5.3.1.2 Bowls 1 and 2 – Red-slipped and Burnished Bowls

A second issue worth discussing in detail is the presence of red-slipped and burnished bowls (Figure 9.1:1-2), which are imports from the Negev Desert region. Two diagnostic sherds and one body sherd of these classes of vessel were recovered from KAJ in 2014 excavations; each of these sherds was recovered from the Locus 543/561 context representing the floor of Room 3 in Area B (Area A also featured a rim sherd from a red-slipped and burnished bowl in a likely disposal context, Smith and Levy 2014: Fig. 4.38:4). These ceramics warrant discussion due to the chronological and cultural significance of these vessels in the archaeological record of the Early Iron Age Southern Levant. Of the assemblage from KAJ 2014, classes Bowl 1 and Bowl 2 both feature red slip and burnish. Bowl 1 is a small, fine-ware round sided bowl with a sharply-rounded rim. The bowl is red-slipped and unevenly hand burnished. Bowl 2 is a thin-walled fine-ware bowl with a curved carination, a band above the carination, and a thickened rim. This bowl is also red slipped and is more regularly burnished.

The presence of red-slipped and burnished bowls at KAJ is an important trend to consider, even despite the overall scarcity of bowls at the site. The red-slipped and hand-burnished bowl carries major chronological significance as it is a characteristic form of the Iron Age IIA period in the Southern Levant. However, the origin of red-slipped and burnished vessels has been subject to some debate. Holladay (1990) argues that this decoration style appears around 950 BCE. Mazar (1998), in his comprehensive discussion on the first appearances of red-slipped vessels in the Iron Age, argues that this decoration style gradually developed in particular regions during the Iron I period. However, Mazar argues that the development of combined red slip and hand burnish only developed somewhat later, probably by the 11th century BCE (Mazar 1998). Faust (2002) asserts that the style should be correlated with the development of the United Monarchy. However, the preponderance of evidence suggests that, as Mazar suggested, red-slipped and burnished vessels do appear to a limited extent in the Iron I before their rate increases drastically in the Iron IIA (Mazar 1998; Singer-Avitz 2016a). The vessels appear at Iron I Strata IX-VII at Tel Beersheba for example, before peaking later in Beersheba VII (Brandfon 1984; Singer-Avitz 2016a). Ultimately, the presence of red-slipped and hand burnished vessels can be seen as a unique identifier for assemblages dating from the late 11th-late 10th centuries BCE (Cohen and Cohen-Amin 2004; Mazar 1997; Mazar 1998; Singer-Avitz 2016). For example, at Qasile, BL1, a rounded bowl with plain rim that parallels KAJ BL1, red slip and hand burnish does not appear in Iron IB stratum XII but becomes fairly common by Stratum X (Mazar 1985: 45). Other strata where these vessels notably appear in high quantities are the Iron IIA strata Arad XII-XI, Beersheba Stratum VII, and Tel Masos Stratum II (Cohen and Cohen-Amin 2004; Singer-Avitz 2016). At Lachish, an important site for understanding the ceramic typologies for the southern Levant, 92% of all bowls are slipped and burnished in Stratum V and 80% in Stratum IV before declining drastically in later periods (Zimhoni 2004). However, Zimhoni points out that red slip and hand burnishing of bowls may have continued for some time, and sites cannot be strictly dated to the Early Iron Age based on their presence or absence. At KAJ, the presence of a red-slipped and hand-burnished vessel should be considered chronologically and culturally. With regards to chronology, the appearance of red-slipped and hand burnished vessels sometime in the 11th century BCE provides an early boundary to its appearance. At sites with larger ceramic repertoires, the rate of bowls that feature red slip and hand burnish could be an important indicator of chronology. However, given the low overall ratio of bowls at the site and only one example of hand burnish at the site, this metric does not prove helpful. As such, given that red-slip and hand burnishing continued into the later Iron Age, albeit at lower rates, one cannot use this approach to decisively differentiate between an Iron IIA or IIB date for the sherd. However, given that most of the closest parallels to KAJ BL1 do date to the late 11th-late 10th centuries BCE, a date in this range seems most likely. Furthermore, all of the closest parallels for BL1 mentioned above are from Iron IIA, suggesting the most likely time frame for this sherd is in the 10th century BCE.

BL2, though also red-slipped and burnished, does not feature the uneven hand burnish that can be such an important diagnostic characteristic. This sherd must therefore be treated separately. BL2 is a thin-walled fine-ware bowl with a curved carination, a band above the carination, and a thickened rim. It is therefore a more complex form than BL1, which is a simple curved bowl without apparent carination. BL2 is similar to BL1 in its fabric type and that it also features a red slip and burnish, though the burnishing on BL2 appears more regular. This type of treatment has less significance for dating the vessel given the particular significance of hand burnishing, not present on this vessel. However, potential parallels for this sherd were found at *Beersheba II* Stratum VII (pl. 21.5) and *Lachish 2004* Stratum IV (pl. 25.56:22). Neither of these parallels is exact, but both are red-slipped and burnished and date to the Iron IIA period. This sherd features a similar fine fabric as BL1.

BL1 has a close parallel at *KEN* in BL 16a in Phase IV, Stratum R2b (pl. 4.1:22) and Phase III-II Stratum A3 (pl. 4.10:9). Smith and Levy's (2014: 310) BL16a are characterized based on petrographic analysis as imported from the Western Negev, thus, given the close parallel to that type, it is likely that BL1 and potentially BL 2, which shares a similar fabric and decoration, from KAJ is also an import from that region. Other parallels to KAJ BL1 include *Tell el-Qudeirat* Bowl 1 (pl.11.1:1; 11.30:2), *Timna Site 34* (pl. 6:11), *Lachish 1997* Stratum IV (pl. 3.5:14), Arad Stratum XI (p. 6: 2), *Beersheba II* Stratum VI (pl. 26:18), and *Qasile* BL 1, among others. Meanwhile, KAJ BL2 has parallels in *KEN* Bowl 24 (pl. 4.1:26), *Lachish 2004* Stratum IV (pl. 25.56:22), and *Beersheba II* Stratum VII (pl. 21.5), which features similar decoration though lacks carination. *Tawilan* (pl. 6.7:12) features similar form though not necessarily fabric or decoration. The parallels to KEN Bowls 16 and 24 provide an interesting point of comparison, given the frequency of these bowls at Area R from KEN.

Beyond parallels, the red-slipped bowls also carry cultural significance. Interestingly, despite the relative frequency of red-slipped and burnished bowls at Iron IIA sites in Judah, they are relatively uncommon at sites in the Negev (Cohen and Cohen-Amin 2004; Bernick-Greenberg 2007a). This may be due to the low status of inhabitants of these Negev sites (Cohen and Cohen-Amin 2004) or the limited need for wheelmade wares among non-sedentarized pastoral nomads occupying this region. Red-slip and burnish, generally speaking, is almost always applied to bowls used for food consumption rather than storage jars or cooking pots (Faust 2002). This is likely because the burnish would result in a more slippery vessel (Rice 1987: 232; Singer-Avitz 2016: 508) but one that is likely to be harder and more lustrous (Rice 1987: 355; Singer-Avitz 2016: 508). In general, serving vessels are likely to be fine, decorated ceramics, with open forms (Rice 1987: 240). Bowls 1 and 2 match these characteristics and were likely used as serving vessels, possibly for individuals rather than groups given their small size. At KAJ, red-slipped bowls are primarily found in Building 2, with one sherd representing the class found in Area A, likely in a disposal context. The use of these fine, imported ceramics as serving vessels may indicate that elites in Area B were demonstrating their wealth and access to high-quality trade goods through conspicuous consumption (cf. Clark and Blake 1994; Garraty 2000). Relatedly, the small size of the vessels suggests that a relatively small group of elites were active at KAJ given a lack of larger fine serving vessels (cf. Blitz 1993; Hendrickson and McDonald 1983). Overall, the presence of finer ceramics likely used as serving vessels in this structure provides additional evidence that the building may have been used by elites.

9.5.3.1.3 Krater 1

KAJ Krater 1 is also a significant type at the site, and is in fact the most common vessel form found at KAJ. The vessel is a krater with a thickened and somewhat flattened rim, creating an interior and exterior ledge and a short neck. The krater also features a handle attached at the rim of the vessel. All but one of the sherds in this class are produced using a similar fabric with a white appearance. Interestingly, the lone sherd to be produced with a reddish fabric also features white slip, possibly indicating that a whitish appearance was preferred for this class of vessel. This vessel class has a number of parallels. A first parallel is *KEN*'s KR 11, which features a rounded, thickened rim with interior and exterior ledges of varying width. As KEN KR11 is a somewhat broad class, KAJ KR1 fits within the range of variation of that class. Specific parallels from KEN are found in KEN integrated phases III and I (pls. 4.18:2; 4.20:1; 4.23:3) as well as one example of a different class from *KAJ06,* KR26 (pl. 4.38:9). Other parallels come from *Tawilan* (pl. 6.17:6); *Busayra* (pl. 9.22:7); and *Lachish* Stratum V (pl. 3.32: 1, 8). Parallels to highland Edomite sites such as Tawilan and Busayra may indicate some degree of cultural affiliation between Early Iron Age KAJ in the lowlands of Faynan and the Late Iron Age traditional highland polity of Edom. One particular sherd in this class, vessel (Figure 9.4:5), features a more substantial folded-over rim treatment more closely paralleled by *Lachish 2004* Stratum V-IV (pl. 25.55:5). Overall, these parallels range in period, including the Iron IB, Iron IIA, and Iron IIB. However, since this is somewhat of a general form, including a fairly wide range of kraters with thickened rims, it is difficult to use parallels to specifically date this class, beyond confirming that it is indeed an Iron Age form.

9.5.3.1.4 Krater 2

Krater 2 from the 2014 excavations at KAJ (Figure 9.5:1-3) is another important class identified at the site. Krater 2 is a krater with upright walls, a thickened and slightly everted rim, and an inward carination in the upper quarter of the vessel producing a sharp ridge on the exterior of the vessel and a channel between the rim and the carination. These kraters parallel some examples of *Qasile* BL 8, a carinated bowl with a "cyma" form, referring to its recurving rim. The cyma bowl type is common in the Iron I period and continues into the 10th century BCE (Mazar 1985). The cyma bowl is a type that has a fair amount of variation, though Mazar (1985) defines subtypes by the presence and style of handles on the vessel. Many cyma bowls have plain rims with a significant degree of eversion, a characteristic not seen in KAJ Krater 2. Rather, KAJ Krater 2 features an upright and thickened rim, while still featuring the channel and sharp carination seen in the cyma style. As such, these examples are not a prototypical example of the Cyma bowl, but still bear some similarity. At Tell Qasile Stratum XII, the majority of these bowls have white surface treatment, while later strata predominantly feature red slip, burnish, and black decoration. The examples from KAJ also feature white surface treatment and not red slip or burnish. Specific parallels include *Qasile* BL 8 in Stratum XII BL 8 (pl. 16:15) and Stratum XI BL 8 (pl. 24:8), as well as *Lachish* Stratum V B-17 (pl. 3.22:3), *Tell el-Qudeirat* Stratum 4b (pl. 11.17:1) and Substratum 3a-b (pl. 11.50:4). Taking into account the parallels, a date in the early Iron IIA seems appropriate for the vessels in this class. Interpreting their use, kraters are larger, open forms, suggesting that they may be serving vessels for larger social groups (cf. Blitz 1983; Hendrickson and McDonald 1983). These vessels were found in Area C and in Room 2 of Area B, a non-elite context and a potential food preparation context, respectively. Thus, the presence of these undecorated kraters may suggest group food consumption or food preparation for that purpose.

9.5.3.1.5 Cooking Jug

Only one wheel-made cooking pot rim was found at 2014 excavations at Khirbat al-Jariya, Cooking Jug 1 (Figure 9.8:1), for a rate of ca. 2.5% based on the small sample size of rim fragments at the site. Including non-diagnostic body sherds as well, 55 cooking pot sherds were found (out of the total of ca. 1,551 sherds from KAJ 2014) for a rate of ca. 3.5%. In Area A, excavated in 2006, four diagnostic cooking pot sherds were found for a rate of ca. 3.9% (Smith and Levy 2014: 407). As discussed above, these low rates of cooking pots fit within the range of variation of Iron Age sites in the Wadi Arabah associated with copper production. The scarcity of cooking pots at these sites may indicate that other vessel forms were used for cooking at these sites. Beyond quantitative analysis, typological study can also be illustrative. At KAJ, the only cooking vessels found are closed-form cooking jugs (Figure 9.8:1; Smith and Levy 2014: fig. 4.38:11-12), whereas at KEN many cooking pots take on more open forms. In addition, many of the cooking pots from KEN feature ridged rims characteristic of the "Edomite" cooking pot (Smith and Levy 2014: 336). This type is not seen at KAJ. This observation is relevant for understanding KAJ's relationship to Late Iron Age sites in the highlands of Jordan at which "Edomite cooking pots" are common. The form of cooking pots, reflecting methods of food preparation, can be important as cuisine can closely reflect ethnicity (Hesse

1986; Killebrew 1999). As such, the type of cooking pot used at KAJ can provide insight into the social organization of occupants of the site. However, the small sample size means it is difficult to make interpretations based on this evidence.

9.5.3.2 Handmade Ware

9.5.3.2.1 Handmade Arabah Ware

The presence of handmade ware at KAJ provides an interesting complement to the wheel-made ware. As discussed above, the presence of Negebite Ware/Handmade Arabah Ware provides a link to the presence of nomadic people engaged in copper production and trade in the Wadi Arabah and Negev desert (Bernick-Greenberg 2007b; Kleiman et al. 2017; Martin and Finkelstein 2013; Martin et al. 2013; Yahalom-Mack et al. 2015). At KAJ, despite a small sample size overall, coarse, tempered handmade wares are present. In particular, four diagnostic sherds can be tentatively classified as Handmade Arabah Ware. These sherds include two rim sherds and two base sherds. The rim sherds both seem to represent unique forms, potentially wide mouth jars or kraters. These sherds consist of various wares (Ware Groups 1A, 1F, and 3) but are generally recognized by their brown or gray color and coarse or friable texture. The base sherds (one pictured in Figure 9.14) also provide an interesting point of comparison. Though the overall form of these vessels is unclear, the coarse fabric, temper, and flat bases are characteristic of Handmade Arabah Ware at many other sites. It is possible that these vessels represent cooking kraters (cf. Bernick-Greenberg 2007b). If so their use as cooking vessels may explain the lack of traditional wheel-made cooking pots at the site.

Figure 9.14: A base of a Handmade Arabah Ware vessel (Sample KAJ61). Note the coarse fabric with many large inclusions.

9.5.3.2.2 Handmade Holemouth Jars

The other handmade vessels at the site are holemouth jars (Figure 9.9:1-3), which also have an interesting relationship to cooking at the site. These vessels have a relatively fine reddish fabric with few visible inclusions or pores. As such, they are not composed of a typical cooking pot fabric. However, two of these vessels display evidence of use in a hearth, with soot marks on the bottom of the vessels. Furthermore, these vessels are found on the west side of Structure 2, in or near Room 2, which also contained the only clearly-identifiable cooking pot fragments recovered in 2014 excavations, in Stratum B2b. In combination, this may indicate that Room 2 was used for domestic purposes in the Stratum B2b occupation, including food processing and cooking. These holemouth jars may have been used for cooking or food preparation. Another fragment of a handmade holemouth jar with black discolorations on the exterior of the vessel (possibly a result of imperfect firing rather than soot marks, cf. Kleiman et al. 2017) was found in Locus 550. The partially-excavated eastern portion of Building 2 in which Locus 550 is located is also significant for a discussion of cooking as Loci 550, 554, and 556 in Stratum B2a contain the only possible remnants of a hearth excavated in Structure 2. These loci contain a grinding slab, faunal remains, and charcoal embedded in an ashy sediment, potentially suggesting that cooking was done in this part of the site during the Stratum B2a occupation. Though only the rim of a holemouth jar remains and a base is not preserved, the similarity of this vessel to the holemouth jars with a potential cooking association in Room 2 corroborates the possibility of a cooking purpose for these vessels. In general, the question of how food was prepared at the site is an open question. One line of evidence comes from paleobotanical study, which suggests that workers at the site were provisioned with fruit from nearby orchards (Liss et al. 2020). However, where food was cooked and in what vessels is less clear. It is possible that some of these handmade vessels were used for cooking, though more work needs to be done to test this hypothesis. It may also be possible that cooking was done outside of the site in tent residences rather than in production or elite areas at the site itself.

9.5.4 Distribution of Ceramics

One final aspect of the classification and typological analysis of the ceramic assemblage from KAJ worth discussing are some basic analyses of the distribution of ceramic classes across the site. The ceramics from KAJ were recovered from three areas at the site — Areas A, B, and C. Areas A and C, both excavated at the southern edge of the site, represent industrial contexts (slag mounds) with some evidence of habitation as well. Area B, on the other hand, contains the largest structure at the site and displays evidence of slag crushing and possible ritual activity, though the use of Building 2 in Area B was not initially clear. However, analysis of the contexts of ceramic finds has provided additional insight into the use of the different parts of the site. Among the ceramics recovered from Area B are the finest ceramics at the site. This includes the cup-spouted jar and red-slipped fine-ware bowls, both discussed in detail above. Each of these vessel classes were recovered from the same context, Locus 543 and Locus 561, both representing the floor context in the central Room 3 of Building 2. This locus also contained a grinding installation featuring one of the finest grinding slabs at the site with an associated roller. The red-slipped bowls, as discussed above, are likely serving vessels. Fine serving vessels can be used by elites as status symbols, displayed during highly-visible and ideologically-significant food consumption (Clark and Blake 1994; Garraty 2000). In a similar vein, elite contexts are likely to have a high proportion of serving vessels, which are comparatively likely to be decorated, compared to non-elite residences or food preparation areas (Brumfiel 1987; Garraty 2000; Hirth 1993; Turkon 2004). The presence of three fine-ware bowls, likely serving vessels, and a total lack of cooking pots or other vessels clearly linked to food preparation in the central Room 3 suggests that this is an elite context. The cup-spouted jar, Jar 1, adds to the picture. If indeed this vessel was used for the portioning of olive oil (cf. Amiran 1969: 243; Crowfoot et al. 1957: 193), its presence in Room 3 suggests the occupants of the site were exploiting exchange networks for access to imported foodstuffs, which may have served to symbolize their status (Turkon 2004: 227). The presence of these relatively fine-quality ceramics, possibly used to store valuable liquids in the case of the cup-spouted jar or used as fine tableware in the case of the red-slipped bowls, seems to indicate that the central rooms of Building 2 were used by elites at the site. The presence of these vessel classes also parallels the ceramics from Area R, an elite context at Khirbat en-Nahas that also features two cup-spouted jars and red-slipped and burnished bowls. By contrast, the ceramics recovered from Area C at the site are relatively coarse, with several examples of possible Handmade Arabah Ware (also referred to as Negebite Ware; Figure 9.14) found in the area. The presence of these sherds may indicate that the occupants of these parts of the site were of a lower social status, or perhaps relied on more utilitarian ceramics, than the occupants of Building 2. The presence of simpler vessels in industrial areas of the site is also paralleled at KEN, where Area M, a large slag mound, features less painted pottery and cruder ceramics in general (Smith and Levy 2014: 414).

Further analysis of the distribution of ceramics in Area B hints at another circumstantial line of evidence for elite activity at KAJ. As discussed above, the spatial differentiation of food preparation activities may evidence the presence of elites, who in many cases look to outsource food preparation labor (Grantham 2000; Haviland and Moholy-Nagy 1992; Turkon 2004). Thus a comparative lack of evidence of food preparation may characterize elite contexts (Gumerman 1997). In the central rooms of Area B, Rooms 1 and 3, no evidence of food preparation exists as there are no cooking pots and grinding slabs and hammer stones found in this context seem to be associated with slag crushing activities. However, by contrast, Room 2 on the west side of the structure featured some evidence of cooking activities. The only clear cooking pot in Areas B or C, Cooking Jug 1, is found in Room 2 (four cooking pot fragments were found in Area A; Smith and Levy 2014). Furthermore, a base of a Negebite Ware sherd (KAJ53), possibly a form used for cooking (cf. Bernick-Greenberg 2007b), was found in Room 2, as were fragments of a holemouth jar, which have an unclear relationship to cooking. The many hammerstones and grinding slabs recovered from Room 2 were apparently not used for slag crushing given a lack of crushed slag in this Room, and as such may have been used for domestic purposes. Overall, cooking appears to have occured in this Room, though the extent of domestic activities in the room requires further investigation. The same applies to the eastern side of the structure which featured some evidence of a hearth though without ceramic evidence to complement a suggestion of cooking. Adding to the picture is the relative spatial differentiation of Room 2. This room, unlike every other room in the structure, is not directly accessible from the central Room 3. As such, it is possible that this room served a domestic purpose and these activities may have been intentionally segregated from the remainder of the structure. If so, this possibility further demonstrates the elite status of residents of the central rooms in the structure. Moreover, the possibility of spatial differentiation in the structure provides an interesting contrast to the use of similar structures in the broader Southern Levant. Building 2 features similarity to the Iron Age archetype “four-room house” (Faust 2013; Fritz 2007; Holladay 1992; Ji 1997; Netzer 1992; Shiloh

1970; Stager 1985, among others)—though a full evaluation of the similarity of the structure to this type and the significance of this comparison is beyond the scope of this ceramic analysis. Nevertheless, Faust and Bunimovitz (2003), building on the work of Hillier and Hanson (1984), have argued that the four-room house represents the egalitarian ethos of its inhabitants given the direct accessibility of all rooms in the house from the central space. Notably, accessibility and visibility patterns in structures can have significant social implications (Bafna 2003; Goldstein and Sitek 2018; Hillier and Hanson 1984; At KAJ, though Building 2 features a broadly similar layout to the four-room house, the structure's architecture seems to hint at social stratification rather than egalitarianism. Though preliminary, this comparison provides additional evidence for the presence of elites at KAJ as well as for the existence of local modes of social organization.

9.5.5 Classification and Typology: Conclusions

Overall, the classification of ceramics from the 2014 excavations at KAJ have provided important insight into the role the site played in the Iron Age industrial landscape of Faynan. Quantitative analysis of the ceramic classification — despite a relatively small sample size — illustrates that the KAJ assemblage is relatively typical of Early Iron Age assemblages from Faynan (cf. Smith and Levy 2014), suggesting that potters in the region operated in a shared community of practice (Lave and Wenger 1991; Wenger 1998). The ceramics of KAJ also bear similarity to other contemporaneous sites in the Wadi Arabah and the Negev. Parallels of the ceramics generally place the occupation of the site in the Iron IIA period (Table 9.11), corroborating radiocarbon dating of the site. In particular, the ratio of handmade ware among the diagnostic sherds recovered from the site is similar to the rate at KEN. The rates at these sites are relatively high compared to sedentary sites but much lower than the rates at Timna and sites in the Negev. The differential rates may be explained by the semi-sedentary nature of the copper-production sites in Faynan as compared to the Negev sites used as trade outposts. Beyond quantitative analysis of the wheel-made ware vs. handmade ware, the overall vessel form ratios studied and classified here are also in line with other sites in the Arabah.

This includes an overall low rate of traditional wheel-made cooking pots, also rare at other Arabah copper production sites, KEN and Timna. The lack of cooking pots may be explained by the use of Handmade Arabah Ware or perhaps handmade holemouth jars for cooking at the site. In general, quantitative analysis of the KAJ assemblage indicates that the site is a typical Iron Age copper production site from the Wadi Arabah, with great similarity to the KEN assemblage found nearby. These similarities tend to suggest that potters producing the ceramics found at KAJ operated in the same social spheres as those manufacturing the ceramics of KEN.

Table 9.11: The general dates of each ceramic class found at KAJ Areas B and C, based on parallels.

<table>
<tr><th>Early Iron IIA</th><th>Late Iron IIA</th><th>Iron IIB</th><th>Unclear</th></tr>
<tr><td colspan="2">Bowl 1</td><td></td><td></td></tr>
<tr><td colspan="2">Bowl 2</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td>Bowl 3</td></tr>
<tr><td></td><td>Jar 1</td><td></td><td></td></tr>
<tr><td colspan="2">Jar 2</td><td></td><td></td></tr>
<tr><td colspan="2">Jar 3</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td>Jar 4</td></tr>
<tr><td></td><td colspan="2">Krater 1</td><td></td></tr>
<tr><td>Krater 2</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td>Krater 3</td></tr>
<tr><td></td><td></td><td></td><td>Krater 4</td></tr>
<tr><td></td><td>Jug 1</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td>Jug 2</td></tr>
<tr><td></td><td>Cooking Jug 1</td><td></td><td>Juglet 1</td></tr>
<tr><td></td><td></td><td></td><td>Holemouth Jars</td></tr>
</table>

Qualitative analysis and examination of parallels tells a similar story. The KAJ assemblage has many parallels to vessel types from Khirbat en-Nahas. Though a similarity between the ceramic assemblages from these two nearby, contemporaneous copper-producing sites is to be expected, these similarities corroborate our understanding of KAJ as having participated in a regional copper production network in the Faynan region. A closer examination of some of the classes of ceramics from KAJ and their parallels also has resulted in some interesting findings. In general, the range of parallels to the KAJ assemblage indicates the closest similarity to the ceramics from KEN. A general similarity in form provides some evidence of a shared chaîne opératoire between ceramic production at the two sites, implying that both sites existed in the same social framework. The presence of a local early Edomite assemblage at KEN corroborates the hypothesis of local organization of production as potters at KAJ were likely part of a community of practice with those from KEN. Relatedly, very few close parallels from Tel Masos were discovered, suggesting that Finkelstein's (2005; and Piasetzky 2008; Fantalkin and Finkelstein 2006) hypothesis that copper production sites such as KAJ were controlled by a chiefdom centered at Tel Masos is unlikely. However, the assemblage from KAJ also features many parallels to sites in the Negev desert and Judah. These connections provide evidence of trade connections with regions to the west and may also provide additional support to the idea of a desert polity based in the Wadi Arabah and organized around the production and exchange of copper. Parallels in the KAJ assemblage to Late Iron Age sites in the highlands provide some corroboration that this Early Iron Age polity may be an early predecessor of the later traditional polity of Edom as well, as suggested by Smith and Levy (2014).

Beyond a general discussion of how the parallels in aggregate can inform our understanding of trade and political control over copper production, some conclusions can be made regarding some of the more notable ceramic vessels. The presence of Jar 1 and the red-slipped and burnished Bowls 1 and 2 in the central context Loci 543/561 in Building 2 draws a direct connection to the monumental building in Area R at KEN, which also features both cup-spouted jars and red-slipped and burnished bowls. More specifically, KAJ Jar 1 is a unique Iron IIA form with several parallels in Faynan, possibly indicating a special significance to this form in the region among the Faynan elite during the Early Iron Age. The vessel, hypothesized to have been used for the storage of olive oil (Amiran 1969: 243; Crowfoot et al. 1957: 193), may indicate the ability of elites to manipulate exchange networks for the acquisition of high-quality imported foodstuffs, which can function as an important status symbol (cf. (Clark and Blake 1994; Garraty 2000; Turkon 2004). Similarly, Bowls 1 and 2 are fine-ware open forms, suggesting their use as serving vessels (cf. Rice 1987: 240). Moreover, they are burnished and slipped, decorations commonly applied to serving vessels in order to limit porosity (Smith 1983; Rice 1987: 236-240; Singer-Avitz 2016: 508). These distinct bowls may have been used in highly-visible consumption practices, reinforcing elites' status through demonstration of their access to these imported fine-wares (cf. Clark and Blake 1994; Garraty 2000). Thus, these vessels likely indicate that Building 2 at KAJ was used by elites, like Area R at KEN, and may represent the ability of elites at KAJ to leverage control over trade to gain access to imported fine-ware and special consumables such as olive oil.

The richness of Room 3 in Area B can be contrasted to other parts of the site. Closer at hand, Room 2 in Building 2 may be a food preparation area as evidenced by the presence of ceramics related to cooking. The room's spatial differentiation—it is not directly accessible from the central Room 3 as the other rooms of the structure are, may also provide circumstantial evidence for the sequestering of food preparation activities and thus reinforce the interpretation that elites inhabited the central room of the structure. On the other hand, the presence of Handmade Arabah Ware in Area C, a non-elite area of the site, provides a cultural link to sites in the Negev Highlands, which are noted for their high rates of handmade ware manufactured in the Wadi Arabah, and other Wadi Arabah copper production sites such as KEN and Timna. The presence at KAJ of these coarsely-made ceramics, likely the subject of household production and use, suggests that the nomadic populations operating the mines and furnaces of Faynan were related to groups of the Negev highlands (Tebes 2006; Bernick-Greenberg 2007b; Meshel 2002; Cohen and Cohen-Amin 2004; Ben-Yosef 2010; Martin et al. 2013).

Overall, ceramic classification evidence from KAJ suggests that the site should be seen as a well-organized expansion of production from Khirbat en-Nahas. The presence of elites at the site, based on fine ceramics closely paralleling the elite Area R at KEN suggests that production and exchange at the site was centrally-organized by a local ‘Edomite’ polity. Ratios of handmade ware and parallels also suggest connections to sites in the Negev desert, suggesting trade connections and a possible political affiliation with a desert polity based around copper production in the Wadi Arabah and its exchange.

Chapter 10: Ceramic Analysis - Petrography

10.1 Introduction

The third and final avenue of ceramic analysis applied to the ceramics of Khirbat al-Jariya (KAJ), Jordan, is the use of methods of compositional analysis, primarily ceramic petrography. Thin-section ceramic petrography refers to the microscopic study of ceramics using a polarizing light microscope. This technique can shed great light on the ancient world as it can be used to directly observe variation in ceramics (Whitbread 1996: 251, 366). Petrography can be used to study the "technology, style, functions, chronology, place of origin, and symbolic content" of a ceramic vessel (Peterson 2009). These aspects can be crucial to understanding the chaîne opératoire and thus social organization of a site or region (Roux 2016; Whitbread 2016). As such, the application of petrography can bring additional complexity and sophistication to a project of ceramic analysis. In the Southern Levant, petrographic study has been applied to ceramics from periods ranging from the Pottery Neolithic to the Ottoman period in order to test issues such as technological change and trade (Boness et al. 2016; Burton et al. 2018; Cohen-Weinberger 2019; Gilead and Goren 1989; Goren 1987, 1995, 1996; Goren et al. 2004; Martin and Finkelstein 2013; Mason and Milwright 1998; Porat 1989; Porat and Goren 2002; Slatkine 1974; Smith et al. 2014b; Waiman-Barak et al. 2017, 2018)

Compositional analysis through thin section petrography is a key method applied to test several of the central hypotheses of this project. First, the examination of ceramic fabrics is crucial for studying the chaîne opératoire of ceramic production (Roux 2016, 2019; Whitbread 2016). The study of the ceramics of KAJ through petrographic means will help to identify whether the assemblage can be considered homogeneous or heterogeneous in terms of the technological styles employed in crafting the vessels, which can in turn shed light on the social groups and communities of practice engaged in ceramic manufacture (Lave and Wenger 1991; Roux 2016; Wenger 1998). More specifically, the choices made in ceramic production can be specifically examined, especially including choice of raw materials and temper. Examination of these choices, which carry social and possibly ideological meaning (Albero 2014: 57; Sillar and Tite 2000), can provide information on how society and production in Faynan was organized and controlled. Homogeneity of the assemblages of KAJ and Khirbat en-Nahas would suggest the primacy of local, while a more heterogeneous assemblage would need to be observed in order to corroborate the centrality of Tel Masos in the desert chiefdom hypothesized by Finkelstein (Fantalkin and Finkelstein 2006; Finkelstein and Piasetzky 2008). Second, petrographic analysis is also applied to test the hypothesis that copper produced in Faynan was exchanged primarily through the Negev desert. This idea is tested through the use of petrographic analysis to study the provenance of ceramics. Ceramics produced in the Negev and recovered at KAJ provides firm evidence of a trade connection between the two regions and suggests that copper was likely traded along the same route. Third, petrographic analysis also complements previously discussed comparisons between ceramics from KAJ and fine-ware recovered from elite contexts at KEN. Similarities between ceramics from Area B at KAJ and Area R at KEN would suggest a similarity of use and occupation between the two sites. This comparison, as well as the identification of imported fine-wares used as serving vessels, also helps provide evidence as to whether exclusive access to long-distance exchange was a factor in the development of social complexity in the region. Overall, compositional analysis through thin-section petrography provides an essential third component of the comprehensive ceramic study described here and allows for the testing of several of the key hypotheses proposed in this work.

10.2 Ceramic Fabric Analysis

The study of ceramic fabrics is crucial to the understanding of the production and use of ancient vessels. The study of fabrics has two fundamental aims: understanding the geological origin of the clay and inclusions of the ceramic in order to learn about its provenance and learning about the technology and process (i.e. chaîne opératoire) involved in the vessel's manufacture (Quinn 2013: 9-10; Whitbread 2016). The study of the composition of ceramics for these purposes can be divided into three categories: hand-section analysis, thin-section analysis, and chemical/elemental analysis. Of these, hand sample, or macroscopic analysis, is typically the first to be applied as it can serve as a method of developing preliminary fabric groups. These groups can serve as the basis for the selection of samples for more detailed compositional analyses (Pentedeka et al. 2010) or even facilitate extrapolation of information gained from petrographic or chemical study to a larger set (Gauss and Kiriatzi 2011). Typically, hand sample analysis of ceramics is conducted studying a fresh break on the artifact with the naked eye or with a jeweler's loupe. Such study can be sufficient to identify the color of the fabric (typically with a Munsell book), to evaluate the coarseness of the fabric, and to make preliminary identifications of inclusions, including their size, sorting, and angularity (Whitbread 2016). Most of these descriptions are useful but should be subject to testing via optical mineralogy conducted on thin-sections.

Thin-section petrography refers to the use of a polarizing light microscope to study rocks or ceramics (Degryse and Braekmans 2016). These materials are studied by producing a 30 μm thick "thin-section" from the material by using a diamond saw and potentially impregnating the material with resin in case it is friable (Degryse and Braekmans 2016; Peterson 2009). At this width, minerals have characteristic optical properties through which they can be identified (Gribble and Hall 2012). These properties are observed through a polarizing light microscope, which allows the observer to view plain polarized light (PPL) transmitted through the thin-section, or use an "analyzer" to view cross-polarized light (XPL; Gribble and Hall 2012). XPL under normal conditions is not visible, but transmission through minerals allows them, like under PPL, to display certain properties. Properties of minerals visible under PPL include color, pleochroism , habit, cleavage, relief, and alteration, while properties under XPL include isotropism, birefringence and interference color, interference figures, extinction angle, twinning, zoning, and dispersion (Gribble and Hall 2012; Degryse and Braekmans 2016). These properties, in aggregate, allow for the identification of minerals under the microscope; this study is referred to as optical mineralogy. The study of these properties to identify minerals and their characteristics is central to the identification of rock fragments for geological purposes (Gribble and Hall 2012; Degryse and Braekmans 2016).

The study of ceramics with a polarizing light microscope is somewhat different from the study of rocks, given the differing properties of the two materials. Generally, archaeological ceramics are composed of clay minerals and larger inclusions, often referred to as non-plastic (Peterson 2009; Quinn 2013: 7). The minerals that make up the majority of the clay matrix cannot be identified using a polarizing light microscope as they are too small (Quinn 2013: 7). This means that ceramic petrography must primarily focus on the identification of the non-plastic inclusions that are large enough to display optical properties. These can include minerals, lithic fragments, grog (pieces of fired ceramics), or organic inclusions (Peterson 2009). Identifying these inclusions can be challenging and require specialized descriptive or analytical techniques, such as, for example, those needed to differentiate between various argillaceous inclusions like rock fragments, grog, clay pellets, or clay temper (Whitbread 1986). The analysis of voids and pores in a ceramic matrix can also be indicative of technological choices made during ceramic manufacture (Degryse and Braekmans 2016). Thus, ceramic petrographers must rely on techniques from both geologic petrology and soil micromorphology (Quinn 2013; Whitbread 1986).

As mentioned above, one of the two main aims of petrographic study of archaeological ceramics is to examine the provenance of the vessels. Provenancing sherds on the basis of petrography depends on the "provenience postulate/principle," which holds that raw material sources feature chemical differences that can enable differentiation between them. For this to be true, compositional variations between sources must be greater than variations within sources (Weigand et al. 1977; Rands and Bishop 1980; Rice 1987: 415). In other words, comparison between clay sources and ceramics can provide provenance information as long as sources are different enough from each other to enable their correlation with archaeological materials. Studying petrography also requires researchers to be familiar with the geology of the region and, if possible, have samples for reference so that non-plastic inclusions in the ceramics can be associated with their geological origins (Peterson 2009). Provenancing ancient ceramics has been successfully performed on the ceramics of the ancient Southern Levant (Boness et al. 2016; Burton et al. 2018; Goren et al. 2004; Martin and Finkelstein 2013; Smith et al. 2014) and is an important component of the present study. The study of ancient ceramics through thin-section petrography can also be useful for the categorization of ceramics into technical, technopetrographic, and technomorphological groups (Roux 2016). These groups allow for the study of the variability in the chaîne opératoire of ceramic production within an assemblage, identifying the relative homogeneity/heterogeneity of the ceramics of a site and therefore its social organization (Roux 2016).

A third avenue of ceramic fabric analysis consists of the broader category of more objective scientific method as applied to ceramics. There are many scientific approaches that can be applied to ceramics, though a few are particularly common. These include Neutron Activation Analysis (NAA), X-Ray Fluorescence (XRF) and X-Ray Diffraction (XRD), Inductively Coupled Plasma Mass Spectrometry (ICP-MS), and Scanning Electron Microscopy (SEM). These analyses can be grouped into three categories: mineralogical analyses, chemical composition analysis, and textural characterization. Petrographic analysis with a polarizing microscope is in large part a mineralogical analysis, as this type of study allows for the identification of individual mineral grains based on their optical properties. A somewhat more objective method of identifying mineral grains is XRD, which collects information on the ways in which emitted X-rays are scattered and reflected according to the planes in a mineral, thus identifying the form of the mineral (Heimann 2016). Chemical analyses, on the other hand, essentially allow for the identification of the elemental composition of a ceramic sherd.

This can be used to create a “compositional ‘fingerprint’” for the vessel that can be used for provenancing purposes (Tite 2008). Generally chemical methods can be used for studying either bulk composition of the ceramic sherd or for identification of individual mineral grains or clay. NAA has been widely used for bulk analysis, though ICP-MS has become increasingly popular for that purpose in recent years (Glascock 2019; Minc and Sterba 2016; Speakman and Glascock 2007). Laser Ablation ICP-MS can be useful for identifying the elemental composition of individual non-plastic inclusions within the ceramic fabric (Golitko and Dussubieux 2016; Stoner and Glascock 2012), while XRF can do the same but is dependent on producing a homogenous sample or studying of the surface of ceramics (Glascock 2019; Hall 2016; Heimann 2016). Finally, textural characterization of a sherd is also facilitated by petrographic study, as the structure of the ceramic and the techniques applied to form the vessel can be identified through this type of analysis (Quinn 2013). SEM allows for the specific study and identification of clay minerals and their structure, providing an additional level of detail as to the texture and composition of the clay matrix (Tite et al. 1982), which is too fine to study under the polarizing microscope. Overall, these scientific methods can serve as a valuable complement to petrographic study.

10.3 Geology

Several of the geologic units in Faynan (Figure 11.1) and surrounding regions have been identified as the provenance of ceramic sherds from the southern Levant through petrographic analysis. A survey of these geologic origins helps to set the stage for discussion of previous petrographic work and the analysis conducted here.

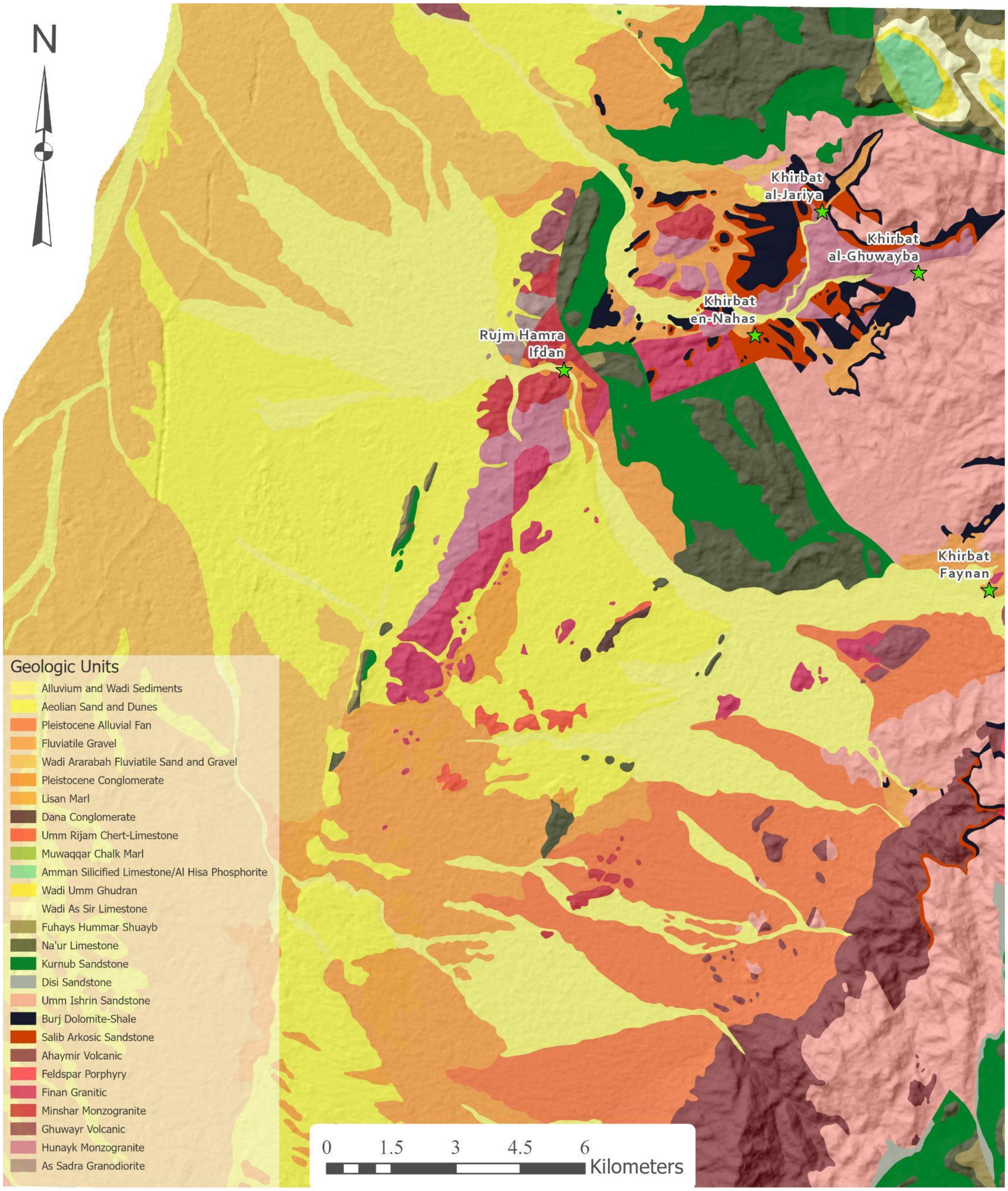

Figure 10.1: Geology of Faynan illustrating selected geologic formations (after Rabba' 1991).

The Kurnub Sandstone unit is an important geological origin of the Lower Cretaceous Shales, known petrographically. This unit appears in Jordan, southern Israel, the Sinai Peninsula, and Saudi Arabia (Nasir and Sadeddin 1989). These sandstones are part of the so-called Nubian Sandstones, consisting of a massive white sandstone unit and a varicolored sandstone unit (Nasir and Sadeddin 1989). In Israel, the former unit is known as the Amir Formation and the latter is known as the Hatira Formation (Bender 1968; Nasir and Sadeddin 1989; Shaw 1947). In Jordan, outcrops throughout the west side of the country, ranging from Jerash to Ras en-Naqab (Amireh 1994). More specifically, in the vicinity of Faynan, large outcrops of the Kurnub Sandstone are south of Khirbat en-Nahas and north of the Wadi al-Jariya, meaning this geology is local to the Faynan region (Figure 11.1; Rabba' 1991). In Faynan, the Lower Cretaceous Kurnub Sandstone overlies the Ordovician Period Disi Sandstone (discussed below); the two layers are separated by an unconformity (Rabba' 1991).

The Kurnub Sandstone, in short, is a mature quartz arenite (Amireh 1992; Nasir and Sadeddin 1992). Nasir and Sadeddin (1989) and Amireh (1992) each conducted studies on the unit in the Wadi Quseib, south of Faynan. The former found that the Kurnub Sandstone consists of "3 m thick basal conglomerate, followed by a 140 m thick coarse white sandstones [...] overlain by multicolored medium- to coarse-grained sandstones up to 110 m thick" (Nasir and Sadeddin 1989). The multicolored sandstones toward the top of the unit gain their color as a result of iron oxide cementation, and, significantly, iron oxides are present throughout as "minute pseudohexagons and spots of hematite surrounding the quartz grains" (Amireh 1992).The sequence features intercalated sandy shales and ferruginous sandstones (Nasir and Sadeddin 1989) as well as "sandy and ferruginous limestones, and marls" (Brenner and Bickoff 1992), which are significant for petrographic identification. Mineralogically, Amireh (1992) found the Kurnub Sandstones, as mature quartz arenite, to consist almost entirely of quartz without feldspars or rock fragments, though Nasir and Sadeddin (1989) recorded the presence of feldspar. The heavy minerals identified by the two studies included zircon, tourmaline, and rutile, with garnet, staurolite, epidote, barite, and anatase present but less common (Amireh 1992; Nasir and Sadeddin 1989). Hornblende may or may not be present (Amireh 1992; Nasir and Sadeddin 1989). The mineralogy of the Kurnub Sandstones is critical for understanding the extent to which they provide a geologic origin to clays used in the production of ceramics found at KAJ.

A second significant geologic unit for petrographic study in the Faynan region is the Disi Sandstone unit. Geologically, the Disi Sandstone dates to the Early Ordovician Period (Bender 1975; Amireh 1994). The formation lies on the Umm Ishrin Sandstone and is separated by an unconformity from the Kurnub Sandstone lying above (Amireh 1994). In Jordan, the Disi Sandstone outcrops as a strip ranging from the southwest to the Wadi Dana and as far as the Wadi Nummeirah (Amireh 1994). They appear to the southwest of the Faynan region, most notably in the vicinity of Petra (Figure 11.1; Rabba' 1991; Smith et al. 2014). In general, the Disi formation is a massive white coarse-grained sandstone with common cross-bedding, gravel lenses and quartz pebbles (Bender 1975). The formation ranges from 250 m in the vicinity of Petra to 0-30m closer to Faynan (Barjous 1995; Rabba' 1991). The Disi Sandstone, like the Kurnub Sandstones, are supermature quartz arenites (Amireh 1994). Detrital light minerals include primarily quartz with some muscovite (Amireh 1994: 208). The heavy mineral fraction consists of zircon, tourmaline, rutile, anatase, brookite, and tourmaline (Amireh 1994: 212).

One final geological origin worth discussing here are the loess soils of the Negev desert. Loess soils, by definition, are aeolian (i.e. transported by wind) sediments that form sedimentary bodies (Crouvi et al. 2017). As mentioned above, loess sediments are primarily silt-sized, ranging from 2–60 μm (Crouvi et al. 2017: 471; Singer 2007: 50). Loess sediments originate in the sand dunes of the Sinai Peninsula; as such, the sizes of loess particles decrease with additional distance from these dunes (Crouvi et al. 2017: 474; Ravikovitch (1952). Loess soils are common in the Negev desert, covering ca. 5,500 sq. km in the region (Crouvi et al. 2017; Dan et al. 1975). In the Beersheba Valley, loess deposits reach up to 15 m thick (Singer 2007: 50). In general, there are regional patterns to loess distribution in the Negev, as primary wind-blown loess covers the majority of the landscape in the northern Negev whereas further south, loess appears in different forms on both plateaus and in valleys (Crouvi et al. 2017: 473). This variation is reflected petrographically, as discussed above. In terms of composition, quartz is the most common mineral inclusion in loess soils (Crouvi et al. 2008, 2017: 475; Crouvi 2009). Other minerals include feldspar, iron oxides, hornblende, epidote, and zircon (Crouvi et al. 2017; Ginzburg and Yaalon 1963). In general, the identification of loess through petrographic means among ceramics of the Southern Levant normally implies an association with the Negev Desert and southern Shephelah where such soils are common.

In general, an understanding of the geological origins of many of the key clay types used in ceramics found in Faynan and neighboring regions is essential information to provenance the ceramics of Khirbat al-Jariya. Identifying local and/or imported wares through ceramic petrography, aided by a discussion of geology, is important for understanding ancient trade and social relationships and thus the development of social complexity in Faynan.

10.4 Previous Work

Ceramic petrography has been increasingly applied in the Southern Levant, though not always as part of a comprehensive and integrated study. The level of petrographic analysis in the Southern Levant pales in comparison to the complexity and sophistication of studies conducted in the Aegean (Badreshany and Phillip 2020). Standout studies in that region have been conducted by Day (et al. 1999), Gauss and Kiriatzi (2011), and Whitbread (1986, 1995), and studies of this region are often more fully integrated into ceramic analysis projects (Badreshany and Philip 2020). In particular, scholars working in the Southern Levant in the region have been reluctant to apply petrographic analysis for the type classification of archaeological ceramics, instead preferring morphology as a metric for classification (Smith and Levy 2014: 302-3). This can be the case even when quality petrographic work is available (Master 2003: 52). Moreover, petrographic work in the Southern Levant has been largely conducted by a limited number of scholars (Badreshany and Philip 2020). Of particular note are Yuval Goren (1988, 1991, 1996; et al. 2004, among others) and Naomi Porat (1989; Greenberg and Porat 1996). Goren has been an especially prolific scholar and many petrographic studies in the region have depended on his expertise and/or comparative collection (cf. Boness et al. 2016; Martin et al. 2013; Singer-Avitz 1999; Smith et al. 2014). While impressive, Badreshany and Philip (2020) have emphasized the risk in over-reliance on expert opinion rather than the publication of detailed evidence. Similarly, previous studies have published only general interpretations rather than the detailed fabric descriptions needed for reinterpretation (Burton et al. 2018: 238). As such, it is incumbent on scholars to publish their petrographic analyses in a systematic way in addition to more subjective interpretations. Despite the limited number of petrographic studies conducted in the Southern Levant, scholars have been more likely to conduct ceramic petrographic analyses in recent years (e.g. Burton et al. 2018; Cohen-Weinberger et al. 2017; Iserlis et al. 2019; Waiman-Barak and Gilboa 2020). Thus, scholars in the region are increasingly recognizing the utility of optical mineralogy for archaeological study.

More specifically, compositional analyses have also been applied to archaeological ceramics from Faynan and nearby regions in a number of studies. One early petrographic study was conducted by Slatkine (1974; 1978), who studied Negebite Ware, Midianite Ware (Qurayyah Painted Ware), and wheelmade vessels found in Israel at several sites including Timna. Rothenberg and Glass (1981, 1983) studied ceramics from Timna, Tawilan, and Qurayyah in Saudi Arabia, finding that the Midianite pottery was likely produced in Qurrayah. These conclusions were later supported by Gunneweg et al. (1991) on the basis of a chemical study using INAA. Gunneweg, in fact, conducted a number of INAA studies, generally finding that Edomite pottery from the Negev was likely produced locally as were ceramics from highland Edom (Gunneweg and Balla 2002; Gunneweg and Mommsen

1990, 1995; Gunneweg et al. 1991). Meanwhile, Edomite ware at Tel Beersheba was also found to be local, though some sherds were produced from *terra rosa* soil found north of the Beersheba Valley (Singer-Avitz 1999). Haimann and Goren (1992) also produced a small study on six Iron II Negebite Ware vessels, suggesting that they were produced using clay local to the Negev. Similarly, a small study of four sherds from Tel ‘Aroer were studied by Iserlis and Thareani (2011), finding that the majority were local. Finally, Bernick-Greenberg’s (2007b: 192, 198-99) comprehensive discussion of Negebite Ware also included a preliminary note on petrographic analysis, suggesting that 6 fragments of Negebite cooking pots originated in central Transjordan, while the remainder of vessels studied originated from local clay including loess.

The most relevant studies to the analysis conducted here were conducted by Al-Shorman (2009), Martin (et al. 2013; Martin and Finkelstein 2013) and Smith (et al. 2014). Al-Shorman’s (2009) diachronic study investigated six domestic ceramic sherds and ten technical ceramic fragments (i.e. tuyères and furnace linings) from the Iron Age with petrographic analysis and various chemical analyses. Martin (and Finkelstein 2013; et al. 2013) also explored the phenomenon of slag-tempering. This study was the first larger scale and systematic compositional study of Iron IIA ceramic sherds from the Negev. Martin sampled ca. 200 Iron IIA vessels from sites in the Negev highlands, many of which represent the “Negev Fortresses” discussed above. Martin’s study produced some interesting conclusions, challenging the understanding based on previous small studies that Negebite Wares were largely locally produced. While Martin’s study provides a perspective from the Negev looking east, the work of Smith (et al. 2014) provides a Faynan-based perspective. This study took a representative sample of 306 sherds from Khirbat en-Nahas (158 samples), Khirbat al-Jariya (7), Rujm Hamra Ifdan (RHI) Sounding A (5), RHI Sounding B (38), and sites in the highlands of Edom from the L2HE project (98) for thin-sectioning and petrographic analysis, providing large scale data on the composition of Iron Age ceramics from Faynan for the first time.

The work of these scholars and others has resulted in the classification of many ware groups based on different characteristics. However, the petrographic groups identified by scholars are often directly comparable (Table 10.1). The broader categories seen—especially across the three studies focusing on ceramics from Iron Age Faynan and the Negev in detail—serve as a standard against which the ceramics of KAJ can be compared. The first category consists of fabrics local to Faynan, typically identifiable through the inclusion of argillaceous shales, iron oxides, and/or copper slag temper. Smith (et al. 2014b) classified 156 samples into this category as Petrographic Group 1: Lower Cretaceous Shales. The Lower Cretaceous Shales are well-known as a petrographic origin (Goren 1996; Goren et al. 2004:104-5; Goren and Halperin 2004: 2559-2561; Greenberg and Porat 1996; Martin and Finkelstein 2013: 25; Porat 1989; Smith et al. 2014: 141-6). These wares are identifiable through the presence of argillaceous shales—the identification of argillaceous inclusions in ceramics is an important aspect of petrographic study (Whitbread 1986)—and iron oxides either as rhombs or ferruginous inclusions (typically limestone). Rarer mineral inclusions in these fabrics consist of "plagioclase and orthoclase feldspars, arkose, chert, sandstone, calcite, and gypsum" (Smith et al. 2014b: 141). Smith (et al. 2014b) further subdivides this ware group into many subcategories, the specificity of which helps to compare to the petrographic groups identified by Martin (and Finkelstein 2013) and Al-Shorman (2009). Martin and Finkelstein's (2013) iron oxide group, associated with the Wadi Arabah, and Al-Shorman's Sample 253p can be associated with Smith's (et al. 2014b) Lower Cretaceous Shale group in general (Table 10.1). In all three of these groups, argillaceous shale inclusions and iron oxides in the form of calcite/dolomitic rhombs and ferruginous limestones are observed. A second identifiable group across the three studies are shale-rich fabrics local to Faynan that also contain crushed slag temper. These wares are included in Smith's (et al. 2014b) Wares A2, A2b, and A6b, representing ceramics with slag inclusions, coarse slag inclusions, and cooking pots with slag inclusions, respectively, making up 30% of sampled vessels. Martin and Finkelstein (Petrographic Group 1) and Al-Shorman (2009: 203) also classify wares as a group based on slag inclusions. The inclusion of slag in Iron Age ceramics is a well-known phenomenon—possible reasons behind this phenomenon are discussed above. Martin (et al. 2013) provides the most comprehensive investigation of this specific tempering practice to date, identifying ca. 200 slag inclusions within his Petrographic Group 1. These slag-tempered wares, part of Smith's (et al. 2014b) Petrographic Group 1, are argued by each scholar to be local to the Faynan region. This is corroborated by the chemical identification by Al-Shorman (2009: 205) and Martin (et al. 2013: 3784) of high rates of manganese characteristic to the ores of Faynan in the slag-tempered wares. The geologic origins of these petrographic groups are discussed in detail below.

Table 10.1: This table presents the petrographic groups classified by Smith (et al. 2014b), Martin (and Finkelstein 2013; et al. 2013), and al-Shorman (2009) and the equivalencies between each study.

Iron Age Faynan and Highlands 306 samples (Smith et al. 2014b)		**Iron Age Negev Highlands Sites** ca. 200 samples (Martin et al. 2013; Martin and Finkelstein 2013)	**Iron Age Faynan** 6 samples (Al-Shorman 2009)	**Characteristic Inclusions**
Petrographic Group 1: Lower Cretaceous Shales (n=256)	Ware A2: Slag Inclusions Ware A2b: Coarse Slag Inclusions	Petrographic Group 1: Slag-tempered clays (n=18)	Pottery Containing Slag Temper (n=3)	Argillaceous shales, slag temper
		Petrographic Group 3: Clays with de-dolomitic iron oxides in the silt fraction (n=24)	Pottery without any slag temper (n=3)	Argillaceous shales, iron oxides as rhombs and ferruginous limestone
Petrographic Group 2: Arkose Group (n=11), (cf. Arkose Group, Goren 1996: 53-54)		Petrographic Group 2: Igneous-rock-tempered clays (n=12), (cf. Arkose Group, Goren 1996: 53-54)		Arkose derived from Granitoids or granite/rhyolite, quartz, feldspar
Petrographic Group 3: Lower Cretaceous Disi Formation Sandstone (n=14)				White fabric, predominance of quartz
Petrographic Group 4: Paleozoic Micaceous Clay (n=5)				Micaceous fabric
Petrographic Group 5: Loess Soil (n=7)		Petrographic Group 4: Loess clays (n=28)		Highly-silty fabric, angular quartz silt
Petrographic Group 6: Lower Cretaceous Shale with Micaceous Clay—Qurayya Ware (n=6)				Micaceous, silty fabric with shales
Petrographic Group 7: Moza Dolomitic Clay (n=2)		Moza wares (n=2)		Calcareous fabric, dolomite sand
Petrographic Group 8: Cypriot Aegean (n=3)				Micaceous clay, silty angular quartz
Petrographic Group 9: Syro-Lebanese Coast—Neogene Clay with Amphiroa Fossils (n=1)				Fossiliferous limestone, Amphiroa fossils
Petrographic Group 10: Greek Transport Amphora (n=1)				Micaceous clay, angular quartz, plagioclase, limestone
		Terra rossa wares (n=2?)		Silty, ferruginous matrix (cf. Goren et al. 2004: 284)
		Taqiyeh marls (n=?)		Limestone featuring coralline algae fossils (cf. Goren et al. 2004: 256-8)

An additional ware group identified in many petrographic studies, including Smith (et al. 2014b) and Martin and Finkelstein (2013), is associated with loess soils. This type of soil is discussed below (as are other relevant geology types). Loess is well-known among petrographic analyses in the Southern Levant (Burton et al. 2018; Boness et al. 2016; Goren 1988; 1991:101-104; 1996: 48; Goren and Gilead 1987; Goren et al. 2004: 112-3; Goldberg et al. 1986; Martin and Finkelstein 2013; Master 2003; Rognon et al. 1987; Smith et al. 2014). Petrographically, loess fabrics are known for being silty and calcareous (Goren 1996:48; Martin and Finkelstein 2012: 27). Angular quartz makes up most of the silt fraction, though calcareous inclusions such as limestone, chalk, calcite are also common (Goren 1996: 48; Martin and Finkelstein 2013: 27). Loess soils have often been divided into two main subgroups based on composition/regional origin petrographically (Martin and Finkelstein 2013: 27). In general, these subgroups are coastal loess (Boness et al. 2016: 196; Goren et al. 2004: 112-3; Martin and Finkelstein: 27; Master 2003: 55) and Shephelah loess (Boness et al. 2016: 192; Goren et al. 2004: 112-3; Martin and Finkelstein 2013: 27; Master 2003: 55), though different inclusions can also reflect different origins (Goren et al. 2006: 112-3). Coastal loess fabrics originate in the northwestern Negev. These fabrics are silty, featuring well-sorted quartz silt, characteristic of loessal soils. The coastal loess also is tempered with rounded quartz sand grains and minerals such as hornblende, zircon, feldspar, and augite (Boness et al. 2016:196; Goren et al. 2004: 112-3; Master 2003). These tempers are suggestive of the use of beach sand to temper the clay (Goren et al. 2004: 113). Shephelah loess, on the other hand, have coarse inclusions of a primarily or exclusively calcareous nature, including *nari*/calcrete, chalk, and limestone (Boness et al. 2016: 192; Goren et al. 2004; Martin and Finkelstein 2013: 28). Thus, in both cases, a more specific provenancing may depend on the type of coarse sand non-plastic inclusions. However, in general, the presence of loess-derived wares provide a strong provenance indicator to the Negev or Southern Shephelah. Both Smith (et al. 2014b) and Martin and Finkelstein (2013) identify loess-derived ceramics (Petrographic Group 6, n=7, and Petrographic Group 4, n=28, respectively) in their studies. The ceramics of these groups they identify as coming from the north or northwestern parts of the Negev and in each study, most if not all ceramics in these groups are red-slipped Martin and Finkelstein 2013: 27; Smith et al. 2014b: 152). The close association between red-slipped fine-wares and wares derived from loess soils has significant implications for this study, discussed below.

A final ware group of particular relevance, only identified by Smith (et al. 2014: 151), is associated with the Disi Formation Sandstone. 14 sherds from KEN were associated with this fabric, representing ca. 8 percent of the samples from KEN (Smith and Levy 2014; Smith et al. 2014b: 165). Vessels in this fabric group have a unique white appearance, and the fabric is siliceous with inclusions of primarily quartz, with chert, gypsum, and limestone also present (Smith et al. 2014: 151). The presence at KEN of sherds from this geologic origin is of great significance based on possible similarity to fabrics from Buseirah (Smith et al. 2014: 165; cf. Bienkowski 2002: 235, 485). Outcrops of the Disi formation in the vicinity of Faynan are found to the southeast, in the Edomite highlands near Petra (Figure 11.1; Marjous 1994; Rabba' 1991). This suggests that either Disi-made wares were imported from the highlands or that clay from the area was brought for the production of these ceramics, in either case suggesting a level of interaction between the highlands and the lowlands (Smith et al. 2014: 165). The Disi Formation is discussed in further detail below.

Finally, seven sherds from Khirbat al-Jariya (KAJ) Area A were also thin-sectioned by Smith (et al. 2014). Interestingly, these sherds showed a different ratio of ware groups than the KEN sample, interpreted by Smith (et al. 2014b: 160), based on the small sample size, to mean that potters practiced a slightly modified chaîne opératoire than at KEN. Most interestingly, none of the seven sherds contained slag inclusions identifiable under the petrographic microscope (Smith et al. 2014: 160). In addition, KAJ featured three examples of the calcite-rich Lower Cretaceous Shale ware group A4, the only three thin-sections in the entire assemblage categorized as such. These differences, though extremely preliminary given the small sample size, provide an interesting point of comparison for the present study.

10.5 Methods

In order to conduct ceramic petrographic analysis on the ceramic assemblage recovered from excavations at Khirbat al-Jariya in 2014, a multi-stage sample selection and preparation strategy was employed. As discussed above, macroscopic analysis can be useful for setting a baseline for microscopic analysis and sample selection. In particular, the division of ceramics into macroscopic fabric groups based on visible characteristics of the fabric and typology can usefully inform thin-section sampling (Pentedeka et al. 2010). With the KAJ ceramic assemblage, the diagnostic rim sherds had been classified according to their form, as discussed above. These sherds were then divided into 15 preliminary macroscopic fabric groups that served as an additional consideration for thin-section sampling. Factoring in both macroscopic study and form classification, a representative sample of 24 sherds were chosen to be sampled. Standard covered, 30 μm thin-sections of these ceramics were produced by Ram Alkaly of R.A. Petrographic of Los Angeles, CA. These thin-sections serve as the basis for petrographic analysis described here.

Once these samples were produced, they were studied using a Motic BA310 Polarizing Microscope featuring 4x, 10x, 40x and 60x objective lenses located in the Levantine Archaeology Laboratory at UC San Diego. This microscope allowed for the study of the ceramic thin-sections in polarized light and cross-polarized light. A three-part methodology was adopted for the study and classification of the sampled ceramics into ware groups. First, each of the samples was examined in PPL and XPL under the microscope and preliminary groups were made with reference to both macroscopic appearance and general microscopic characteristics. Second, these groups were finalized based on more rigorous analysis of non-plastic components and consideration of possible geologic origins as they related to the inclusions. Finally, the groups were formally described and archaeological implications were considered. Overall, the goal of this study was to find and identify non-plastic inclusions and other characteristics in each of the thin-sections in order to divide the overall sample into groups and sub-groups representing the variety of the assemblage. The ware groups were described according to a slightly adapted version of the standardized descriptive system proposed by Whitbread (1989, and applied in Whitbread 1996). This system applies technical terminology that is largely borrowed from Kemp's (1985) approach toward soil micromorphology. This system includes specific language for, for example, the frequency of inclusions in a fabric: Predominant (>70%), Dominant (50-70%), Frequent (30-50%), Common (15-30%), Few (5-15%), Very Few (2-5%), Rare (0.5-2%), and Very Rare (<0.5%; Whitbread 1989; 1996: 379). Specific terminology also applies to description of inclusion boundaries, void shape and size, spacing of grains and voids, and other aspects of the ware (Whitbread 1989; 1996). This detailed and relatively-standardized approach allows for the generation of detailed comparative data. As such, this descriptive system has been largely applied here for the discussion of ware groups. Subgroups in this study will be discussed in less detail to avoid repetition of many of the same characteristics. Instead, deviations or differences from the main ware group—in many cases merely the presence of one particular mineral—have been highlighted and discussed. Finally, the ware groups have been preliminarily associated with their provenance/geologic origins, which are discussed above. These associations—presented below in the Discussion section rather than as Results, given that they are interpretive—have been generated on the basis of comparative study with the large sample of thin-sections analyzed and published on by Smith (et al. 2014), whose study is in turn based on comparative analysis with the collection of Prof. Yuval Goren. The collection and analysis of raw materials is advisable for the study of provenance (Peterson 2009); as such, the provenances discussed below should be considered preliminary until future chemical analysis and comparative study with source material can be conducted.

10.6 Results

Based on macroscopic and microscopic analysis, the sampled sherds from 2014 excavations at Khirbat al-Jariya have been divided into ware groups and subgroups. These classifications reflect the mineralogy of the non-plastic inclusions in the sherds, and help to provide a framework of analysis for the ceramics from the site. Images of each thin section are presented in Appendix A, while the ware groups and their descriptions, following Whitbread (1989, 1996), are presented in Appendix B and briefly summarized in Table 10.2.

Table 10.2: This table summarizes the petrographic ware groups and subgroups identified in this study.

Ware Group	**Subgroup**	**Characteristic Inclusions**	**Geologic Association**
Ware Group 1: Shale-tempered Fabrics	Subgroup A: Shale-tempered fabrics with Quartz and Calcareous Sand Inclusions	Argillaceous shale, quartz sand, calcareous sand	Kurnub Sandstone
	Subgroup B: Shale-tempered Fabric with Slag, Quartz, and Calcareous Sand Inclusions	Argillaceous shale, quartz sand, calcareous sand, slag	
	Subgroup C: Shale-tempered Cooking Pot Fabrics	Coarse argillaceous shale, quartz sand, calcareous sand	
	Subgroup D: Shale-rich Fabrics with Sandstone Inclusions	Red shale, quartzarenite and polycrystalline quartz	
	Subgroup E: Shale-Tempered Calcareous Fabric with Ooids	Calcareous Fabric, limestone inclusions with microfossils/ooids	
	Subgroup F: Coarse Shale-rich Fabric with Grog Temper	Argillaceous shale, grog	
Ware Group 2: Siliceous Fabrics with Quartz Inclusions	n/a	Quartz sand, ferruginous textural concentration features	Disi Sandstone
Ware Group 3: Highly Silty Calcareous Fabrics	n/a	Quartz silt, quartz sand	Loess Soil

10.7 Discussion

10.7.1 Geologic Associations

The results of this petrographic study help to shed light on the Iron Age society of Faynan, despite the relatively small sample size. The ware groups discussed above, though not themselves representing geologic origins, can be considered in terms of their provenance. As discussed above, provenancing ceramics is possible given sufficient variation in the sources of raw materials. Comparative analysis of the Khirbat al-Jariya (KAJ) thin-sections to those of Khirbat en-Nahas (KEN) and other sites studied by Smith (et al. 2014) also provides a useful basis for the study of geologic origin given that Smith's ware groups are oriented by geologic origin.

The first group identified in the present study (Figures A1-12; A15-18; A21-24; A27-34; A39-42; A45-48 in Appendix A) are the Shale-tempered fabrics, largely characterized by the presence of red or gray argillaceous shales. These fabrics also feature iron oxides, both as rhombs (Figure B.1 in Appendix B) and present in ferruginous shales. These wares represent ca. 79% (19/24) of the sampled sherds, making this the most common ware type at the site by far. The characteristics of this ware group, along with comparative study with Smith's (et al. 2014) thin sections, suggest that this ware group should be associated with the Lower Cretaceous Shales (LCS) petrographic group. LCS wares, as discussed above, are well-known petrographically (Goren 1996; Goren et al. 2004:104-5; Goren and Halperin 2004: 2559-2561; Greenberg and Porat 1996; Martin and Finkelstein 2013: 25; Porat 1989; Smith et al. 2014: 141-6). In Faynan, as discussed above, the Lower Cretaceous Shales are represented in the Kurnub Sandstone, which is present throughout Faynan and in the vicinity of Khirbat al-Jariya and Khirbat en-Nahas (Figure 11.1; Rabba' 1991). Petrologically, the presence of shales, which may be ferruginous, and iron oxides is very consistent with the composition of the Kurnub group, as are the presence of heavy minerals such as rutile and epidote (Nasir and Sadeddin 1989; Amireh 1992). The presence of coarse sand-textured quartz inclusions is consistent with the geology of the Kurnub Sandstones, which feature coarse-grained sandstones (Nasir and Sadeddin

1989; Amireh 1992). The calcareous sand, possibly limestone-derived, is also consistent with the Kurnub group (Brenner and Bickoff 1992), suggesting that sand derived from this geology may represent the origin of most of the inclusions in the ware group. While LCS also are present in other regions, additional evidence would be required to suggest an alternate geological origin. As such, this ware group should be considered local to the Faynan region. The shale-tempered fabrics at KAJ are often also tempered with calcareous sand, and evidence of secondary calcite is frequently observed on the edges of pores. Overall, the samples from KAJ may be somewhat more calcareous than those observed at KEN; however, not to the extent of the highly-calcitic ware group A4 observed by Smith (et al. 2014b), which is not seen among the wares of Areas B and C.

The predominance of Shale-tempered Ware Group 1 (19 of 24 sampled sherds) among the ceramics from KAJ Areas B and C provides evidence for the chaîne opératoire of ceramic production applied at the site. The use of clay from one particular geologic origin suggests that this clay source was preferred for its qualities or ease of access from the site. The ferruginous nature of the clay apparently provides technical advantages in the sintering process during firing (Goren 1996:49), suggesting that the clay may have been preferred based on its physical characteristics. It is not clear if the presence of shale inclusions in fabrics of this group is a result of intentional tempering or the use of unsieved clay. On the other hand, the differential rates of rounded quartz and/or calcareous coarse sand in vessels across Ware Group 1 suggests that these non-plastic inclusions likely represented intentional additions. The presence of especially high rates of quartz sand, seen in Cooking Pot samples KAJ15 and KAJ37 (as well as KAJ23) is likely a functional choice, given the effectiveness of quartz temper in toughening the vessel, including during thermal shock inherent to cooking process (Ben-Shlomo 2019; Kilikoglou et al. 1998; Killebrew 1999; Sassaman 1995). Calcareous temper is also common in contemporaneous cooking pots from the region and may have technical advantages under lower temperature or reducing firing conditions as well (Ben-Shlomo 2019; Killebrew 1999:105-6).

The second ware group (Figures A13-14; A19-20 in Appendix A; 2 of 24 sampled sherds) identified among the sherds recovered from KAJ in 2014 are the Siliceous fabrics with primarily quartz inclusions, Ware Group 2. Based on comparative analysis to both the geology of the region and with the assemblage studied by Smith (et al. 2014), this ware group can be tentatively associated with the Disi Sandstone in terms of geologic origin. That the inclusions in the two samples of this group are primarily quartz is consistent with the nature of the Disi formation as supermature quartz arenites. However, it is important to note that the Kurnub Sandstones are also supermature quartz arenites; as such, the geological affiliation suggested here must also rely on comparative study. The fabrics and inclusions of Ware Group 2 identified here bear great similarity to those of Smith's (et al. 2014: 151) Petrographic Group 3, which is affiliated with the Disi Formation. Similarities come especially in the white fabric, viewed macroscopically, the color and texture of the fabric viewed microscopically, and the inclusions of quartz and high-fired ferruginous limestone in some cases. Differences consist of a lack of identifiable feldspar or micas in the samples of Ware Group 2 studied from KAJ. Assuming an association with the Disi Sandstone formation is correct, the clays used to produce the vessels in this group may have come from the outcroppings of this geologic formation in the highlands of Jordan, southeast of KAJ and only ca. 16 km away at their nearest point (Figure 11.1; Marjous 1994).

The third and final Ware Group, Ware Group 3 (Figures A25-26; A35-38 in Appendix A; 3 of 23 sampled sherds), identified in the samples from KAJ consists of highly silty fabrics. Thes fabrics are identified by their calcareous matrix—relatively unique in the assemblage—and the high rate of well-sorted angular quartz silt seen in each fabric. These features are characteristic of ceramics produced from clay derived from loess soils, as discussed above. These fabrics are also identifiable by their lack of shale inclusions, distinguishing them from the majority of sherds from the KAJ sample. Given the similarity of the mineral composition of these sherds to the mineralogy of loess soil, it is likely that the three sherds in Ware Group 3 were produced using loess-derived clays. This association is corroborated by comparison with the thin-sections studied by Smith (et al. 2014: 151-2) and categorized as Petrographic Group 5: Loess Soil. Of the sherds from KAJ, Samples KAJ34 and KAJ35 bear great similarity to Smith et al.'s Group 5, all of which are fineware vessels that are red slipped and hand burnished (see above for discussion of this phenomenon and its importance). While the calcareous matrix and angular quartz silt of each of the three vessels of Ware Group 3 are quite similar, the coarse inclusions present in each fabric tentatively allow for more specific provenancing. Sample KAJ34 features rounded quartz sand, but the Dominant inclusions in this sherd are calcareous, consisting of both shell and a calcareous sand that may represent *nari* (cf. Boness et al. 2016; this potential association warrants more testing and comparative study). Loess fabrics featuring a high rate of calcareous sand, whether that be *nari*, chalk, or limestone, have been identified as representative of the northern Negev or southern Shephelah, where calcareous raw material is common (Boness et al. 2016: 192; Goren et al. 2004; Martin and Finkelstein 2013: 28). As such, Sample KAJ34 should be tentatively identified as an import from this region. Sample KAJ35, on the other hand, features coarse inclusions of almost exclusively rounded quartz sand. Loess fabrics with predominant quartz sand inclusions are often identified as "Coastal Loess," representing an origin in the northwestern Negev and potential temper with beach sand (Boness et al. 2016:196; Goren et al. 2004: 112-3; Master 2003). Sample KAJ35 should thus be associated with the northwestern Negev. Both of these sherds are red-slipped fine-wares; similar ceramics from KEN and KAJ had been previously sourced to the loess deposits of the Negev (Smith et al. 2014b) and those results are corroborated here. Sample KAJ21 provides a more difficult provenancing challenge. This sherd, recovered from the slag mound in Area C, is not a red-slipped fine-ware. Rather, this sherd has a more friable texture and different color (7.5YR 5/2 Brown to 7.5YR 3/1 Very Dark Gray on the surface of the sherd, 5YR 6/2 Pinkish Gray to 5YR 6/4 Light Reddish Brown in the core), traits observable macroscopically. Microscopically, the calcareous matrix and angular quartz silt is highly reminiscent of the loess-associated fabrics described above. However, the coarse non-plastic inclusions consist of not only quartz but also weathered feldspars and granite. This type of silty calcareous matrix with granitic inclusions is not paralleled in the assemblage at KAJ or among the sites studied by Smith (et al. 2014), nor is it representative of the two main loess groups described above. As such, the relationship of this vessel to the two fineware bowls KAJ34 and KAJ35 is not clear. This vessel requires further study and comparison.

10.7.2 Social and Cultural Associations

The high rate of shale-tempered fabrics at KAJ, which are likely associated with the local geology of the Kurnub Sandstone, has important implications for our understanding of the role KAJ played in a regional network of copper producing sites as well as on the hypotheses tested in this work. The rate of Lower Cretaceous Shale-related fabrics at KAJ (ca. 79%) is similar to the overall rate of such wares in the assemblage studied by Smith (et al. 2014: Table 5.9) at ca. 83.6%, or ca. 71% factoring in only sherds from contemporaneous Early Iron Age sites in the sample. One contrast with the findings of Smith (et al. 2014: 146) in the study of Lower Cretaceous Shale-derived fabrics comes in the presence of Smith's Ware A4, a medium fine ware with more calcareous inclusions than quartz and a more calcareous matrix. Smith (et al. 2014: 159-160) found this ware to be relatively prevalent at KAJ, with three of the seven sampled sherds from KAJ categorized in this ware group, suggesting that potters at KAJ may have exploited different clay sources than those at KEN. Based on comparative analysis with the samples from KAJ 2014 and those recovered from excavation in Area A in 2006 and sampled by Smith, this ware was not identified among the former sample. Rather, the shale-tempered fabrics of Ware Group 1 were similar overall to the LCS wares at KEN, though with a somewhat higher rate of calcareous temper. This variation may be explained by the use of wadi sand local to each site as temper. However, in general the ceramics from KAJ do show a clear preference for the same shale-rich, ferruginous clay that was predominantly used at KEN as well.

That the vast majority of the ceramics sampled for the present study were produced using shale-rich clay likely derived from the local geology of the Faynan region is significant for our understanding of the organization of society in the Faynan region during the Early Iron Age. As discussed above, potters generally prefer to acquire base clays within 1 km of a settlement, and almost all potters exploit clay sources within 7 km of their settlement (Arnold 1980). Interestingly, outcrops of the Kurnub Sandstone associated with the Lower Cretaceous Shales are not the closest geologic formation to KAJ and indeed are not within 1 km of the site, though this formation does outcrop within 1 km of KEN and slightly more than 1 km from KAJ (Figure 11.9). Thus, the predominance of ceramics composed of these fabrics—Ware Group 1 in the present study and Petrographic Group 1 in Smith's (et al. 2014b) classification—suggests a preference for the use of these shale-rich clays among the potters of Early Iron Age Faynan. This partiality may be explained by the functional advantages of the ferruginous clay originating in the Kurnub Sandstone, which provides technical benefits during firing (Goren 1996: 49). Nevertheless, the shared preference for these clays at KAJ and KEN illustrates that the ceramic assemblages from these sites are largely homogenous (cf. Roux 2016). This is demonstrated by the predominant use of a single local clay source; variability is not seen in the use of widely differing clay sources from within the region or external to Faynan except in the case of imported ceramics. A homogenous assemblage reflects a shared technological tradition and chaîne opératoire, which in turn relates to a social group in which processes of production are taught and learned (Roux 2016). These groups are communities of practice (cf. Lave and Wenger 1991; Wenger 1998). By illustrating that potters at KAJ and KEN likely represent members of the same social group, the comparative petrographic analysis conducted here also demonstrates that settlement and copper production at KAJ was organized by a local social group whose potting traditions relied on the clays and of the Faynan region. Were production organized and controlled from another region, such as Tel Masos as suggested by Finkelstein (2005; Fantalkin and Finkelstein 2006; Finkelstein and Piasetzky 2008: 89), we would expect to see a heterogenous assemblage (cf. Roux 2016). Such an assemblage would contain a more variable range of fabrics and technical traditions (Roux 2016). This is not the case at KAJ, with the exception of a relatively small number of imported ceramics. Moreover, the relative lack of imports from the the vicinity of Tel Masos—only one sherd from Areas B or C can be associated with the Northern Negev/Southern Shephelah region in which the Beersheba Valley lies—fails to provide evidence for foreign control of society and production in Faynan. Instead, the ceramics from KAJ, including those from both the elite context Area B and industrial/domestic context Area C, are predominantly local and similar to the fabrics from Khirbat en-Nahas. Even in Loci 543/561, which represent the floor of the central Room 3 in Building 2 in Area B where imported red-slipped bowls were found, the majority of sherds sampled for petrographic analysis are of relatively local, Edomite origin (two samples in Ware Group 1, one in Ware Group 2, two in Ware Group 3). Notably, no Egyptian Ware or Qurayyah Painted Ware is found at KAJ either. As such, there is little evidence of foreign elites active at the site, suggesting that copper production at KAJ was organized locally.

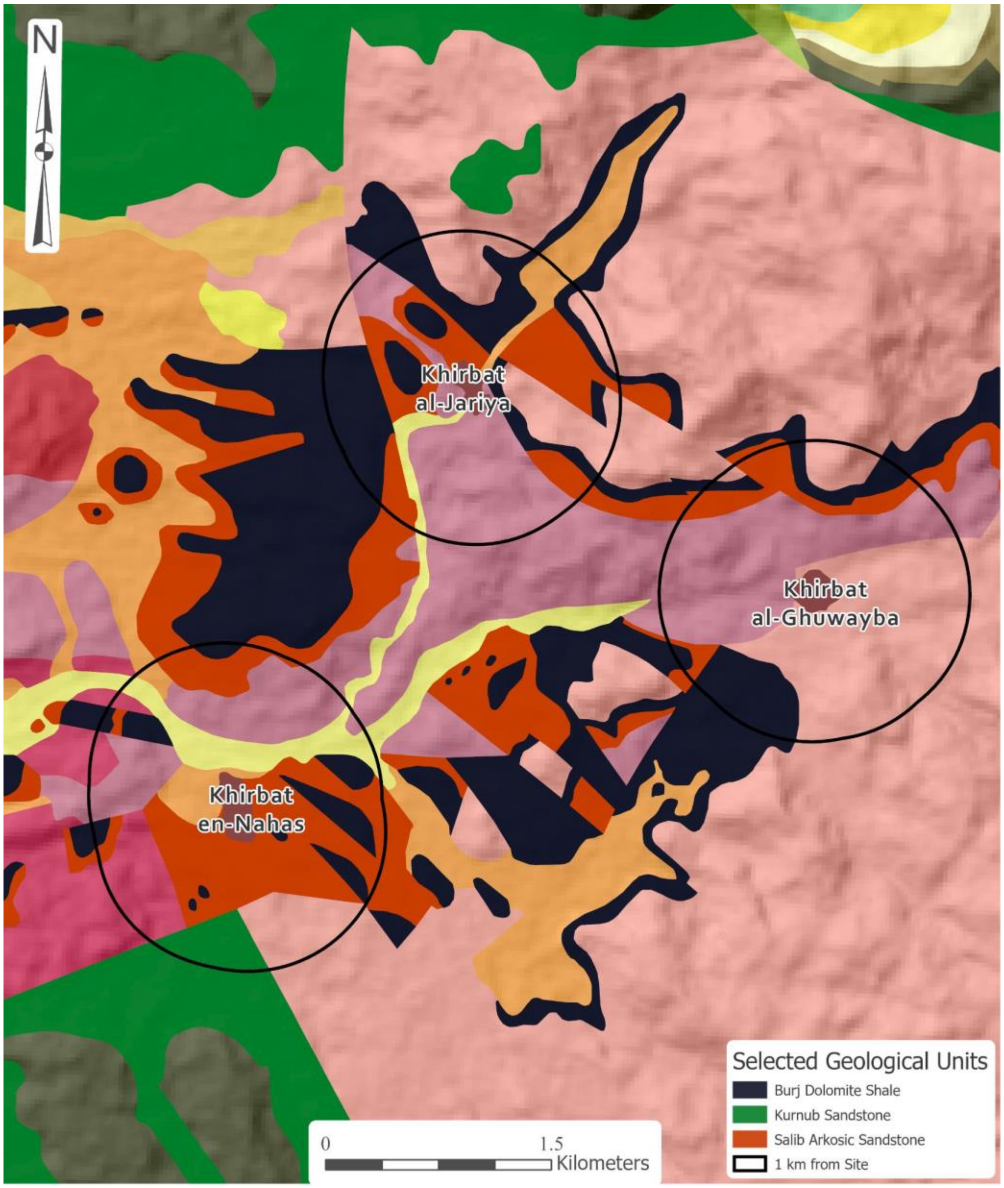

Figure 10.2: Geologic map (after Rabba' 1991) illustrating the geological units within 1 km of Iron Age sites in Faynan, a preferred distance for the collection of base clay by potters (Arnold 1980)

However, one contrast between the ceramics of KAJ and the assemblage from KEN, previously noted by Smith (et al. 2014: 159) is the scarcity of slag-tempered ware at the former site. At KEN, 30% of the ceramics sampled for thin-sectioning contained slag (Smith et al. 2014: 156). At KAJ, none of the seven sherds sampled by Smith (et al. 2014: 159) contained slag, and the present study identified only one sherd (Sample KAJ30) with apparent slag inclusions (future work will investigate the slag inclusions in this sherd as well as isotropic inclusions in several samples from Ware Group 1). Notably, KAJ30 is the only sherd from KAJ with slag inclusions identified through petrography. However, of the overall ceramic assemblage, only ca. 3% of the sampled sherds from KAJ (a total of n=31) contain slag inclusions. Notably, the Handmade Arabah Ware sampled for this study (Samples KAJ21, KAJ28, KAJ53, and KAJ62) did not contain slag temper, despite the frequency of slag temper in this ware type from other sites (cf. Martin et al. 2013). The relative scarcity of slag temper cannot be explained by a lack of material. Crushed slag was readily available at KAJ, including in Areas A, B, and C, as well as bedrock basins dedicated to slag crushing found around the site. As such, the relative lack of slag inclusions in the ceramics of the site is difficult to explain. While the commonality in raw materials used for the manufacture of ceramics suggests a connection in the chaîne opératoire in terms of procurement of raw materials between the contemporaneous sites KAJ and KEN, the significant contrast in the rates of slag temper at each site suggests a difference in tempering practices at each site. As discussed above, scholars have suggested that the inclusion of slag may have served an ideological purpose or acted as a trademark for the semi-nomadic people of the desert polity engaged in copper production and trade (Ben-Yosef 2010: 691-3; Martin et al. 2013: 3790). It may be the case that potters at KAJ, neither the central production site nor a trade-oriented site such as those in the Negev Highlands, operated in a slightly different environment in which demonstrating their identity through conspicuous ceramic production techniques was less necessary. Regardless, it seems as if potters at KAJ shared traditions of ceramic forms and raw material selection, but differed in tempering practices. This adds nuance to the overall similarity of chaîne opératoire of ceramic manufacture at the two sites.

The presence of the siliceous, quartz-tempered wares of Ware Group 2 at KAJ also provides a point of comparison for the relationship between the lowlands of Faynan and the traditional highlands of Edom. As discussed above, the Disi Sandstone outcrops throughout the southwest of Jordan but the closest accessible presence of this geological feature is to the southeast of the site in the vicinity of Petra, in the traditional heartland of Edom (Marjous 1994). The presence of Disi-derived ware at both KAJ and KEN suggests a certain level of interaction between the two regions, as has been argued by Smith (and Levy 2014; et al. 2014a, 2014b). Smith (et al. 2014b) suggests that his Disi-derived Petrographic Group 3 may relate to Bienkowski's "White Ware" (Bienkowski 2002: 235; Smith et al. 2014b: 165). This connection warrants further testing, especially given the identification of the Disi-associated Ware Group 2 in the present study. The provenance of sherds from Ware Group 3 at KAJ is also significant. Sample KAJ17, a fine-ware bowl (Bowl 3) with white fabric, was recovered from Locus 543. This locus is associated with the central Room 3 in Building 2 in Area B, an elite context at the site. Notably, only three fine-ware bowls were recovered from the site in 2014 excavations, all of these were found in either Locus 543 or 561, two associated loci that together represent the floor of Room 3. The other sherd from Ware Group 2 recovered in 2014 came from the floor of Room 1, a context that is directly adjacent to Room 3 and contemporaneous with L543 and L561 in Stratum B2b. No Disi-related sherds were recovered from excavations of Area A in 2006. As such, the only fabrics at KAJ connecting the site to the highlands of Edom come from the elite context of Building 2. Though a small sample size of only two sherds, this suggests that elites at the site may have had exclusive access to imported wares, whether these ceramics were produced in the highlands or from imported clay (cf. Smith et al. 2014b: 165).

Further evidence suggesting that elites at the site may have had exclusive access to fine imported wares comes from the ceramics of Ware Group 3, the loess-associated fabrics. Samples KAJ34 and KAJ35 represent imported fine-ware bowls. These bowls are both associated with Locus 561, the context from the floor of Room 3 used by elites and discussed above. As discussed above, the fine texture of these bowls and their burnish indicates that they were used as serving bowls (Rice 1987: 236-240), while their decoration also suggests their use by elites for consumption rather than for food preparation (Brumfiel 1987; Garraty 2000; Hirth 1993; Turkon 2004). Moreover, the fact that these fine-ware bowls were imported, based on the petrographic analysis conducted here, suggests that they were luxury goods, imported by elites at KAJ possibly in order to display during highly visible food consumption rituals (Clark and Blake 1994; Garraty 2000). The presence of two imported fine-ware bowls in Room 3 in Area B provides further evidence that elites occupying Building 2 maintained primary access to interregional exchange routes. One caveat is that one red-slipped fine-ware bowl associated with loess soil was also recovered from Area A and studied by Smith (et al. 2014b). This may suggest the presence of elites in Area A, discard of a broken vessel in the refuse of a slag mound, or a more widespread access to the goods obtained via interregional trade connections. However, the density of imported wares in the central rooms of Building 2 and the complete absence of imported wares in Area C or Disi-associated ware in Area A suggests that the occupants of the Area B structure did have disproportionate access to trade networks.

Comparing the presence of red-slipped and burnished fine-ware bowls produced from loess clay at KEN and KAJ also yields insight into the associations between the two sites. Smith's (et al. 2014b) petrographic study identified ten samples as belonging to Petrographic Group 5 (Ware I1)—five from Area R, two from Area A, one from Area T, one from Area S, and one from KAJ Area A (Smith and Levy 2014: 339, 345, 355, 367, 382, 405). Each of these ten samples was taken from a fine-ware red-slipped and hand-burnished vessel; nine of the ten are definitively identified as bowls (Smith et al. 2014b: 152; Smith and Levy 2014: 339, 345, 355, 367, 382, 405). These fine-ware vessels are thus proportionately overrepresented in Area R, an elite context at KEN. Spatial analysis conducted by Smith and Levy (2014) also suggests that red-slipped and burnished bowls are present in 9th century BCE layers near the Area A gatehouse (Smith and Levy 2014: 417); Area A served as a possible elite residence during late 10th-early 9th century BCE Layer A3a in which red-slipped bowls were found. The presence of red-slipped and burnished bowls in elite contexts suggests that elites at the site exploited interregional exchange networks to gain access to these fine imports, likely for use as tableware. At KAJ, the presence of two loess-derived red-slipped and burnished fine-ware bowls in

L561 provides a clear link between Area R at KEN and Area B at KAJ—both these contexts were likely occupied by elites who benefited from overseeing exchange networks largely-centered on the export of copper through the Negev, the source of the loess clay that was used to manufacture the fine-ware bowls. This analysis provides evidence in support of the first hypothesis studied here, regarding the presence of elites at KAJ.

Based on the new data from KAJ, the discovery of loess-derived fabrics from the Northwestern Negev and Northern Negev/Shephelah provides further corroboration of the existence of the interregional exchange networks through which copper was likely exchanged. These trade relationships had been previously evidenced by Martin's (et al. 2013; Martin and Finkelstein 2013) petrographic study of ceramics from the Negev, studies sourcing copper artifacts in the Mediterranean to Faynan (Kiderlen et al. 2016; Yahalom-Mack et al. 2014), and Smith's (et al. 2014b) petrographic study of ceramics from Iron Age sites in Jordan, most notably KEN. The latter study demonstrated the (infrequent) presence of imported wares at Early Iron Age sites in Faynan. The implications of the presence of these imported wares, especially at KEN, were interpreted by Smith (et al. 2014) in two ways: first as evidence of the engagement of inhabitants at KEN in widespread exchange networks and second that local elites directing industrial activity at Iron Age sites imported fine-wares for their personal use (Smith et al. 2014b). Each of these hypotheses is corroborated by petrographic evidence from the present study. Wares imported from the Edomite Highlands suggest and the Negev suggest that residents at KAJ were involved in exchange networks ranging from east of the Wadi Arabah to the Mediterranean coast. In addition, the presence of Disi-associated ceramics and red-slipped and burnished imported fine-wares, now demonstrated to have been imported from the Negev/Shephelah region, in elite contexts illustrates that these elites exploited trade connections to import ceramics for their own use. Importantly, the tentative provenance of Sample KAJ35 to the northern Negev/southern Shephelah, i.e. the general vicinity of Tel Masos, should be understood as providing evidence for trade relationships between the two regions rather than as evidence of political control given the extremely limited (one sherd) presence of samples sourced to that region. Overall, the petrographic analysis described here provides additional evidence of the existence of east-west trade routes from Faynan through the Negev Highlands.

10.8 Conclusions

The petrographic study of the 24 ceramic samples presented here provides insight into many of the key questions addressed in this study. First, the analysis illustrates that the ceramics of KAJ are predominantly made with raw materials local to the Faynan region, namely the Lower Cretaceous Shales of the Kurnub Sandstones (Figure 10.1). This trend holds true even in Area B, an elite context where we might expect to see predominantly imported ceramics representing non-local rulers at the site were production at KAJ controlled by a chiefdom centered at Tel Masos. Instead, the ceramics of Area B are largely local, with a small percentage of imported ware demonstrating the interregional connectivity of KAJ-based elites. Focusing on the likely locally-produced ceramics of Ware Group 1, the similarity between raw material choice and technology used at KEN and KAJ is of primary importance. The ceramics at each site are largely composed of similar shale-tempered fabrics, Ware Group 1 in the present study and Petrographic Group 1 according to Smith (et al. 2014b). At both sites, and especially KAJ, a relatively homogenous assemblage indicates one tradition of ceramic manufacture (i.e. chaîne opératoire), particularly with regard to clay selection.

On a deeper level, differences emerge between the two assemblages. The ceramics of KAJ appear to be slightly more calcareous, factoring in rates of calcareous sand and secondary calcite throughout the matrix and in pores. This observation should be tested through bulk chemical analyses of sherds from each site in order to provide a more objective basis for comparison. A clearer difference between the ceramics at the two sites is the relative frequency of slag inclusions. At KEN, a full 30% of sampled sherds featured slag temper. At KAJ, only one sherd (ca. 4%) contains slag inclusions based on petrographic analysis of a relatively small sample (future work will study slag and isotropic inclusions through chemical analyses to shed additional light on this issue). Combined, the more calcareous nature and lower presence of slag among ceramics from KAJ suggests that potters at the site adopted slightly different tempering practices than those at KEN. Potters at each site may have relied on local wadi sand of different composition at each site for tempering. Moreover, potters at KAJ may not have seen the need to temper their ceramics with slag. Why potters at KEN chose to do so and potters at KAJ did not remains unclear.

Beyond local wares, the imported ceramics recovered from excavation at KAJ in 2014 help address issues of engagement in interregional exchange networks and the role of elites in these trade patterns. In general, the presence of ceramics associated with the Disi Sandstone of the Edomite Highlands and the loess soils of the Negev Desert/Southern Shephelah indicates that inhabitants of KAJ were participating in trade networks ranging between these two areas at minimum, and likely beyond given the presence of Qurayyah Painted Ware originating in the Hejaz at KEN (Smith et al. 2014b) and copper sourced to Faynan identified as far away as Greece (Kiderlen et al. 2016). The identification of ceramics sourced to the Negev Desert is particularly significant as it corroborates a growing consensus that copper mined and smelted in Faynan was likely exchanged through the Negev to the Mediterranean coast.

In comparing KEN and KAJ, the petrographic work presented here suggests similarities between Area R at the former site and Area B at the latter. Area R at KEN is known to be an elite context, demonstrated by relatively monumental architecture and the presence of fine, imported ceramics (Levy et al. 2014; Smith and Levy 2014). Most notably, Area R featured high rates of red-slipped and burnished fine-ware bowls petrographically sourced to the Negev Desert (Smith and Levy 2014; Smith et al. 2014b). These bowls are paralleled by those found in L543/L561 in Area B at KAJ, which more than likely is an elite context based on the fine ceramics and groundstone artifacts found there. The presence of imported wares in these loci suggests that elites at KAJ, likely engaging in the same interregional exchange networks as those occupying Area R at KEN, were able to exploit exclusive access to this trade in order to secure fine ceramics, among other goods, for their own use.

Overall, the petrographic work here provides insight into the role of elites and the social and political organization at KAJ, one of the largest Iron Age copper production sites in the region. Future chemical analysis will build on this work especially in investigating the phenomenon of slag tempering.

Chapter 11: Public Archaeology, Open Data, and Digital Engagement

11.1 Public Archaeology

Archaeologists have a responsibility to share information with the public about the knowledge they produce and the methods they use to do so (Kintigh 1996). Despite this responsibility, archaeologists have often fallen into modes of archaeological practice that treat the public's lack of engagement with archaeological data as evidence of either their lack of interest in or their inability to understand serious archaeological practice (Grima 2016). The latter, categorized and sometimes critiqued as the “deficit model” of public archaeology, implicitly suggests that archaeologists view the public as needing education in order to understand how to appreciate the archaeological record (MacDonald 2002; Merriman 2004; Richardson 2014; Richardson and Almansa-Sánchez 2015). The “multiple perspective model” is an alternative approach that frames the public as central to knowledge generation and relies on the audience to bring their own experience to the table. In doing so, differing audiences would ideally participate in and enjoy the creation of archaeological knowledge through hands-on or interactive engagement (Merriman 2004; Williams et al. 2019).

Following the multiple perspective model, digital and 3D approaches to cultural heritage can provide opportunities for the public to engage directly with the archaeological record (Williams et al. 2019). Multimedia approaches have strong potential for engaging the public in the processes of archaeological data collection, as a topic related to but separate from learning about the data (Baione et al. 2018; Pavlidis et al. 2017). In addition to increasing the accessibility of data acquisition, multimedia-focused projects can generate a reflexive and inclusive atmosphere for interpretation of archaeological data. In particular, 3D visualization has immense potential for generating an immersive experience for members of the public that mimics the reality of experiencing a site (Berggren et al.

2015; Forte 2010, 2011, 2014; Forte and Siliotti 1997; Garstki et al. 2019; Knabb et al. 2014; Levy, Ben-Yosef, and Najjar 2014) or as a framework for storytelling (Bonacini et al. 2018; Hupperetz et al. 2012; Smith et al. 2019; Srour et al. 2015). Furthermore, the use of hypermedia—documents in which topics, information, and multimedia elements are linked in a text and available for free-form exploration rather than strictly sequential storytelling—can amplify this potential, as the use of interactive links and features allows users to create their own path through the data and generate their own interpretations (Bertemes and Biehl 2009). These hypermedia documents should ideally be interactive and present a baseline of archaeological knowledge that provides avenues for further exploration of particular topics. This format can facilitate engagement by users of differing backgrounds and familiarity with the information, all while featuring many types of archaeological data and information represented in varying ways (Pujol et al. 2012). Fortunately, the types of data that allow for this type of engagement are increasingly available.

Relatedly, the concept of "deep mapping" may serve as a framework in which archaeologists can bring the data that they collect and analyze for research purposes to bear in engaging the public in interactive ways. Narrative is necessarily temporal and spatial, as stories are always situated in these ways (Bodenhamer 2015). As scholars of time and space, archaeologists are well positioned to address this challenge of situating a story. Yet, beyond simply illustrating what happened when, deep mapping is a process of providing multiple layers of representations and multiple forms of media in a way that is by definition not static and may tell multiple stories (Earley-Spadoni 2017). Narrative from the perspective of deep mapping involves the use of various forms of documentation that come together cohesively while not forsaking the individual threads of evidence for the whole (Bodenhamer 2015)—similar to hypermedia. A deep map should also be multiscalar, in both space and time (Roberts 2016). In this as well, a relationship to hypermedia is clear, in that the exploration of many datasets of different types and scales can both expose and generate new understanding. Ultimately, there is a need for approaches to public archaeology that make use of digital datasets in engaging and interactive ways. Earley-Spadoni (2017) highlights Esri's ArcGIS StoryMaps as one platform that may allow for the type of interactive, hypermedia deep mapping that can serve as a way to combine many threads of evidence into digital storytelling.

11.2 Open Data

Modes of sharing archaeological data have begun to undergo a paradigm shift. A data-ownership model, in which the producers of data retain sole access to datasets only to publish them in exclusive publications has gradually lost support (Marwick et al. 2017). This model risks the loss of data to obsolescence and limits the potential for new interpretations of sites and artifacts (Kansa 2012; Kansa and Kansa 2011). The alternative to the data-ownership model is the data stewardship model, in which data is considered common property to be shared and made accessible to all (Hampton et al. 2015; Marwick et al. 2017). Under the data stewardship model, open data is a central concept. Data can be considered "open" when it is freely available in a usable format without excessive intellectual property restrictions (Kansa 2012). Several widely-used digital data repositories exist and facilitate storage and access to open data, notably the Digital Archaeological Record (tDAR, McManamon et al. 2017) and OpenContext, which archives data with the California Digital Library (Kansa et al. 2014). Not all open data is alike, however. Generally, two models for digital sharing of data exist: static datasets and living datasets (Costa et al. 2014). The former consists of downloadable datasets published in an archive, typically without a mechanism for users to explore the data as they search (Costa et al. 2014). Living datasets, on the other hand, provide dynamic, interactive experiences for users. These platforms have issues with longevity but can facilitate greater engagement with datasets through querying and exploring the data within a web-based platform (Costa et al. 2014). The living dataset model can overlap with deep mapping and hypermedia as well, situating open datasets within multiple layers of context. A fully-contextualized and interactive open dataset is not only useful for sharing with the public but can also supplement or even replace traditional excavation reports (Clarke 2016; Opitz 2016, 2018). This possibility is discussed further below in the second case study, which focuses on living datasets for academic-oriented open data publication.

11.3 Archaeology in a Digital Age

The types of multimedia archaeological datasets that can catalyze interactive engagement by the public with the processes of archaeological investigation and with the actual archaeological record itself are now commonly collected by archaeological projects as a standard practice. These datasets, though typically collected to facilitate archaeological interpretation and documentation, can also serve as the basis for effective and engaging public outreach. As digital tools are becoming a standard part of the archaeological tool kit, there are growing opportunities for involving the public in the archaeological process through exposure to these methods and datasets.

One of these types of data is geographic data, collected, managed, and analyzed with geographic information systems (GIS). GIS software packages are used by nearly all archaeological projects today. Archaeology, as a fundamentally spatial field, requires the use of some way to track and perform analysis on the locations of artifacts and sites. GIS is often used as a framework for analyses in landscape archaeology (Howey and Brouwer Burg 2017; Parcak 2017). To that end, two types of analysis of how people interact with their landscape through sight and movement, visibility (e.g. Bernardini et al. 2013; Dungan et al. 2018), and cost path analysis (Gustas and Supernant 2019; Taliaferro et al. 2010) are frequently applied to archaeological datasets. Even more common is the use of GIS for spatial database management, where GIS allows archaeologists to perform typical spatial documentation but in a more efficient manner (Howey and Brouwer Burg 2017; Verhagen 2017). In practice, the use of GIS for storing and maintaining spatial data often necessitates a rigorous, digital data collection methodology (which may include photogrammetry as a complementary method for top plan drawing; Berggren et al. 2015; Levy and Smith 2007; Olson et al. 2013). In addition, the generation of maps for publication is nearly universal among field projects. Thus, spatial data, collected in a GIS framework, are collected and stored by most institutions engaged in archaeological work, though frequently published in only limited ways. Indeed, GIS is often applied by archaeologists for data collection or analysis rather than for outreach or engagement, despite its potential in these realms (Earley-Spadoni 2017).

The generation of 3D models of archaeological units and sites, though not necessarily a standard practice, is also increasingly common. Archaeological projects most often collect 3D data through laser scanning or digital photogrammetry, either of which can be applied terrestrially or aerially with varying degrees of viability (Howland 2018). Terrestrial photogrammetry, as alluded to above, can be a valuable tool for generating spatial data over the course of excavation and documenting its progress (De Reu et al. 2014; Howland et al. 2014a; Olson et al. 2013; Peng et al. 2017). Generating 3D models from images taken from the ground is also likely the most cost-effective method of generating 3D data (Haukaas and Hodgetts 2016). Aerial photogrammetry, though somewhat more expensive as it requires an elevated camera platform, has seen dynamic growth as a tool of archaeological 3D modeling in recent years. This approach has seen widespread use for 3D documentation of sites (Carvajal-Ramírez et al. 2019; López et al. 2016; Sauerbier and Eisenbeiss 2010). Also common is the use of photogrammetric modeling for the generation of spatial data that facilitate GIS-based mapping (Hill et al. 2014; Howland et al. 2014a; Reshetyuk and Mårtensson 2016; Uysal et al. 2015; Verhoeven et al. 2012). In short, digital photogrammetry is already widely applied and likely to become even more common due to its cost-effectiveness (Fernández-Hernandez et al. 2015; Howland 2018). As with many digital tools, the extent to which projects will be able to apply 3D technology depends on their funding and hardware resources. However, the decreasing cost and the ease of digital photogrammetry mean that even less well-funded projects should be able to collect some amount of 3D data in the field.

In general, the proliferation of archaeological 3D data collections provides excellent opportunities for their distribution and use in public outreach and storytelling, though the availability of these data does not necessarily result in quality public archaeology. Archaeologists have recognized the vast potential of GIS and 3D data collection for documentation and analysis, but they are only beginning to take full advantage of the capability of photogrammetric 3D models for public-facing interactive engagement (Earley-Spadoni 2017). Often, digitized collections are not shared widely with the public, as they are part of active, unpublished research projects (Scopigno et al. 2017). However, for projects interested in engaging the public, sharing 3D data is straightforward and can be free. For example, Sketchfab, an online 3D model hosting platform with free and paid tiers, can be used to good effect for providing the public with access to 3D models of archaeological artifacts and sites (Baione et al. 2018; Means 2015; Scopigno et al. 2017). Sketchfab allows for some degree of explanation and contextualization of models within the platform and can also allow for more immersive virtual reality and augmented reality experiences (Ellenberger 2017). However, publication of 3D models as individual files in an online database fails to appropriately contextualize the artifacts within their archaeological, geographic, cultural, or historical framework (Lloyd 2016). As such, even publishing of archaeological 3D data to the public may not take full advantage of the opportunities provided by the increasing availability of these datasets.

11.4 ArcGIS StoryMaps

Esri's ArcGIS StoryMaps is an online digital storytelling platform centered on situating digital datasets in a narrative format. The platform allows content creators to add text, photographs, videos, 3D models, and maps created using Esri's online mapping interface, ArcGIS Online, to a web page where users can access additional content by scrolling down through different slides. As such, StoryMaps can be a useful platform for publishing digital archaeological data, situated appropriately with contextual information that users can explore according to their own interest. Overall, ArcGIS StoryMaps can be an effective tool for education and digital engagement for any number of public outreach projects (Antoniou et al. 2018; Cope et al. 2018; Kallaher and Gamble 2017; Strachan and Mitchell 2014). Within archaeology, however, StoryMaps has been the subject of only limited use despite the application's apparent suitability for archaeological storytelling (Alemy et al. 2017; Amico 2019; Malinverni et al. 2019). We aim to consider the viability of StoryMaps for archaeological public outreach and ultimately suggest that the platform can be a powerful tool for archaeologists, primarily based on three main characteristics that recommend its use to scholars interested in digital storytelling in a hypermedia or deep mapping context: its ease of use, its compatibility with many different types of datasets, and its interactivity.

Evaluating ArcGIS StoryMaps requires a look at not only its utility but also its cost-effectiveness and viability vis-à-vis other similar platforms. StoryMaps requires, at minimum, an ArcGIS Online "Creator" license costing $500/year. Hosting large archaeological datasets on ArcGIS Online also requires the use of "credits," the availability of which depends on license level. As such, the platform can be cost-prohibitive for scholars who do not already have access to Esri's suite of services through an institutional license. Several viable open-source alternatives to ArcGIS Online's web mapping platform exist, including Leaflet and MapServer, with Mapbox also representing a paid option with a free tier of use. While web mapping alternatives are readily available, platforms allowing for the use of multiple web maps as a framework for interactive storytelling, as ArcGIS StoryMaps does, are less common. One open-access platform, StoryMapJS, provides an appealing interface with the ability to integrate various forms of data. However, StoryMapJS fails to allow for much of the open-ended mapmaking, including uploading user-generated datasets, that is possible through ArcGIS Online and ArcGIS StoryMaps. Mapme is another alternative allowing for map-based storytelling. The platform features (very limited) free functionality, though generating maps with user-collected datasets in Mapme requires a paid subscription, costing $348+/year. Unfortunately, the outputs produced through Mapme are not as refined as those produced by ArcGIS StoryMaps in their visual appeal and overall sophistication. In addition to cost and functionality, another concern with digital platforms is their life cycle of support. For example, one digital map-based storytelling platform that has been highlighted as a StoryMaps alternative, MapStory (Earley-Spadoni 2017), now appears to lack functionality. The reported support timeline for Esri's StoryMaps app runs through 2024 and beyond, which may be the limit of what one can expect in today's rapidly changing digital environment. Given these aspects of the StoryMaps platform, the Esri product is a superior choice over the available alternatives when economically viable.

With regard to the usability of ArcGIS StoryMaps, stories in the program are created through a straightforward interface in which content can be edited in a form that matches the finished output. In other words, content creators and researchers are able to construct their StoryMaps without having any knowledge of coding or how to construct a web page. This means that archaeologists should be able to easily construct a compelling narrative regarding their fieldwork or an archaeological site or region with no more technical knowledge required than what it would take to construct a PowerPoint presentation. While the platform has a relatively high ceiling in terms of the level of interactivity it is possible to allow for, at its most basic level, a StoryMap need not be more complex than narrative text with embedded pictures or static maps. Additionally, this simple and adaptable format allows a StoryMap to be easily updated with additional research or feedback from the public. This feature can be important in allowing for stories about archaeological heritage to be updated with multiple perspectives of stakeholders.

Another main benefit of using the StoryMaps platform is its compatibility with the types of sophisticated digital datasets that are increasingly collected by archaeological field projects as a matter of normal practice. Most prominently, StoryMaps allows for the integration of maps created or published in Esri's ArcGIS Online platform. While paper maps can be useful and aesthetically pleasing, we are now in an era where "interactive and immersive" representations of archaeological data and processes are possible (McCoy and Ladefoged 2009), through platforms such as ArcGIS Online. Maps on ArcGIS Online and other web mapping platforms are interactive, allowing users to manipulate the map extent (by zooming, panning, etc.) and also click different map features to open pop-ups in order to learn more. These platforms provide users with an ability to explore spatial data to an extent not possible with printed maps (Smith 2016). This interactivity is critical for hypermedia and deep mapping concepts and has also been used effectively to provide additional levels of engagement even to articles published in traditional academic outlets, which are not typically interactive (Hammer and Ur 2019). Content creators can customize the pop-ups that appear upon clicking map features to provide additional levels of information and interactive content, including text, photographs, and even other StoryMaps, generating multiple layers of hypermedia content that users can explore at their own pace and according to their own interests.

In addition to highly interactive online maps, StoryMaps also straightforwardly allows for the inclusion of digital photographs, videos, and 3D models, which can facilitate additional engagement with the archaeological stories being told beyond the accompanying text narrative. The inclusion of 3D data should provide a bridge from textual storytelling that only hints at place to 3D recordings or reconstructions of place that can heighten immersion. In general, map-based platforms such as StoryMaps or GIS suffer from a bias toward an absolute perspective toward space, in which Euclidean distances and measurements take primacy over experiential, phenomenological, or topological depictions (O'Sullivan et al. 2018). Photographs, videos, and 3D models can help to resolve this bias to some extent, as they can represent immersive rather than top-down or absolute perspectives. Archaeologists often already have many of these digital datasets on hand due to twenty-first-century archaeological practice and can facilitate the introduction of such data to users through StoryMaps. In doing so, archaeologists can introduce users to the stories of ancient societies and the methods of archaeological practice. Of course, not all projects are predisposed to making use of sophisticated digital datasets. However, generating a compelling StoryMap does not require projects to make use of expensive field recording technology. Even simple spatial datasets such as, for example, the locations of important sites in a region, images of those sites and artifacts recovered there, and videos taken at the site can provide a dynamic framing for an archaeological narrative within StoryMaps. Moreover, given that advanced digital recording methods are increasingly affordable and applicable without purchase of specialized tools and software, even less well-funded projects should be able to apply digital datasets to generate deep mapping environments within StoryMaps.

11.5 Faynan, Jordan

In order to demonstrate the applicability of StoryMaps for archaeological deep mapping, storytelling, and public engagement, we used datasets collected from recent excavations in Faynan, Jordan. Faynan is located approximately 30 km south of the Dead Sea in the deserts of southern Jordan. This region is also one of the largest copper ore resource zones in the Levant. These copper ores were intermittently exploited throughout history from roughly the Early Bronze Age until the Islamic period. The archaeology of Faynan has been the focus of the Edom Lowlands Regional Archaeology Project (ELRAP), a collaboration between the University of California San Diego and the Department of Antiquities, Jordan (principal investigator: Thomas E. Levy; co–principle investigator: Mohammad Najjar; Levy, Ben-Yosef, and Najjar 2014), since 1997. ELRAP investigates the relationship between social complexity and industrial-scale copper production particularly during the Early Iron Age (ca. 1200–800 BC) through a combination of surveys and excavations (Ben-Yosef 2010; Levy, Ben-Yosef, and Najjar 2014). The Iron Age in Fayan is the period of the most intense copper smelting, with an estimated 33,000–36,000 tons of produced metallic copper (Ben-Yosef 2010).

Much of our understanding of Faynan during the Iron Age comes from the ELRAP excavations at the main copper smelting sites dating to the period, primarily Khirbat en-Nahas, Khirbat al-Jariya, and Khirbat al-Ghuwayba. Khirbat en-Nahas is the largest Iron Age copper smelting center in Faynan (Levy, Najjar, et al. 2014). The site includes the collapsed architecture of more than 100 buildings and an estimated 50,000–60,000 tons of copper slag, the waste by-product of copper smelting, still visible on the surface (Hauptmann 2007; Levy, Najjar, et al. 2014). Similar to Khirbat en-Nahas, Khirbat al-Jariya is characterized by architectural collapse and slag mounds (Ben-Yosef et al. 2010, 2014). Located circa 3 km to the northeast of Khirbat en-Nahas, the site straddles the Wadi al-Jariya covering an area of approximately 4.8 ha and features circa 15,000–20,000 tons of copper slag. ELRAP also conducted excavations at Khirbat al-Ghuwayba, a smaller-scale smelting site located about 4 km east of Khirbat en-Nahas (Ben-Yosef et al. 2014). While Khirbat al-Ghuwayba has been less extensively excavated, its location near a local spring and archaeobotanical analysis of materials collected at Khirbat al-Jariya suggest that it might have served the additional function of provisioning contemporaneous smelting centers. Together, these three smelting sites, along with smaller mining camps throughout the region, were central to the industrial landscape of Iron Age Faynan and the first complex society in the region; the access to abundant copper ores was critical to this development.

To investigate these sites, ELRAP uses methods of cyberarchaeology, applying methods of computer science, natural science, and engineering to archaeological research (Levy, Ben-Yosef, and Najjar 2014; Levy et al. 2010, 2012). ELRAP records high-precision coordinates of artifact locations and locus perimeter/depth using a total station on a daily basis. This digital recording of spatial data facilitates easy integration into GIS, as data from the total station can be directly imported into GIS platforms. All geospatial data collected on ELRAP projects are visualized and further analyzed using Esri's ArcGIS. ArcGIS is also essential for digitizing archaeological features at a site to produce site/excavation maps (discussed further below). The combination of the total station and GIS maintains a digital record of all necessary geospatial information connected to the archaeological record from the moment it is excavated through final data storage and publication.

In addition to GIS-based recording, ELRAP projects also collect spatially referenced 3D data through systematic photography of excavations for the generation of publication-quality imagery and photogrammetry (terrestrial and aerial). These images and the models that derive from them serve as an excellent basis for digital multimedia outreach. For models of larger areas, ELRAP has employed aerial photography using a helium balloon with an attached camera frame (Howland et al. 2014b). All of the produced models are also georeferenced using ground control points in order to orient them in space and to geographically connect the models to the archaeological data. Using photogrammetry during the excavation serves two functions: (1) to produce 3D models that provide a photorealistic digital record of the site/excavations at that moment and (2) to produce digital elevation models and orthophotographs that provide an ideal base for site mapping of archaeological features in GIS. Ground photogrammetry and aerial photogrammetry, as discussed above, are increasingly cost-effective and practical approaches to recording for archaeological projects. The combination of a digital recording strategy, comprehensive digital photography, detailed geospatial data, and photorealistic 3D models of the archaeological record provides a wealth of data that can facilitate interactive engagement with the archaeological past. As a spatial aspect to data is critical to archaeological research, much of the digital data collected by ELRAP—and many archaeological projects—is spatially referenced. This includes inherently spatial data such as digital elevation models, orthophotographs, and mapped site features, as well as the 3D data collected on the project. The availability of these datasets is an advantage for digital public outreach, though the priority for outreach is providing an engaging and entertaining narrative allowing for immersive engagement rather than showcasing elaborate datasets.

11.6 Case Study 1: The Kingdom of Copper StoryMap

The ELRAP team generated a StoryMap focusing on the Iron Age polity centered in Faynan titled The Kingdom of Copper (Figure 1). This StoryMap is intended to perform digital storytelling and deep mapping through an interactive hypermedia framework. Many of the digital datasets collected through ELRAP's cyberarchaeology field and lab methods are featured in the StoryMap, including digital maps of environmental characteristics, architecture, and material remains from sites in Faynan, as well as digital photography and 3D models. Many of these datasets required little modification in order to bring into StoryMaps as they are inherently digital.

In order to generate the StoryMap, team members developed an iterative planning process to ensure that the StoryMap would meet its goals of digital public outreach in an interactive mapping environment (Figure 2). This process can serve as one model for how to conceptualize and develop an interactive public outreach project using digital data in ArcGIS StoryMaps (Alemy et al. [2017] provides an excellent overview of the technical process of creating a StoryMap). In general, our strategy was to make sure that narrative and engaging users in the archaeological process drove the framing of the StoryMap, rather than designing the product based on the availability of datasets. To that end, our first stage in generating the StoryMap was to create a storyboard conceptualizing the story elements important to framing the archaeology of Faynan, Jordan, in its appropriate context. Next, it was important to write the text to be laid out in the StoryMap, telling a story based on archaeological information rather than the suitability of existing maps, images, or 3D models for accompanying the story elements. Writing a compelling story based on archaeological information is challenging, and researchers may benefit from collaboration with experienced storytellers. Analyzing and developing media to complement the text is also necessary, though this should be taken up after storyboarding and writing the StoryMap narrative. In many cases, projects will be able to publish existing project maps including GIS vector and raster data to ArcGIS Online or existing photogrammetric models to Sketchfab with minimal modifications, though in some cases it will be necessary to involve new datasets to contextualize the text. Importantly, our project only developed the StoryMap after fieldwork, without orienting field data collection toward creating this type of digital outreach project. As argued above, many projects will be in a position to also integrate normally collected digital data into a StoryMap. After writing the text and considering and developing media, we installed both text and media elements into the StoryMap. In order to engage readers through our grounding concepts of deep mapping and hypermedia, it is essential to ensure that map elements feature high levels of complexity and interactivity. Thus, maps should be edited to ensure that additional levels of information are available for users to explore and engage with if they are interested. Only at this stage did we publish the StoryMap. However, even the published version of the StoryMap was not considered a final product. Since publishing the StoryMap, we have made many edits to the product, including the addition of a comment box designed to solicit feedback from the public, especially stakeholding groups in Faynan and Jordan. Through feedback in this comment box, we aim to continually redesign and rewrite the StoryMap in order to bring in different voices and stories to be heard and told. We have already redesigned and rewritten parts of the StoryMap in response to public feedback. Thus, we conceive of the StoryMap as a work in progress in perpetuity, subject to update at any time using StoryMaps' straightforward editing tools. Overall, our process for StoryMap generation aims at establishing practices for developing interactive storytelling for public outreach that allows users to engage in a deep mapping environment that allows for interpretation of multiple layers of meaning. By developing an iterative process without a final draft, we aim to continually improve the outreach potential of the platform.

The current version of The Kingdom of Copper StoryMap is aimed at telling the story of how copper production in Faynan was able to lead to the development of complex society in the region during the Iron Age and of the archaeological methods used to interpret the region's archaeological record (e.g., Liss et al. 2020). The first part of the StoryMap introduces readers to the Faynan region with an emphasis on its geographic location. In particular, this portion of the StoryMap includes a presentation of Faynan's regional context using satellite images on several scales and a gradient map with isohyets (contour lines representing zones of identical rainfall levels) depicting its level of precipitation up to the present and emphasizes its unique environment. StoryMaps' basis in digital maps means that the platform is ideal for geographically situating archaeological analysis in space, while text descriptions accompanying maps can help readers situate the data and analysis in time.

The second part of the StoryMap provides insight into the drivers of the development of industry in Faynan in the Iron Age by introducing the audience to copper production and its role in the ancient world. At this point, the development of Iron Age social complexity around the abundant copper ores of Faynan is framed against the collapse of the Late Bronze Age economic system. Specifically, this section provides a discussion of the importance of slag as an indicator for copper production and a display of the many sites potentially destroyed in the Late Bronze Age as part of a regional collapse using a combination of interactive maps and photographs. Each map in this section is interactive through clickable pop-ups that allow users to learn more about topics in the story. The StoryMap then provides readers with an illustration of the geologic context to show the availability of copper and 3D visualizations of the major copper-producing sites (Khirbat en-Nahas and Khirbat al-Jariya). The ability to include photorealistic 3D models provides the audience with an authentic experience of the sites and the surrounding terrain and helps to provide a more immersive experience of the archaeological data, overcoming the bias of mapping outputs toward absolute conceptions of space. Our current understanding of the excavations (discussed above) is presented in the associated text. Primarily, the goals of this section of the StoryMap are to introduce readers to the types of evidence that archaeologists use to interpret the environment of the region and the history of the Late Bronze Age so that they can freely explore and understand these datasets on their own terms.

The StoryMap also features a section on the process of archaeological investigation. This section is aimed at engaging the public in how archaeologists conduct research at archaeological sites and what tools and techniques we use. The archaeological methods that led to the interpretations given in the StoryMap are presented, accompanied by videos and photographs. The videos allow the viewer to observe archaeology in practice while learning about how these techniques aid in developing our understanding of the past. The archaeology of Khirbat en-Nahas is highlighted with digitized maps, 3D models, and the opportunity to learn more about each excavation area through clicking and reading pop-ups for each area (Figure 3). Through the interactivity in these datasets, we hope to engage the public in the archaeological process, giving our perspective on how we acquire and interpret data but also providing the datasets themselves so that readers may explore as they are interested and take away their own conclusions. The final section of the StoryMap, discussed below, focuses on modern Faynan and community engagement.

One key point of emphasis for us in constructing the StoryMap was to generate as many interactive elements as possible in order to provide a true hypermedia environment that allows for multiple levels of engagement. To that end, the StoryMap includes 13 interactive maps, nine of which have specific features that provide more information upon a click of an element in the map. These additional features include descriptions of sites, features, and empires, as well as images of sites and features. Also present in the StoryMap are two videos showing archaeological processes, five interactive 3D elements, hyperlinks to other relevant content, and dozens of photographs. As such, the StoryMap overall is heavily oriented toward providing engaging multimedia content that users can explore at their own discretion. This project ideally serves as an example of how StoryMaps can integrate many forms of digital data into an interactive deep mapping application. Though different projects will naturally approach archaeological storytelling and public outreach in different ways, this platform can provide a useful mechanism for digitally inclined projects to integrate datasets into a deep mapping environment with many interactive forms of media.

11.7 Toward Community Engagement

The final section of the Kingdom of Copper StoryMap focuses on the local communities that reside in the region today, primarily members of the ‘Ammarin, Sa'idiyyin, Rashaydah, and ‘Azazmah tribes. Many in these communities are members of the ELRAP, and it is their cultural heritage that is addressed by the archaeological content of the StoryMap. As such, they play a primary and important role in how that heritage is investigated and interpreted. The “Faynan Today” section of the StoryMap provides recognition of these communities and their role in how their cultural heritage is to be understood.

However, this recognition is not, in and of itself, enough to say that the stakeholding communities have been “engaged.” Importantly, the people of Faynan and the nearby town Qirayqira play the most active role in the continuous reinterpretation of the cultural heritage of the Faynan region. This occurs most especially through their work at the Faynan Museum, an archaeology museum in the area; the Faynan Ecolodge, an eco-hotel that offers tours of archaeological sites by locals; and the Dana Biosphere Reserve, which preserves many of the important sites in Faynan. These locally operated organizations and the overall engagement of the communities of Faynan are critical in place-based education (Sobel 2005) and allow inhabitants of the region and visitors to engage with archaeological heritage at the source. This place-based learning is a necessity, especially to overcome a critical flaw in StoryMaps and internet-based digital storytelling—its inherent Eurocentric bias due to lack of equality in worldwide internet access (Bertemes and Biehl 2009). StoryMaps may not be an appropriate avenue to overcome this inequality, as the platform is only accessible via the internet. This can mean that StoryMaps projects may be inherently geared toward a disproportionately wealthy, English-speaking, and literate audience. Scholars would do well to take heed and consider stakeholding groups when they approach archaeological projects through StoryMaps. In recognition of this need to engage not only English-speaking audiences, The Kingdom of Copper StoryMap is available in Arabic. Furthermore, we hope to install a version of the StoryMap in the Faynan Museum in order to reach members of the local community without internet access in person. We also aim to make use of the platform's compatibility with audio platforms by recording the text of the main story in order to increase the accessibility of the StoryMap to nonliterate users.

As StoryMaps are easily editable, when used for public engagement they should not be seen as an end product to show stakeholding communities but, rather, as a first draft that communities can engage with, edit, and use as a platform to tell their own stories and explain their own relationship with their cultural heritage. To work toward this ideal, we aim to show The Kingdom of Copper StoryMap to Jordanian citizens and the people of Faynan and discuss it with them in person. For digital interaction, the StoryMap also features a comment box, linked up through Esri's Survey123 application. Through this comment box, we hope to get feedback on the story told in the StoryMap and also elicit stories and contextual information from the Faynan community for inclusion in the StoryMap. Only by engaging local populations in this way can we successfully move beyond deficit-based learning models and adopt a multiple perspective model that treats the archaeological past as the living cultural heritage of people living today. Future work on the StoryMap in the community in Faynan will help reveal the extent to which this process is successful and help our understanding of whether or not StoryMaps can be effectively used for engagement of non-internet-connected local communities.

11.8 Case Study 2: The Ceramics of Khirbat al-Jariya StoryMap

In addition to the public-facing *Kingdom of Copper*, we have also developed a two-part StoryMap oriented toward the scholarly community. This platform focuses on the analysis of ceramics from Khirbat al-Jariya, with three datasets serving as the primary basis for the StoryMap: 3D models of the ceramic sherds from Khirbat al-Jariya, GIS-based locus polygons recorded during the 2014 excavations at KAJ, and written descriptions of locus contexts from the site. In the first StoryMap, titled *The Ceramics of Khirbat al-Jariya in Context* (https://storymaps.arcgis.com/stories/bf0c203dbf7c45ac95c862d644e75b7c), the 3D models of the ceramics from KAJ are embedded from Sketchfab and organized by locus. The spatial and descriptive data for each context is also given. While the main subject of this online publication is the ceramics themselves, their integration within their spatial and descriptive context allows scholars to see and understand the full picture. As such, this StoryMap provides excavation report-level detail in an interactive open data environment. Moreover, the maps showing each locus and the 3D sherd models themselves are interactive and downloadable. The second StoryMap, titled *The Ceramic Typology of Khirbat al-Jariya* (https://storymaps.arcgis.com/stories/d33f7e32f50748afb373b5752217312d), features the same 3D models of ceramics, this time grouped by form classification rather than spatial and archaeological context. Taken together, the two StoryMaps provide a total picture of the diagnostic ceramic forms of KAJ and their contexts. They also represent a new approach toward Open Data, as few — if any — StoryMaps have been published to both describe and share archaeological data in an accessible and understandable way. The StoryMap platform serves both as a storytelling framework and a data sharing infrastructure, in the living dataset model of Open Data.

11.9 Summary

Esri's ArcGIS StoryMaps is an effective and straightforward tool for archaeologists to share their data and research. The interactivity of the platform allows for hypermedia and deep mapping outputs that facilitate engagement by the public in the archaeological past and with the archaeological process. The variety of digital datasets that are regularly collected by archaeologists in the twenty-first century nearly all lend themselves well to inclusion in the StoryMaps platform. This, along with the ease of sharing a StoryMap online, increases the accessibility of archaeological data. By framing datasets within a scrolling text story, archaeologists can contextualize their data while also allowing for the type of free-form interaction that allows for many forms of engagement. The Kingdom of Copper StoryMap serves as a case study of the usefulness of the StoryMaps platform for interactive multimedia public engagement. Similarly, the Ceramics of Khirbat al-Jariya StoryMap serves as a model for publishing archaeological datasets in 3D and in context. Ultimately, such digital outreach projects should be seen as works in progress to allow multiple perspectives to be shared, rather than as a final output set in stone.

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Chapter 12: Summary of Main Argument of Dissertation

Table 12.1: The hypotheses tested in this dissertation.

Hypothesis	***Alternate Hypothesis***	***Method(s) of Testing***	***Expected Results Assuming Hypothesis***	***Expected Results Assuming Alternate Hypothesis***
Area B Building 2 Contains an Elite Context	Building is a non-elite residential or industrial context	Study of serving/food preparation vessels; comparative study of ceramics from Building 2 with elite contexts at KEN and non-elite contexts at KAJ	More serving vessels than food preparation vessels. Ceramics from Building 2 are finer than those found in Areas A and C at KAJ. Building 2 ceramics will bear similarity to elite contexts at KEN	Substantial presence of food preparation vessels. Ceramics from Building 2 are not noticeably finer than those from other Areas at KAJ. Parallels in the Area B assemblage are to non-elite contexts
Local Organization of Copper Production	Tel Masos-based organization	Petrographic Analysis Typological Analysis	Local clays used to produce ceramics. Homogeneous assemblage. Assemblage similar to KEN, "local Edomite" assemblage	Homogeneous assemblage. Tel Masos imported ceramics, many parallels to Tel Masos, especially in elite contexts.
Trade of copper primarily through Negev	Trade of copper primarily through other regions, such as north to Moab or south to present-day Saudi Arabia	Ceramic Analysis, Petrographic and Typological	Similarity of ceramics between Faynan and sites in the Negev and coastal plain, possible sourcing of Faynan ceramics to Negev	Dissimilar ceramics between Faynan and Negev, few ceramics sourced to Negev. Greater similarity in assemblage to another region, ceramics sourced to other regions.
Trade Catalyzed Social Complexity	Trade did not catalyze social complexity	Comparative study of Faynan ceramics from elite and non-elite contexts to other regional assemblages	Evidence of "elite" foods, fine serving vessels used to reinforce social status of elites in elite contexts	Locally-produced ceramics, no evidence of "elite" foods at the site.

The analyses presented here consist of a comprehensive study of the excavation of Khirbat al-Jariya Areas B and C in 2014 and the ceramic evidence from these contexts. Four main hypotheses were tested through the work presented here. First, Building 2 in Area B represents an elite context at the site, whose inhabitants would have held social influence and political power. Relatedly, a second hypothesis tested suggests that copper production in Early Iron Age Faynan, including and especially at Khirbat al-Jariya, was locally controlled rather than being controlled by an external entity. The final two hypotheses relate to trade relationships at the site. These conjectures are that copper produced at Khirbat al-Jariya was primarily exchanged through the Negev Desert on its way to the Mediterranean coast, and that elites at the site were able to leverage exclusive control over this trade into increased wealth and power, thus catalyzing increased social complexity.

Table 12.2: The first hypothesis tested in this dissertation.

Area B Building 2 Contains an Elite Context	Building is a non-elite residential or industrial context	Study of serving/food preparation vessels; comparative study of ceramics from Building 2 with elite contexts at KEN and non-elite contexts at KAJ	More serving vessels than food preparation vessels. Ceramics from Building 2 are finer than those found in Areas A and C at KAJ. Building 2 ceramics will bear similarity to elite contexts at KEN	Substantial presence of food preparation vessels. Ceramics from Building 2 are not noticeably finer than those from other Areas at KAJ. Parallels in the Area B assemblage are to non-elite contexts

The first hypothesis tested here, that Area B represents an elite context, was tested through typological and petrographic analysis of the ceramics recovered from excavations at KAJ in 2014. Excavating Area B, the hypothesized elite area, and Area C, an industrial/residential area, provided a fruitful basis for comparison. Prior to the ceramic analysis presented here, the use of Building 2 in Area B was uncertain, as the structure contained evidence of slag processing, suggesting a more industrial use (Liss et al. 2020). However, typological analysis of the ceramics from Area B revealed the presence of several important classes with implications for the presence of elites at the site. Most significant of these are the ceramics recovered from Loci 543/561, a floor context in Room 3 of Building 2, itself in Area B. Wares found in this room are central to testing the hypothesis that the structure represents an elite context, as this room contains a relatively elaborate grinding installation, providing initial impetus to the idea that occupants of this room were of higher social status than those of other parts of the site.

Of the ceramics of Loci 543/561, the presence of fine-wares provides an especially important test of this proposal that elites occupied Area B. Bowls 1 and 2, the two red-slipped and burnished bowls, feature many common characteristics of serving vessels, as they are fine-ware open vessels decorated with burnish and slip (Smith 1983; Rice 1987: 236-240; Singer-Avitz 2016: 508). Bowl 3, the only other fine-ware bowl recovered from 2014 excavations at KAJ, also comes from the same context and was also likely a serving vessel. The relatively high-frequency of these fine-ware bowls—and the absence of evidence of food preparation— in this central context provides some corroboration that this part of the structure was occupied by elites given that elite contexts are likely to have a high proportion of serving vessels and that elites may outsource food preparation activities (Brumfiel 1987; Garraty 2000; Hirth 1993; Turkon 2004). Evidence of cooking in Room 2, spatially-differentiated from the rest of the structure to some extent, provides support for this assertion as food preparation activities can be spatially segregated from other household activities (Gumerman 1997; Haviland and Moholy-Nagy 1992; Turkon 2004). Thus, evidence of food preparation and consumption in Area B seems to suggest the presence of elites in the central rooms of Building 2.

A more detailed examination of Bowls 1 and 2 adds support to this hypothesis. The former vessel closely parallels Bowl 16a from Khirbat en-Nahas, also a red-slipped and hand-burnished bowl interpreted by Smith and Levy (2014) to represent an import from the western Negev. Relatedly, KAJ Bowl 2 bears similarity to Smith and Levy's (2014) Bowl 24, also argued to be an import from the

Negev. The question of whether or not the bowls of this specific type were imported to KEN was confirmed by Smith (et al. 2014b) through petrographic analysis, which found that these red-slipped and burnished bowls at KEN were almost exclusively produced using loess-derived clays local to the Negev. Inversely, every vessel found by Smith (et al. 2014b) to have been produced from loess clays (Petrographic Group 5, Ware I1) was also red-slipped and burnished. Of the 10 samples categorized as Ware I1 by Smith (et al. 2014b), five originate in Area R at KEN, one in Area T, two in Area A, one in Area S, and one in KAJ Area A (Smith and Levy 2014: 339, 345, 355, 367, 382, 405). The implications of this are two-fold. First, red-slipped and burnished bowls imported from the Negev are disproportionately common in Area R at KEN, which is an elite context at the site featuring many imported fine-wares and monumental architecture (Levy et al. 2014; Smith and Levy 2014b). These vessels are also present in Area A near the gatehouse in 9th century BCE layers when Area A would have been serving as an elite residence (Smith and Levy 2014: 417; Levy et al. 2014: 108). This suggests that these red-slipped and burnished imports are representative of the presence of elites. Second, the dominance of this vessel type in Area R draws a connection between that context and Area B at KAJ, where red slipped and burnished vessels are also disproportionately common among the small assemblage. This connection is corroborated by the petrographic analysis conducted on the red-slipped and burnished Bowls 1 and 2 from L561 in Area B, which confirmed that these also are loess-derived (Ware Group 3) fabrics and thus imports from the Negev. As such, the presence of these fine bowls in Area B suggest that elites similar to those who occupied Area R (and Area A during Layer A3a) inhabited Building 2 at KAJ.

Another line of evidence to consider with regard to the presence of elites in Area B is Jar 1, found in the same Room 3 context as the bowls discussed above. Jar 1 is a relatively unique and well-crafted cup-spouted jar. This vessel was likely used for the storage and portioning of a valuable liquid, such as olive oil (Amiran 1969: 243; Crowfoot et al. 1957: 193). The consumption of olive oil—a valuable commodity produced and exported in the Iron Age Southern Levant —by residents of

Building 2 may have served to reinforce their status through conspicuous consumption of such a valuable imported foodstuff (Turkon 2004). This vessel also has many parallels, discussed extensively above. However, in the context of the hypothesis that elites occupied Area B, two parallels from Area R at KEN are most relevant. One of these vessels, published by Smith (et al. 2014b: pl. 4.1:14) as JR 28, provides one of the closest parallels overall to the cup-spouted jar from KAJ, when comparing the presence of one handle adjacent to the cup spout on the KEN sherd (as opposed to two adjacent handles on the KAJ vessel) and a cup spout that does not lie flush to the vessel's shoulder. The other, more complete vessel from Area R (Levy et al. 2014: Figure 2.202), a decorated example not as morphologically similar to the KAJ example, provides additional evidence of the disproportionate rate of these vessels in this part of KEN. Taken together, the presence of two cup-spouted jars in Area R and none in the remaining areas at KEN or other assemblages studied by Smith and Levy (2014) suggests that cup-spouted jars were especially popular among Faynan elites. A likely explanation is that these vessels were used for the storage and dispensation of a valuable liquid, such as olive oil perhaps, only available to the elite and as such only present in elite contexts. This interpretation gives additional significance to the cup-spouted jar in Area B at KAJ and corroborates the hypothesis that Building 2 was an elite context.

Finally, the ceramics from Area B can be compared to those from Area C, the other area excavated in 2014 excavations at the site. Area C, a 1x1 m probe into a slag mound at the southern edge of the site, consists of both industrial and domestic contexts (Liss et al. 2020). By comparing the ceramics from this area to that of Area B, the hypothesized elite context, it is possible to understand if the ceramics of the latter area are notably finer or feature a higher rate of imports. In general, the ceramics from Area C do appear to be coarser than those of Area B. Area C features three of the four diagnostic Handmade Arabah Ware sherds recovered from the 2014 excavations at the site. The overall coarseness of the ceramics from this area in contrast to the fine imported wares of Area B suggest that the occupants of Area C were of a lower social status, or perhaps relied on more utilitarian ceramics, than the occupants of Building 2.

Table 12.3: The second hypothesis tested in this dissertation.

Local Organization of Society and Copper Production	Tel Masos-based organization	Petrographic Analysis Typological Analysis	Local clays used to produce ceramics. Homogeneous assemblage. Assemblage similar to KEN, "local Edomite" assemblage	Homogeneous assemblage. Tel Masos imported ceramics, many parallels to Tel Masos, especially in elite contexts.

The second hypothesis tested is the proposal that copper production in Faynan and at Khirbat al-Jariya during the Iron Age was locally controlled by a semi-nomadic desert polity rather than externally by a foreign polity. This premise comes contra the proposal of Finkelstein (1988, 2005; and Piasetzky 2008; Fantalkin and Finkelstein 2006), who has suggested that industry in Faynan was controlled by a chiefdom centered at Tel Masos. This hypothesis was tested through analysis of the ceramics from Khirbat al-Jariya Areas B and C and examination of the chaîne opératoire of the production of the ceramics of the site. Typological study of the KAJ assemblage has discovered many parallels between the ceramics of KAJ and those of KEN. The assemblage of KAJ generally appears to fit within the local Early Iron Age Edomite complex detailed by Smith and Levy (2014) on the basis of both typological parallels and quantitative similarities. This analysis suggests that KAJ was part of a regional network of copper producing sites in the Iron Age including, most notably, Khirbat en-Nahas. On the other hand, the typological analysis presented above illustrates few (only three) forms similar to those found at Tel Masos. The generally different typology of ceramics from Faynan and from Tel

Masos makes it difficult to substantiate the idea that elites at Tel Masos may have controlled society and production in Faynan given a lack of stylistic parallels.

Petrographic analysis also provides additional evidence in favor of the supposition that production and occupation of KAJ was organized locally rather than by Tel Masos. Of the 24 sherds thin-sectioned for petrographic analysis, only one (Sample KAJ34) plausibly came from the vicinity of Tel Masos. This sample, a red-slipped and hand-burnished bowl, featured the loess with calcareous inclusions typical of the Northern Negev/Shephelah region and was featured in Room 3 of Building 2 in Area B. However, one sherd is not enough to provide evidence of foreign control at a significant site such as KAJ. Moreover, this sherd should be contrasted against the vast majority (79%, or 19/24) of the petrographic sample, which have been identified as shale-tempered fabrics associated with the Kurnub Sandstones (Ware Group 1), a geologic unit outcropping locally in the Faynan region. Considering the elite-associated Area B alone, the majority of sherds sampled from that area (15/19) were also included in the local Ware Group 1, despite the presence of a small fraction of imported sherds. The predominance of ceramics from this geologic origin among the ceramics of both KAJ and KEN indicates that clay selection for locally-produced ceramics was a shared technological choice among Faynan potters. The overall homogeneity of these assemblages is indicative that the two sites operated in a shared community of practice (Lave and Wenger 1991; Roux 2016; Wenger 1998). Overall, that so many of the ceramics from KAJ were produced locally suggests social organization of production occurred on the local level rather than by a foreign entity.

One complicating factor to this hypothesis is the relative lack of slag temper in ceramics recovered from KAJ. Slag inclusions in ceramics have been identified in many studies of ceramics from Faynan, Timna, and the Negev (Al-Shorman 2009; Bachmann and Rothenberg 1980; Ben-Yosef, 2010; Glass 1988; Martin and Finkelstein 2013; Martin et al. 2013; Rothenberg, 1980; Slatkine 1978; Smith 2009; Tite et al. 1990). This phenomenon in Iron Age ceramics has been assumed to be representative of populations involved in copper production and exchange, who possibly included crushed slag in their ceramics for ritual purposes (Ben-Yosef 2009; Martin et al. 2013). However, based on petrographic analysis conducted here, only one of the 24 sampled sherds from Areas B and C, or 31 sampled sherds also including thin sections from Area A studied by Smith (et al. 2014b), contains slag temper (future work will investigate isotropic inclusions in several samples from Ware Group 1). Moreover, none of the handmade ware sampled for petrographic analysis contained slag inclusions. A rate of less than 5% contrasts sharply with the 30% of sampled wares from KEN featuring slag (Smith et al. 2014b). This difference, though significant for understanding the importance of slag tempering at Iron Age sites in Faynan and nearby regions, does not indicate a role for a non-local political entity at KAJ. As such, the petrographic evidence still largely suggests that production was locally organized rather than the site being subject to control by an external entity such as a chiefdom centered at Tel Masos.

Table 12.4: The third hypothesis tested in this dissertation.

Trade of copper primarily through Negev	Trade of copper primarily through other regions, such as north to Moab or south to present-day Saudi Arabia	Ceramic Analysis , Petrographic and Typological	Similarity of ceramics between Faynan and sites in the Negev and coastal plain, possible sourcing of Faynan ceramics to Negev	Dissimilar ceramics between Faynan and Negev, few ceramics sourced to Negev. Greater similarity in assemblage to another region, ceramics sourced to other regions.

The third hypothesis tested is that copper produced at KAJ and in Iron Age Faynan was primarily exported through the Negev Desert. Evidence from lead isotope analysis of Early Iron Age copper artifacts suggests that copper was exchanged to Egypt and/or via maritime trade along the Levantine coast (Artzy 2006, 2012; Ben-Dor Evian et al. 2021; Eliyahu-Behar and Yahalom-Mack in press; Hall 2021; Kiderlen et al. 2016; Stos-Gale 2006; Yahlom-Mack and Segal 2018a, 2018b;

Yahalom-Mack et al. 2014, 2017). However, the exact trade routes are not known, and the proposal that copper was traded directly westward across the Negev Desert must be tested by using ceramics as a proxy for exchange of copper. Were copper to have been exchanged through the Negev in high quantities reflecting the large amounts of copper produced at Khirbat al-Jariya, we would expect that such a flourishing trade would leave other remnants, including in the ceramic assemblages of sites involved in the trade. As such, by demonstrating the existence of a trade relationship between Khirbat al-Jariya and the Negev Desert, we can provide circumstantial evidence for the ancient copper trade. Typological analysis of ceramics from KAJ evidences the existence of exchange networks involving sites in the Negev. First, many of the sherds from Khirbat al-Jariya parallel vessels from sites in the Beersheba Valley or Negev. Particularly significant are the red-slipped and burnished Bowls 1 and 2 that parallel bowls of this type from many sites west of the Wadi Arabah. Similar bowls are also reported by Smith and Levy (2014: 310) to represent imports from the Western Negev. These typological similarities are corroborated by quantitative analysis of the assemblages from these sites. Though sites in the Negev Highlands, Timna, and Tell el-Qudeirat feature a far higher rate of handmade wares than copper production sites in Faynan such as KAJ and KEN, these sites are all united by featuring higher rates of such wares than at sedentary sites (Bernick-Greenberg 2007b; Kleiman et al. 2017; Martin and Finkelstein 2013; Smith and Levy 2014). This link is corroborated by the sourcing of ceramics at Negev Highlands sites to Faynan (Martin and Finkelstein 2013). Overall, parallels and similarities in the ceramic assemblages reflect similarities in ceramic production traditions that are further tested through petrographic analysis in order to demonstrate social and economic connections.

Beyond typological comparison with sites in the Negev, comparisons with sites in other regions, such as the Hejaz (western Saudi Arabia) and Moab, north of Edom. Connections with the Hejaz are most readily identifiable by the presence of Qurayyah Painted Ware (QPW)/Midianite pottery. QPW is called as such due to its characteristic appearance of an off-white slip and painted with red and black designs and the fact that it has been petrographically provenanced to the vicinity of Qurayyah, an Iron Age site in Northern Arabia (Bernick-Greenberg 2007a: 140-1; Parr 1982, 1992; Smith and Levy 2014: 411). 43 sherds representing these vessels were found at Khirbat en-Nahas, suggesting a trade relationship of some sort between that site and the Hejaz region. Alternatively, Kleiman (et al. 2017:257-8), building on Rothenberg (1998) and Ben-Yosef (2010, 2016), has suggested that QPW represents not trade but the presence of metalworkers from the Hejaz who brought with them knowledge of metallurgy, and that these ceramics were used in ritual metalworking practices. This suggestion requires further analysis. However, QPW sherds were not found at KAJ in any of the three areas. Though the sample size of KAJ is relatively small, the absence of this type of ware among the ca. 1,551 sherds recovered from KAJ in 2014 studied here or the assemblage from Area A means that a trade connection—or migration—between KAJ and the Hejaz is difficult to substantiate on the basis of extant evidence. Addressing the issue of a trade connection with Moab is more challenging, as the region does not feature such an easily identifiable characteristic ware type. As such, typological comparison between the ceramics of KAJ and published forms from sites in Moab is necessary. This comparison has not resulted in many clear parallels to contemporaneous Moabite sites, though further study is needed especially given a general lack of pottery and well-published assemblages from the Early Iron Age (Herr 2015). As such, substantial trade connections with Moab and regions north and northeast of Khirbat al-Jariya are also unsupported at this time.

Beyond typological analysis, petrographic study draws a clearer link between KAJ and the Negev Desert through the provenancing of ceramics. The two red-slipped and burnished bowls, KAJ34 and KAJ35, paralleled by vessels from sites in the Negev, were also identified as being composed of clay derived from loess soil (Ware Group 3). More specifically, KAJ34, consisting of a calcareous fabric with a great deal of angular quartz silt and calcareous inclusions, was identified as consisting of Northern Negev/Shephelah loess a well known ware type (cf. Boness et al. 2016: 192; Goren et al. 2004; Martin and Finkelstein 2013: 28). Sample KAJ35, on the other hand, is also composed of loess but features predominant quartz sand rather than calcareous inclusions. Angular quartz silt, calcareous matrix, and the sole or primary non-plastic inclusion being rounded quartz sand are characteristic features of coastal loess, also a well-known ware type originating in the Northwestern Negev (Boness et al. 2016:196; Goren et al. 2004: 112-3; Master 2003). Thus, both of these sherds have been provenanced to the Negev Desert. The import of these sherds from their clay source in the Negev to Khirbat al-Jariya evidences a trade connection between these regions. Given the primary role of KAJ as a copper production site, it is likely that copper was also exchanged through this network.

Table 12.5: The fourth hypothesis tested in this dissertation.

Trade Catalyzed Social Complexity	Trade did not catalyze social complexity	Comparative study of Faynan ceramics from elite and non-elite contexts to other regional assemblages	Evidence of "elite" foods, fine serving vessels used to reinforce social status of elites in elite contexts	Locally-produced ceramics, no evidence of "elite" foods at the site.

The final hypothesis tested here is the premise that engagement in long-distance trade was a primary catalyst of the development of social complexity in Faynan and at Khirbat al-Jariya. In other words, elites in the region were able to parlay exclusive access to lucrative exchange networks into social and political power. This hypothesis is tested through both typological and petrographic analysis of ceramics from Khirbat al-Jariya Areas B and C. Typologically, the main vessels of significance to consider with regard to the role of exchange networks in which elites at KAJ were active are those that are identified as possible imports or fineware or vessels used for the storage of high-value foodstuffs. The red-slipped and burnished fine-ware bowls, Bowls 1 and 2, recovered from the elite context of

Loci 543/561, are most representative of the former category of finds. These vessels, as decorated, thin-walled fine-wares, are substantially different than many of the ceramics found elsewhere at the site, with the exception of one similar sherd found in a likely disposal context in Area A (Smith and Levy 2014: Fig. 4.38:4). Petrographic analysis confirms the uniqueness of these vessels in the assemblage from Areas B and C at the site. These two vessels, composed of loess-derived clays, represent imports from the Negev and as such would not have been available but through participation in exchange networks ranging to the Mediterranean coast. The presence of these two imported vessels in this elite context, and imported fine-wares not present in Area C suggests that elites at the site were able to maintain near-exclusive access to fine imported goods. Moreover, these fine-ware bowls, likely serving vessels, were likely used during consumption ceremonies, reinforcing the status of elites through demonstration of their ability to access these vessels (Clark and Blake 1994; Garraty 2000). As such, it is likely that by exploiting exchange networks to access fine tablewares, elites were able to further increase the legitimacy of their high status.

Similarly, fine-ware Bowl 3, found in the same context as the two red-slipped bowls, has provided evidence of the presence of elites with access to finer ceramics than the general population at KAJ. However, it is the fabric of this vessel, the siliceous, quartz-rich Ware Group 2 that is likely associated with the Disi Sandstone formation that outcrops near Petra, that allows for some interesting analysis of elites' engagement in exchange networks. Similar fabrics were studied by Smith (et al. 2014: 165), who suggested that these vessels were either imported to Faynan or the clay used to produce the fabric was imported. The same applies to the presence of this vessel at KAJ. In either scenario, the presence of this bowl (as well as a medium-coarse ware of the same Ware Group 2) in Area B suggests that the potential elites in Building 2 were reaping the benefits of trade relations at supra-local scale by importing clay or fine-ware vessels for their own use.

A third vessel class that provides evidence for elites at KAJ exploiting exchange networks for their own aggrandizement is the cup-spouted jar, Jar 1, also found in the same elite context in Area B. This vessel is finely-crafted, though likely not imported. Rather, its significance lies in the (as yet unverified) possibility that this vessel was used to store and dispense a valuable liquid such as olive oil (Amiran 1969: 243; Crowfoot et al. 1957: 193). Though potentially tens of thousands of tons of copper were exported from Faynan, little evidence of material goods can be found to represent the other side of the ledger. However, the presence of Jar 1 in this elite context raises the possibility that elites at KAJ exploited exchange networks in order to acquire valuable foodstuffs, in part to burnish their own status through consumption as discussed above. Thus overall, ceramic evidence from KAJ, where many high quality and/or imported ceramics are nearly exclusively found in the elite context Area B, suggests that these elites engaged in long-distance exchange networks for their own benefit and in doing so, maintained power and influence in Iron Age society in Faynan.

Appendix A: Petrographic Images

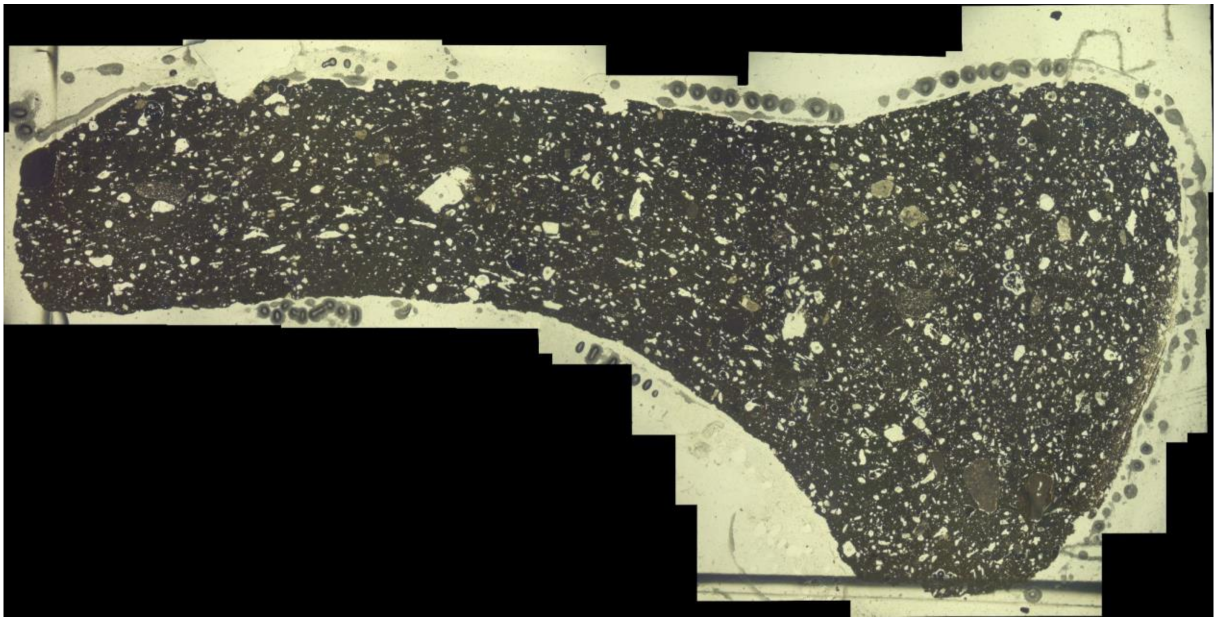

Figure A.1: Thin-section of Sample KAJ5, PPL. This Sample is part of Ware Group 1, Subgroup A.

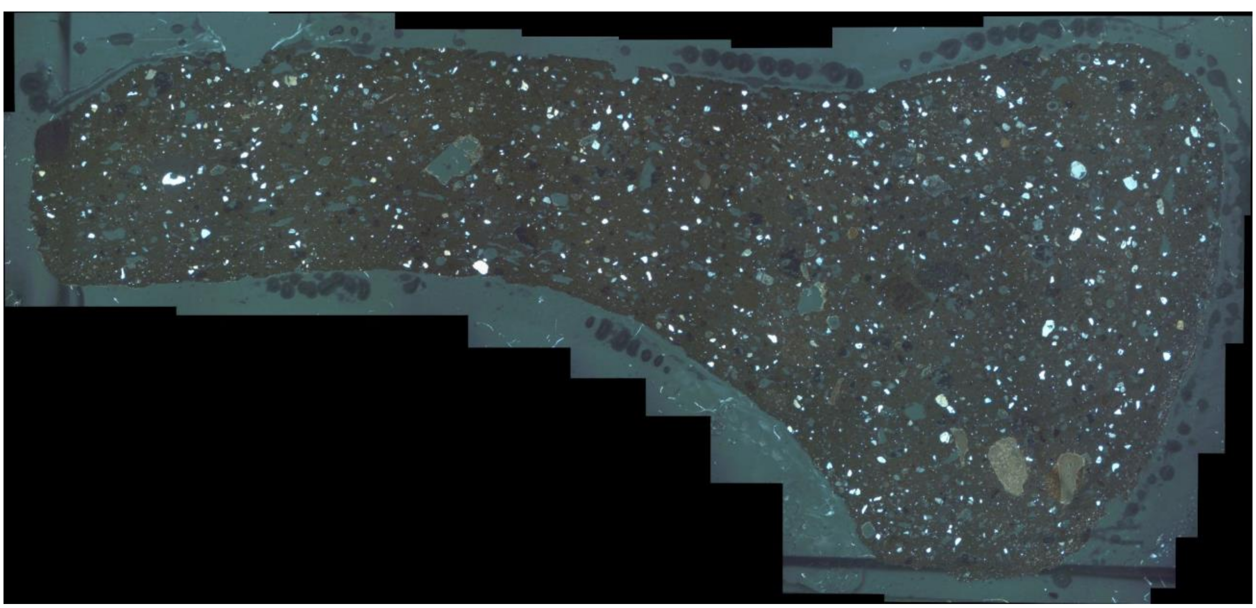

Figure A.2: Thin-section of Sample KAJ5, XPL. This Sample is part of Ware Group 1, Subgroup A.

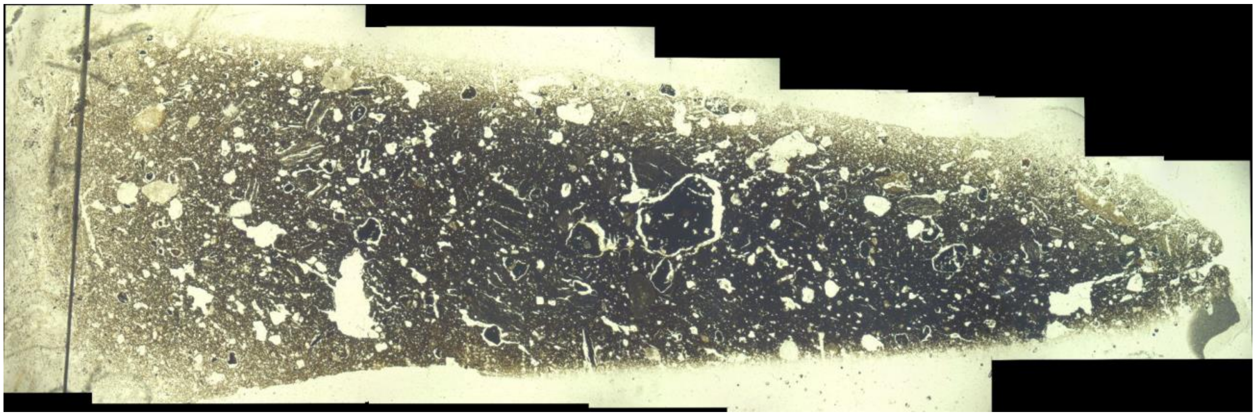

Figure A.3: Thin-section of Sample KAJ8, PPL. This Sample is part of Ware Group 1, Subgroup A.

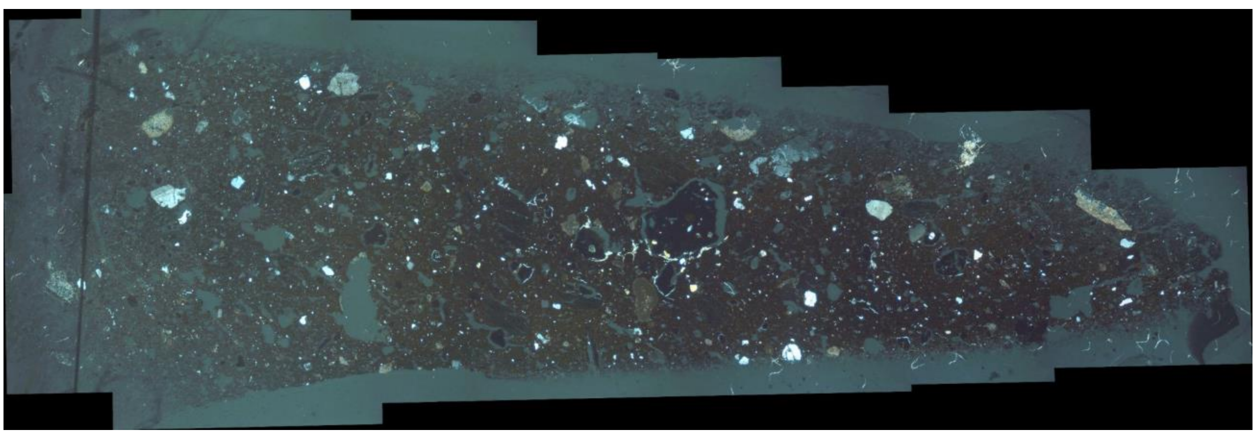

Figure A.4: Thin-section of Sample KAJ8, XPL. This Sample is part of Ware Group 1, Subgroup A.

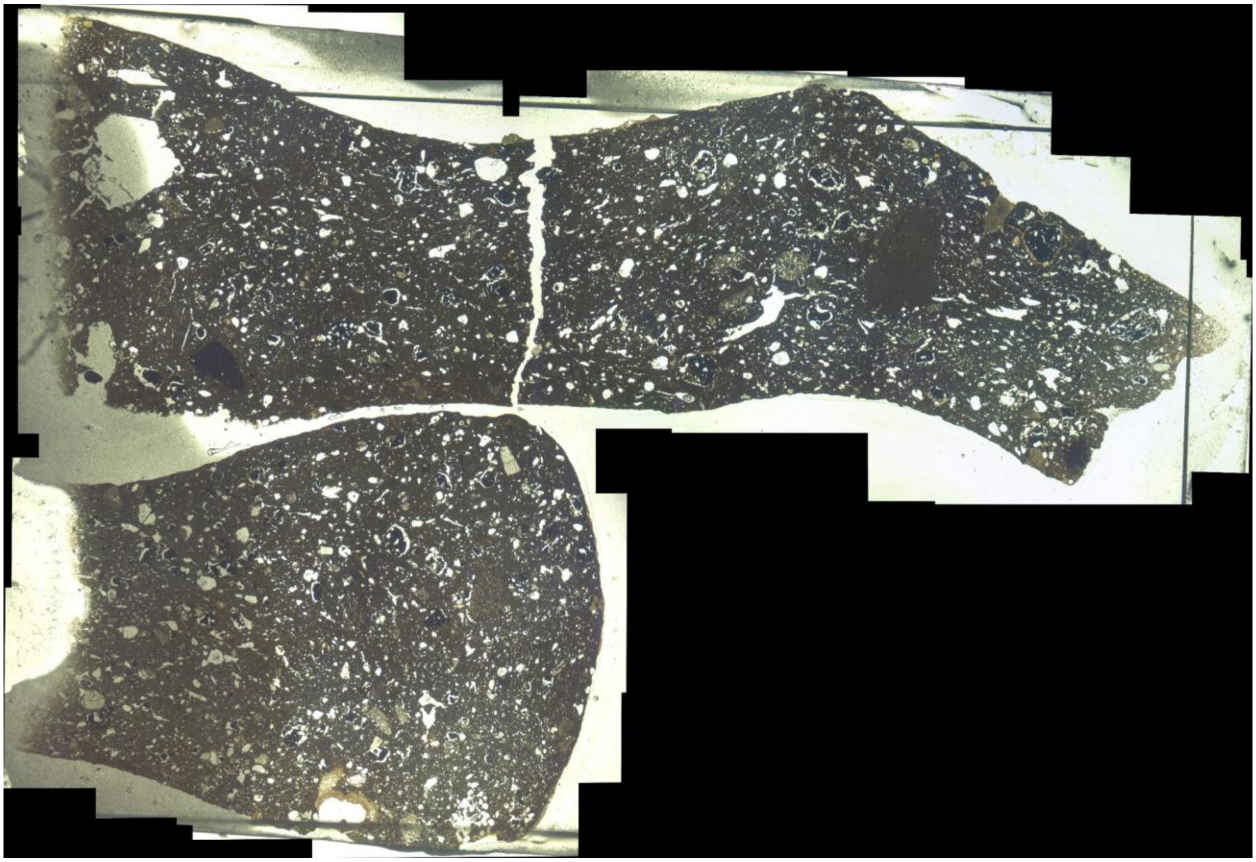

Figure A.5: Thin-section of Sample KAJ9, PPL. This Sample is part of Ware Group 1, Subgroup A.

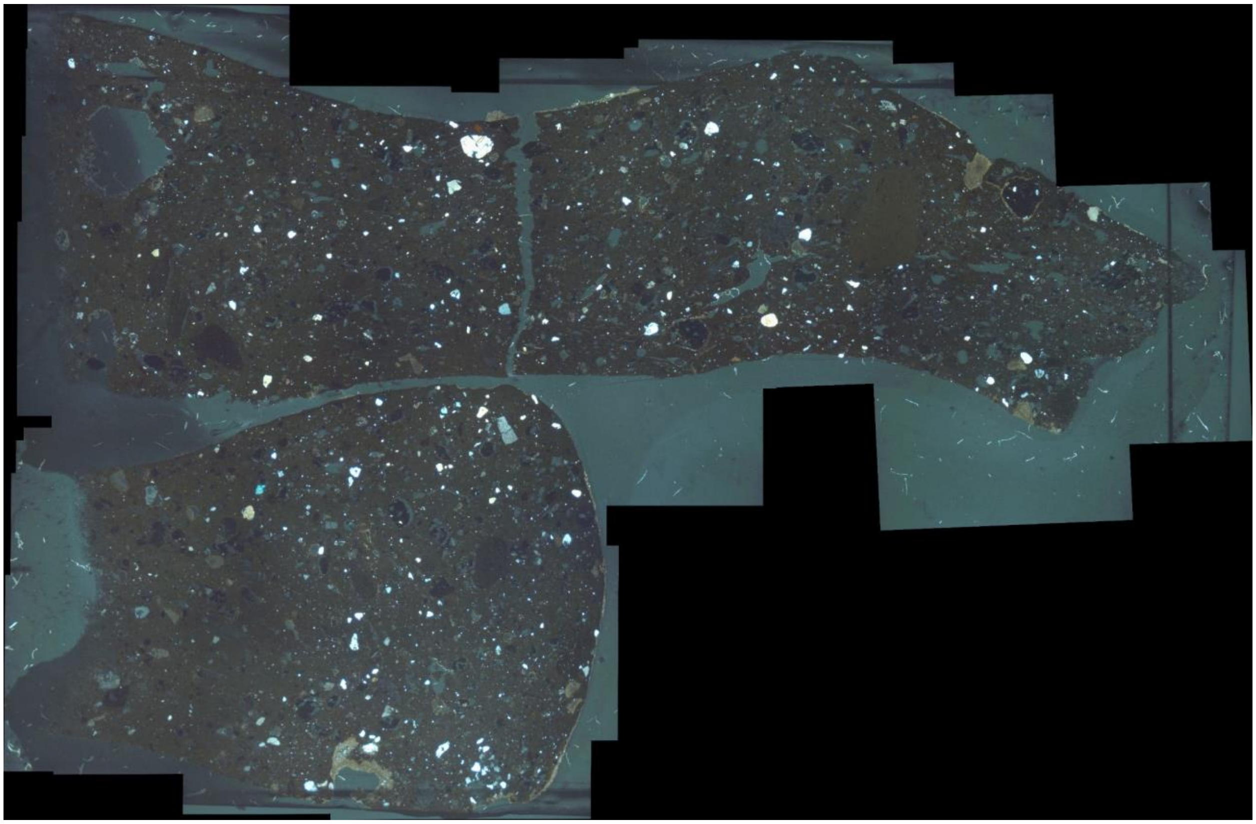

Figure A.6: Thin-section of Sample KAJ9, XPL. This Sample is part of Ware Group 1, Subgroup A.

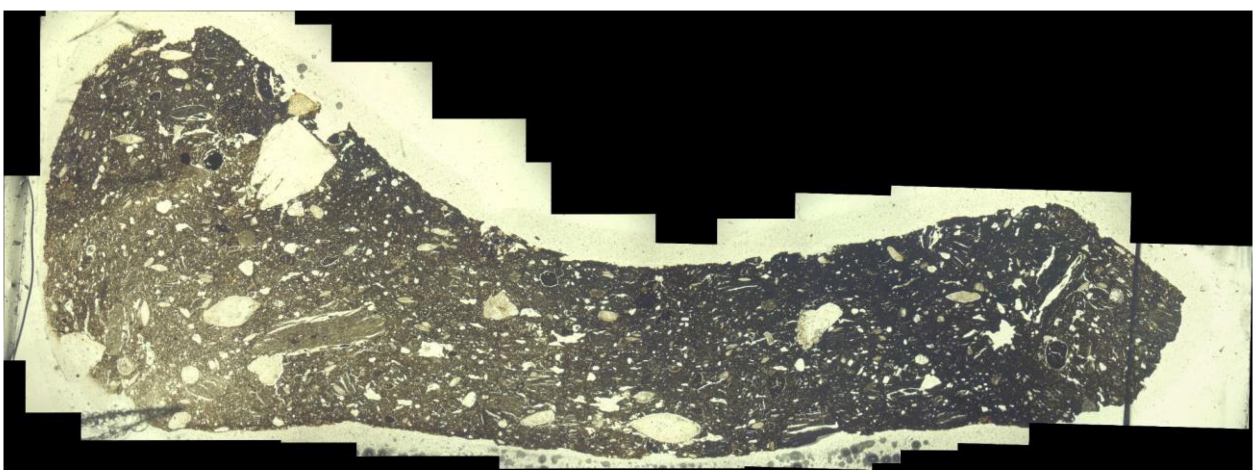

Figure A.7: Thin-section of Sample KAJ11, PPL. This Sample is part of Ware Group 1, Subgroup A.

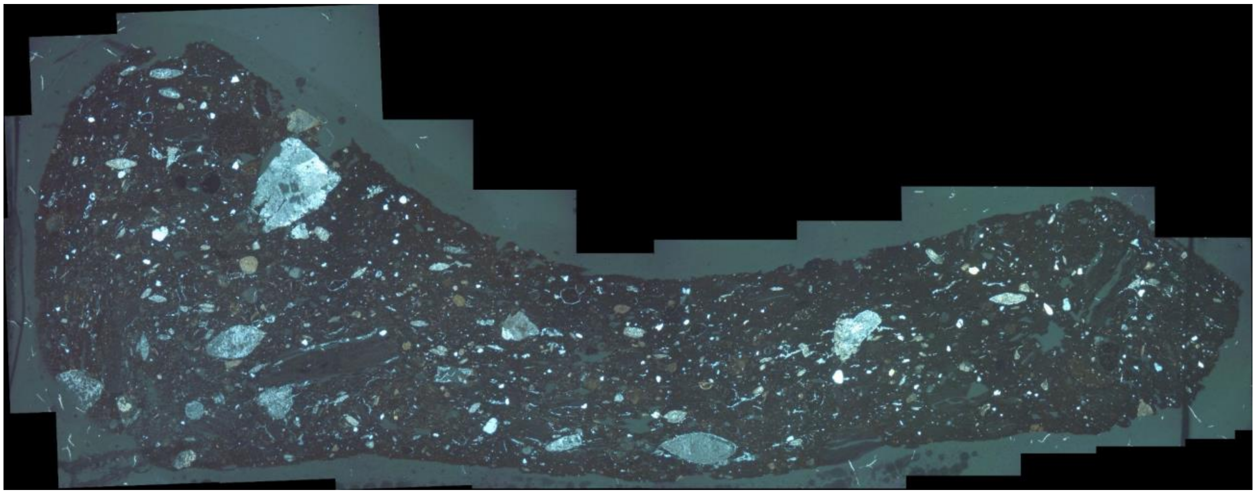

Figure A.8: Thin-section of Sample KAJ9, XPL. This Sample is part of Ware Group 1, Subgroup A.

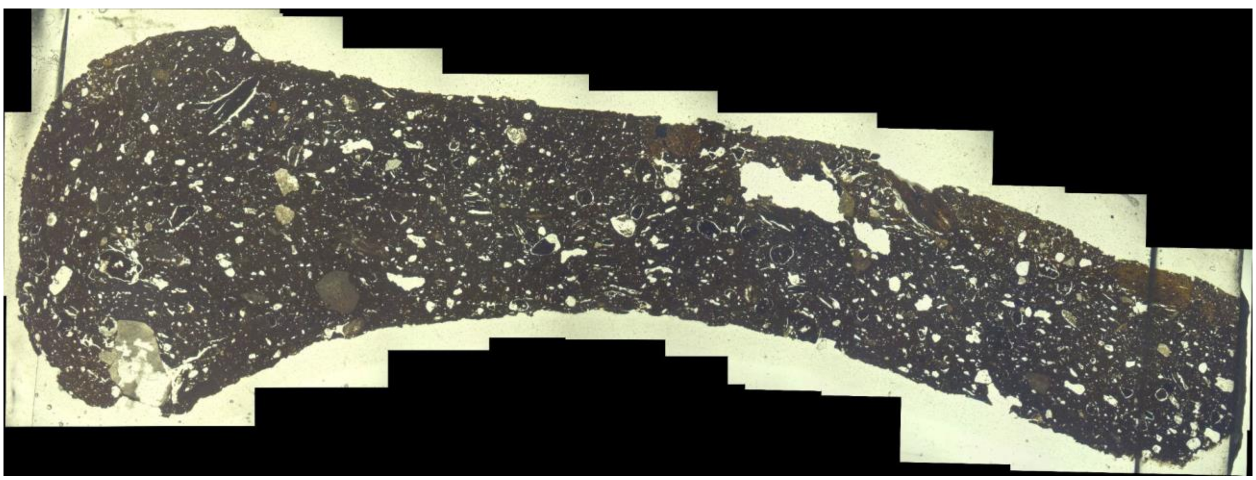

Figure A.9: Thin-section of Sample KAJ11, PPL. This Sample is part of Ware Group 1, Subgroup A.

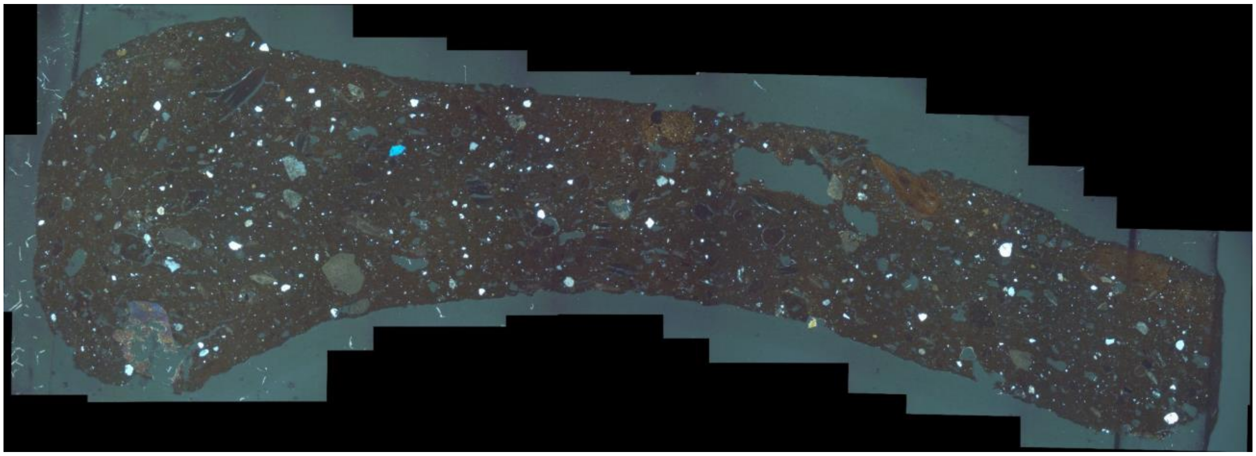

Figure A.10: Thin-section of Sample KAJ11, XPL. This Sample is part of Ware Group 1, Subgroup A.

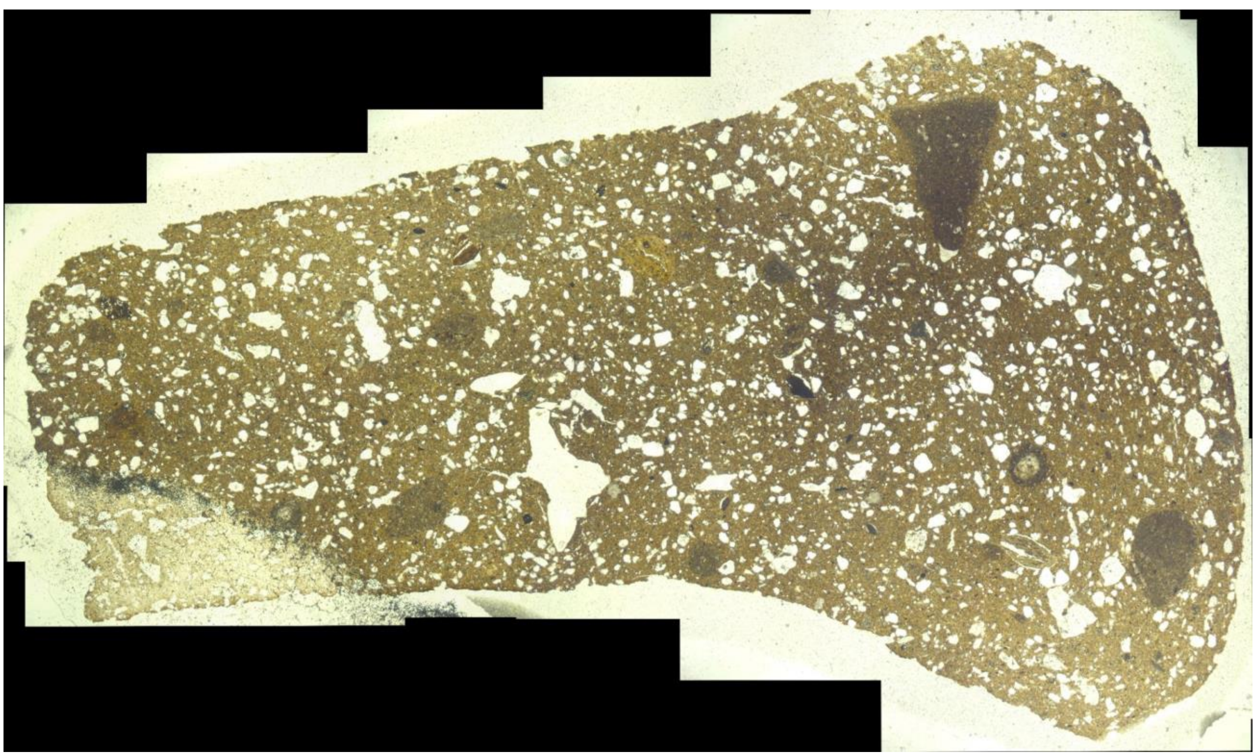

Figure A.11: Thin-section of Sample KAJ13, PPL. This Sample is part of Ware Group 1, Subgroup E.

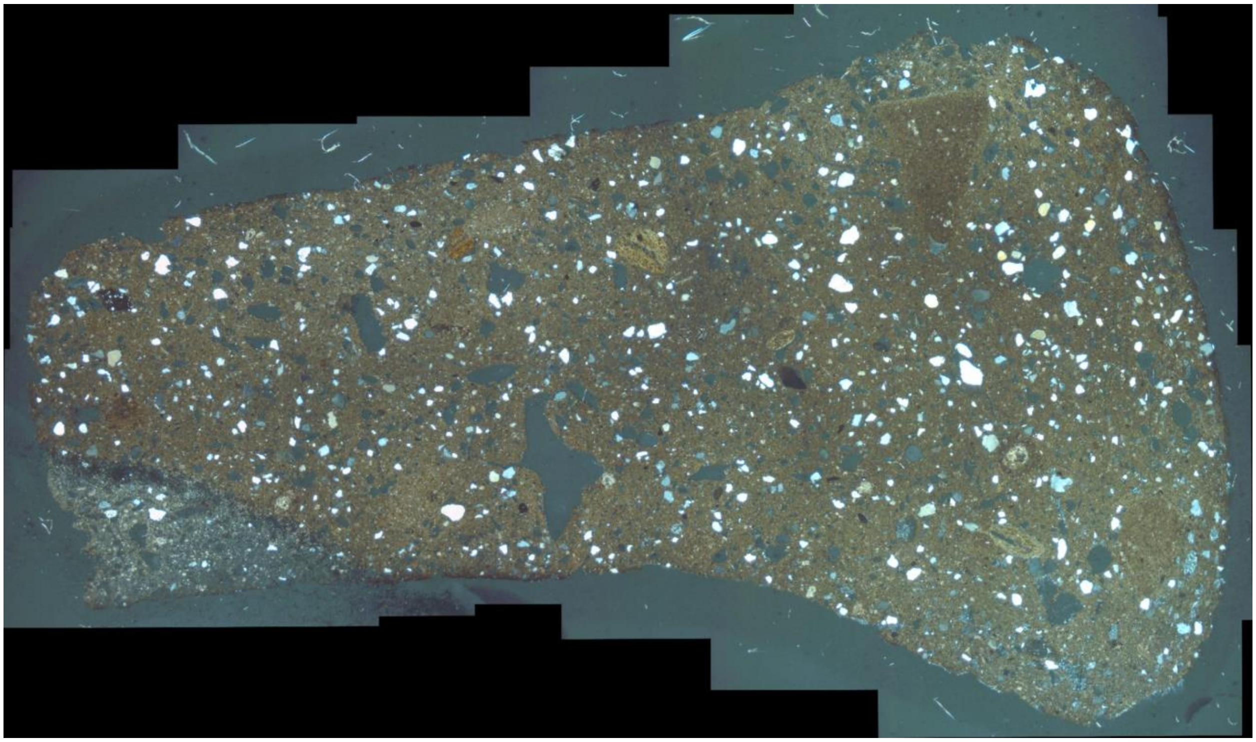

Figure A.12: Thin-section of Sample KAJ13, XPL. This Sample is part of Ware Group 1, Subgroup E.

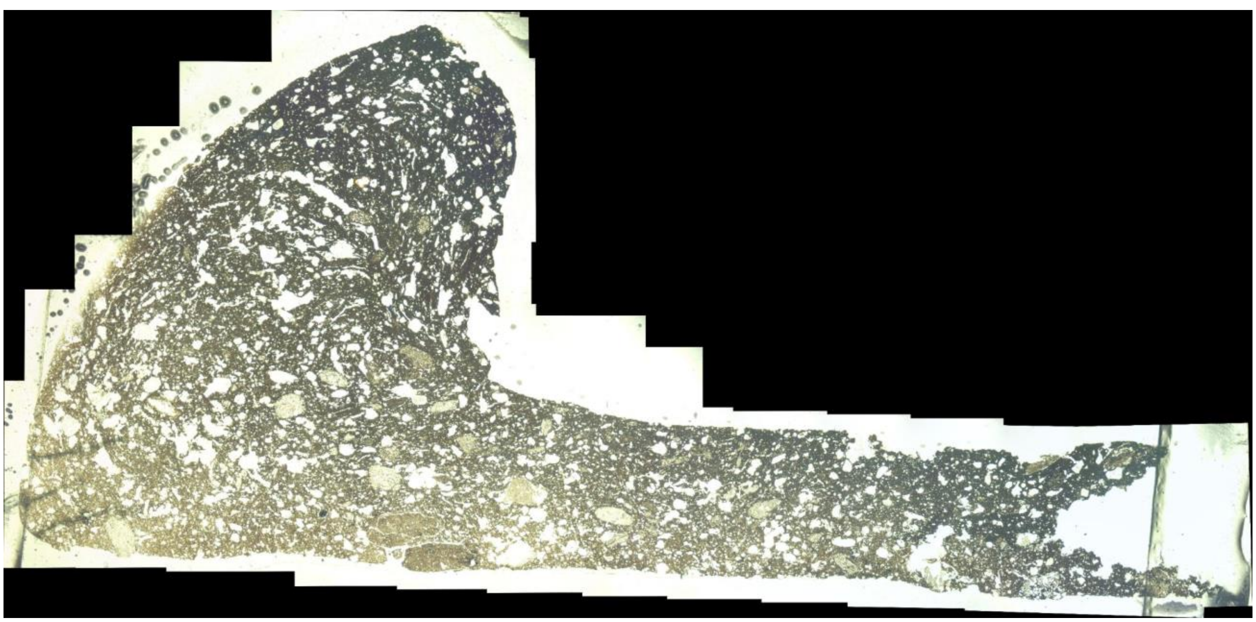

Figure A.13: Thin-section of Sample KAJ14, PPL. This Sample is part of Ware Group 2.

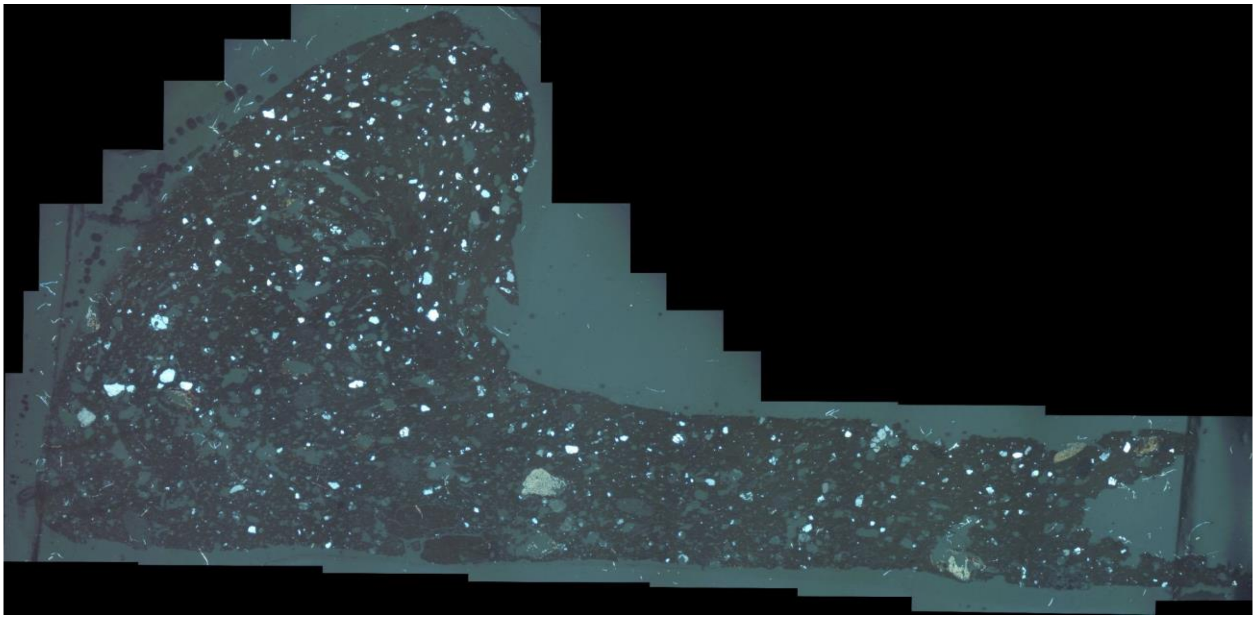

Figure A.14: Thin-section of Sample KAJ14, XPL. This Sample is part of Ware Group 2.

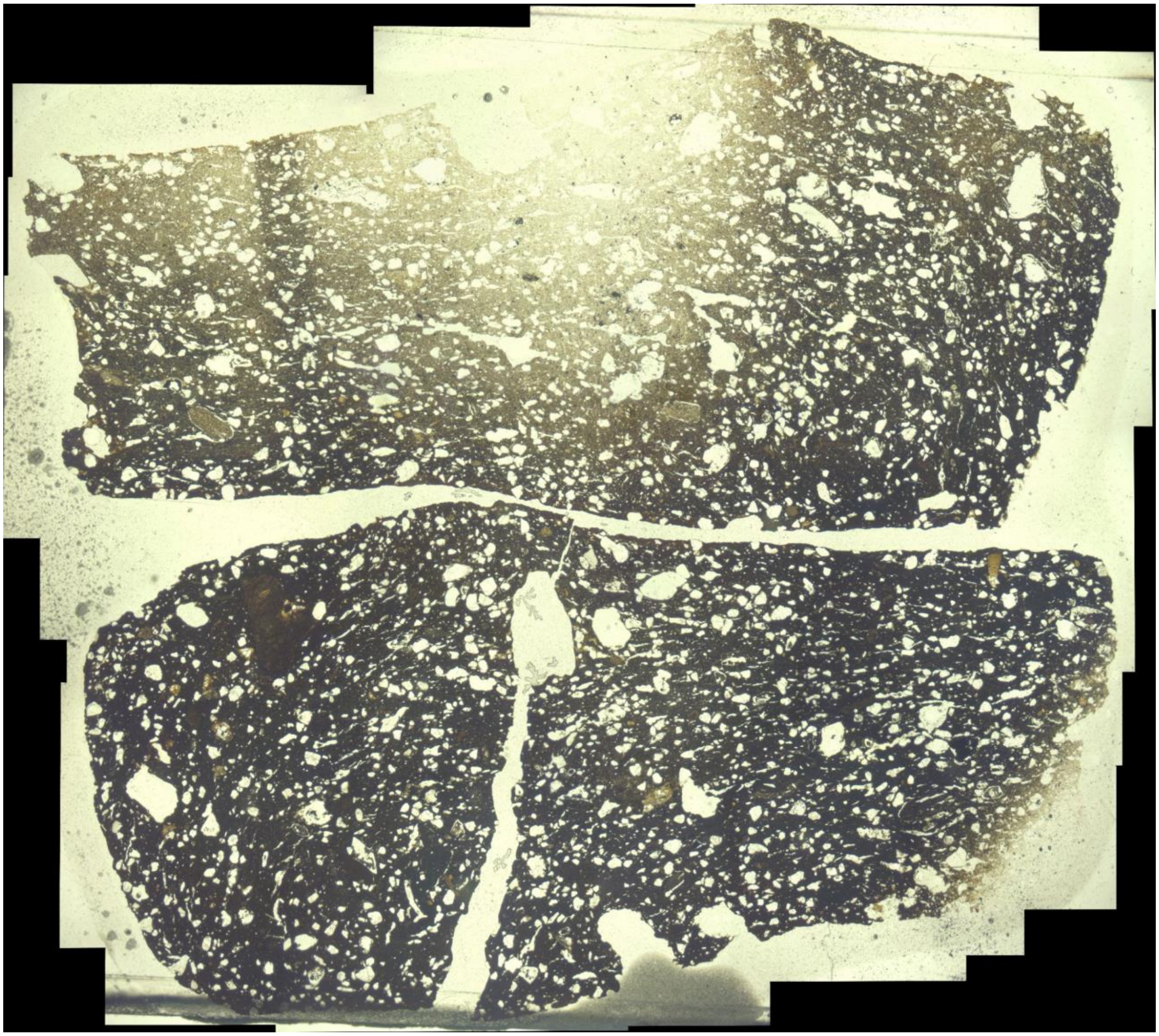

Figure A.15: Thin-section of Sample KAJ15, PPL. This Sample is part of Ware Group 1, Subgroup C.

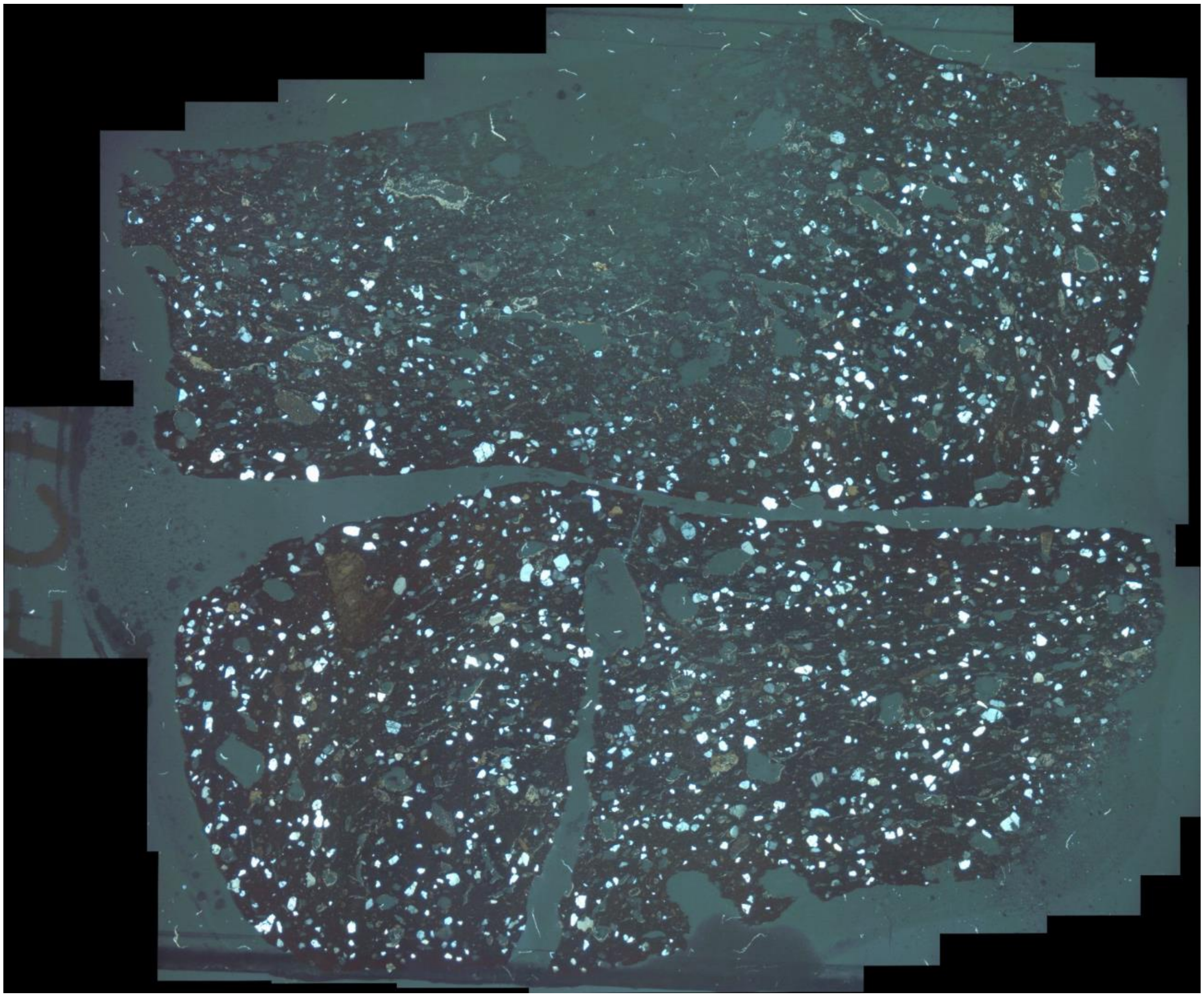

Figure A.16: Thin-section of Sample KAJ15, XPL. This Sample is part of Ware Group 1, Subgroup C.

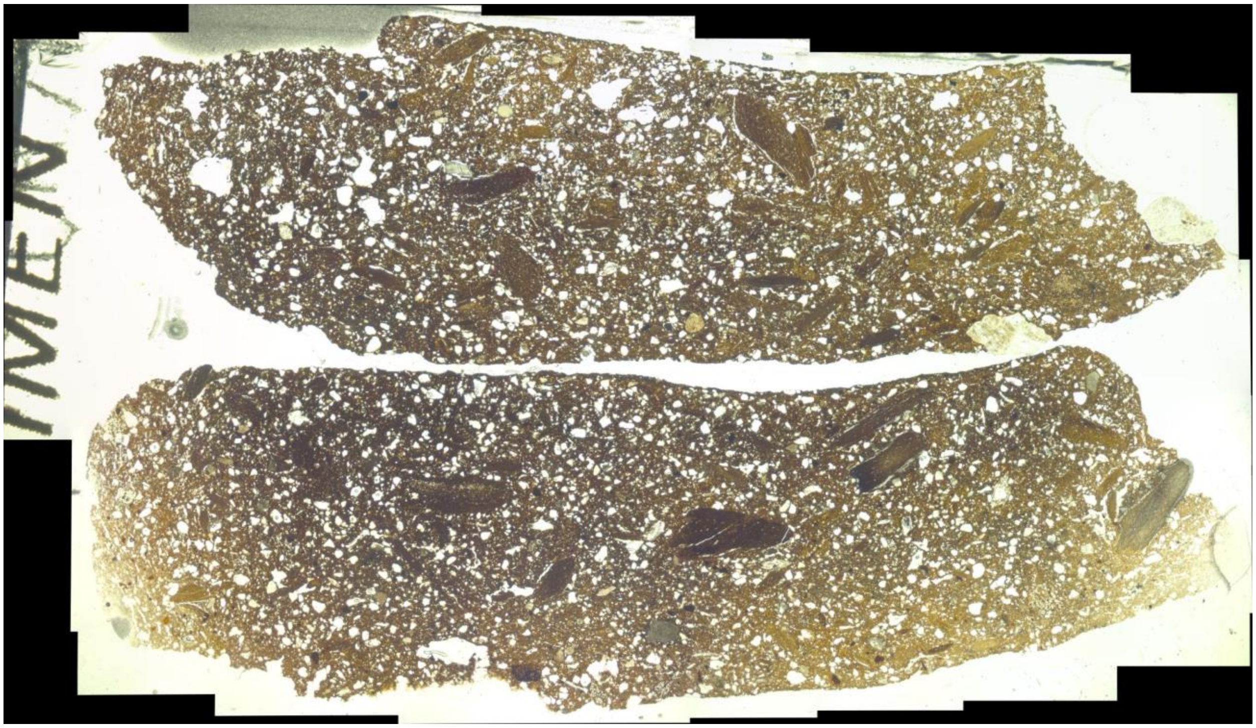

Figure A.17: Thin-section of Sample KAJ16, PPL. This Sample is part of Ware Group 1, Subgroup D.

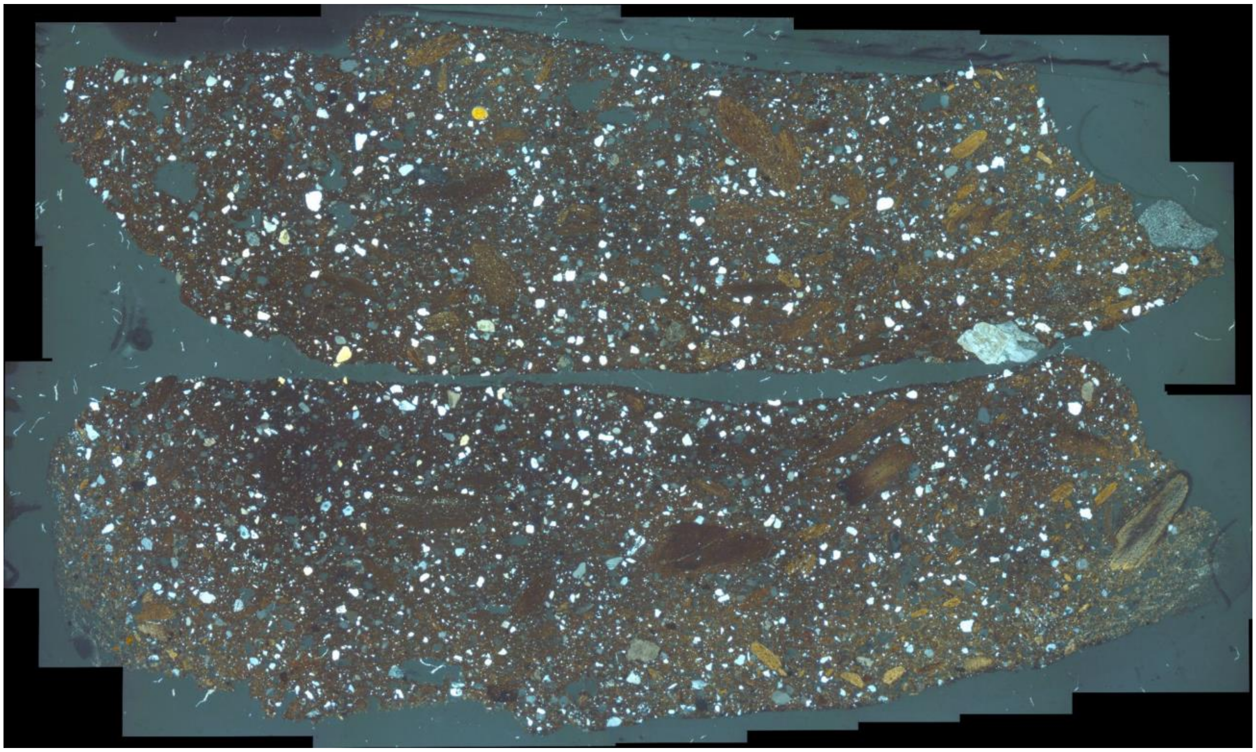

Figure A.18: Thin-section of Sample KAJ16, XPL. This Sample is part of Ware Group 1, Subgroup D.

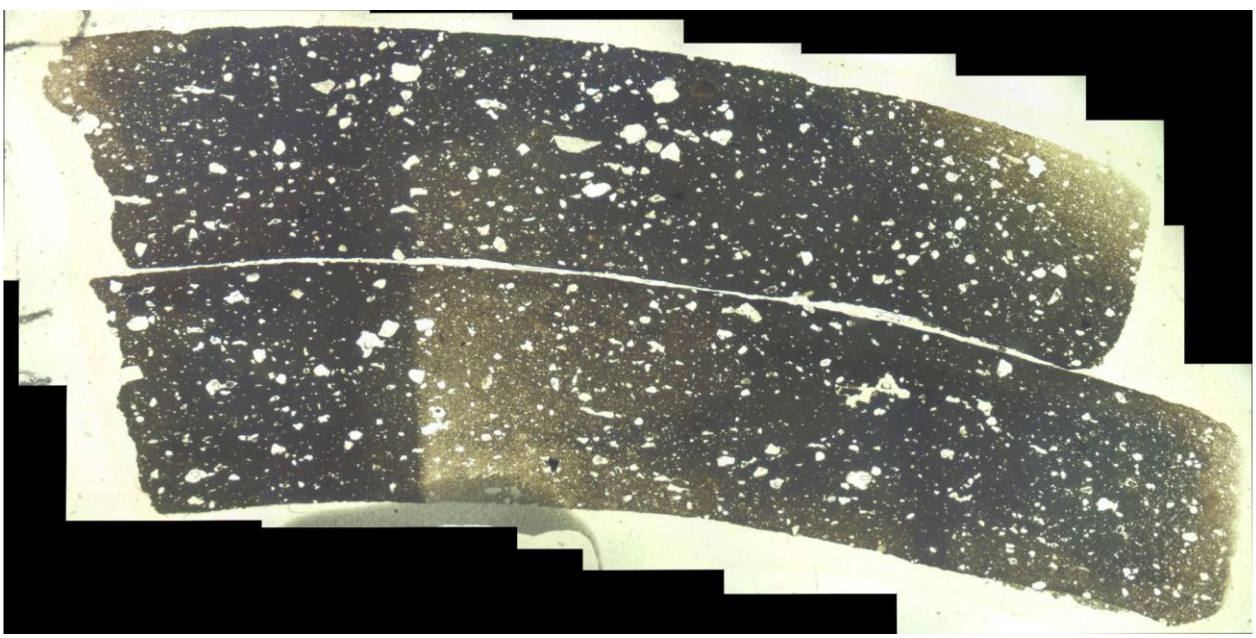

Figure A.19: Thin-section of Sample KAJ17, PPL. This Sample is part of Ware Group 2.

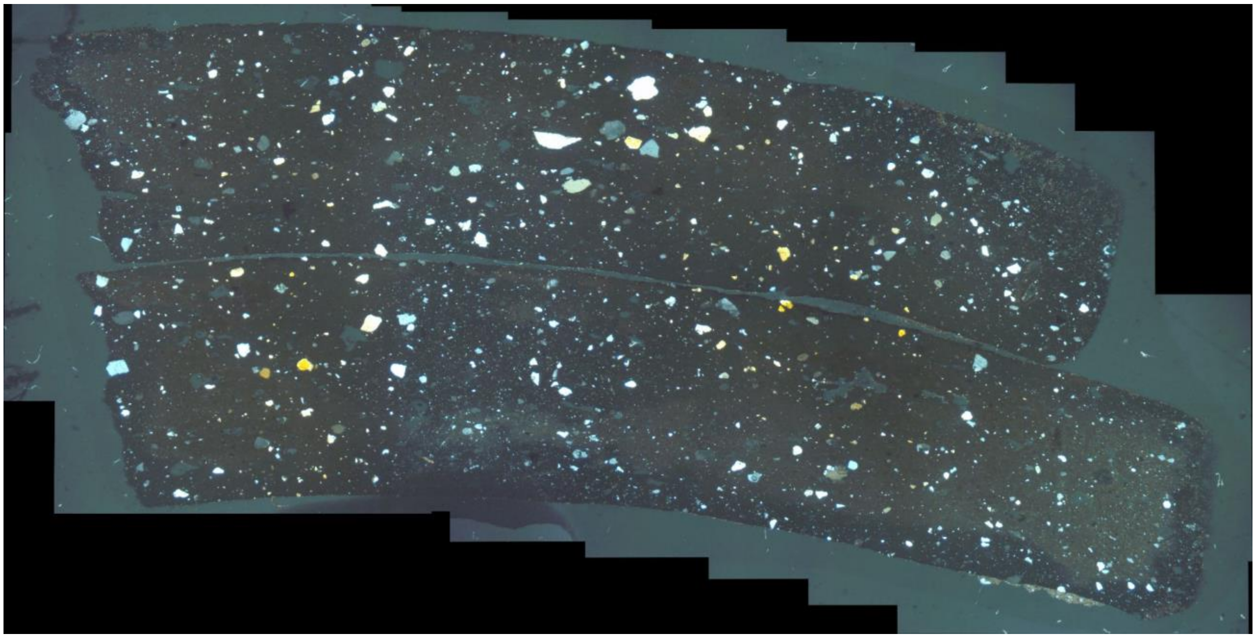

Figure A.20: Thin-section of Sample KAJ17, XPL. This Sample is part of Ware Group 2.

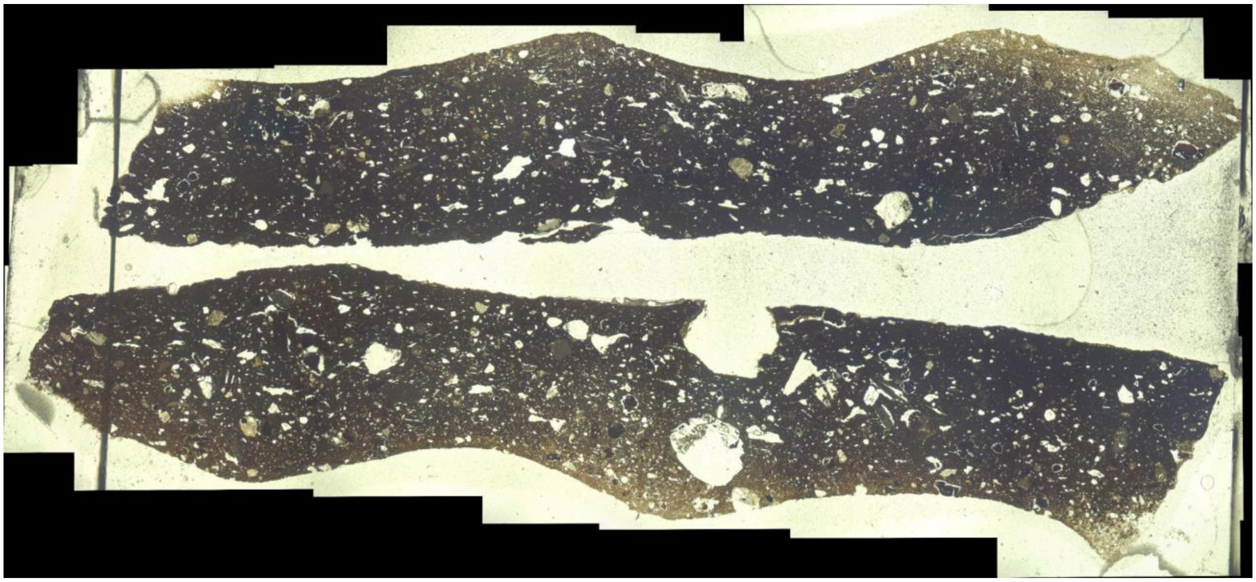

Figure A.21: Thin-section of Sample KAJ19, PPL. This Sample is part of Ware Group 1, Subgroup A.

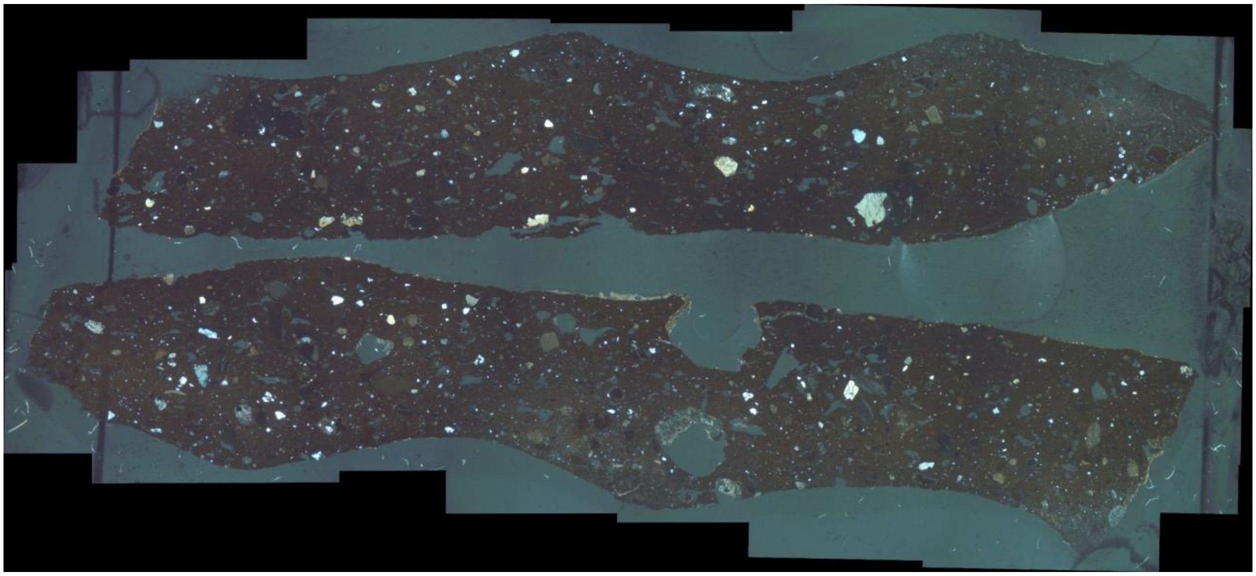

Figure A.22: Thin-section of Sample KAJ19, XPL. This Sample is part of Ware Group 1, Subgroup A.

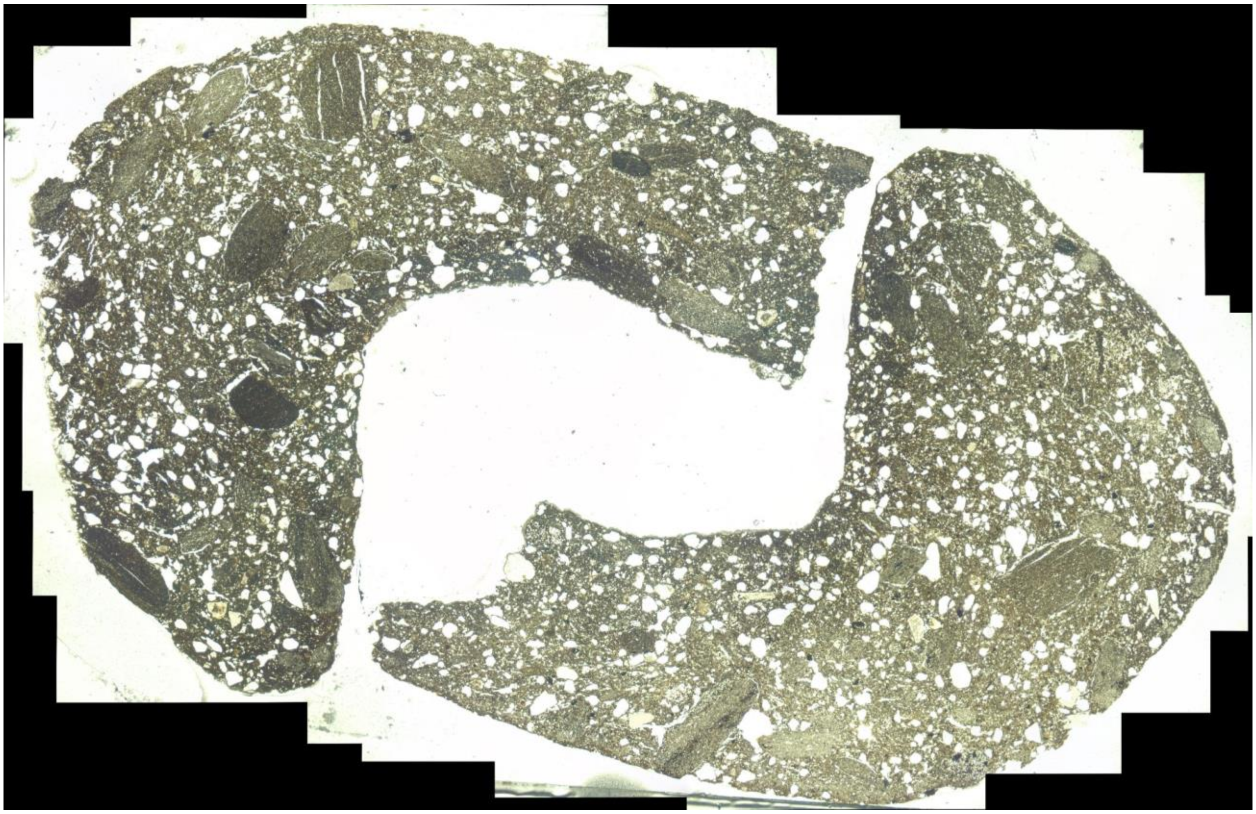

Figure A.23: Thin-section of Sample KAJ20, PPL. This Sample is part of Ware Group 1, Subgroup A.

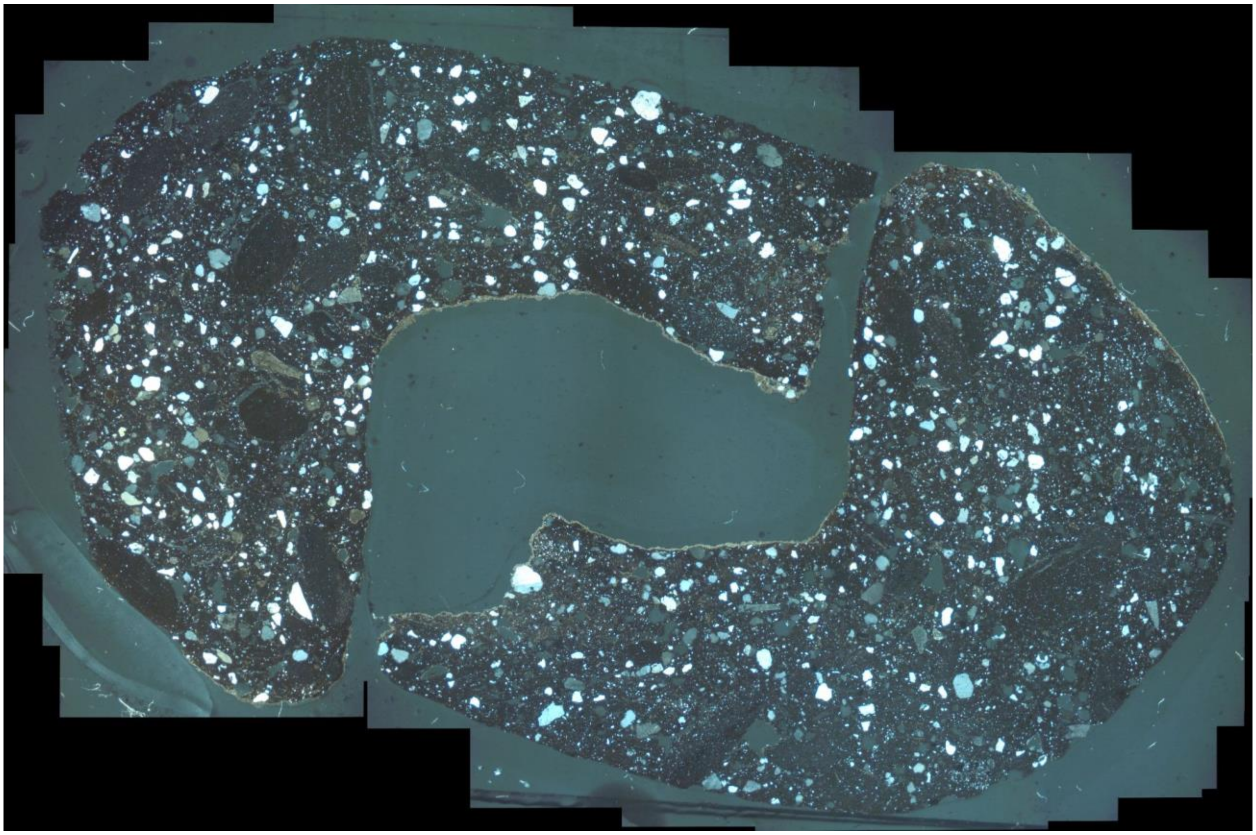

Figure A.24: Thin-section of Sample KAJ20, XPL. This Sample is part of Ware Group 1, Subgroup A.

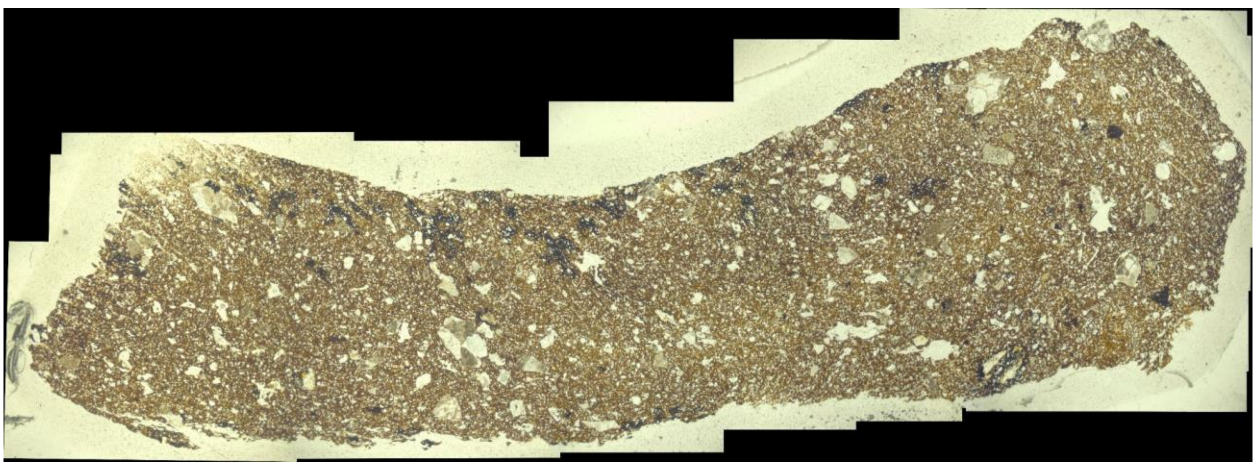

Figure A.25: Thin-section of Sample KAJ21, PPL. This Sample is part of Ware Group 3.

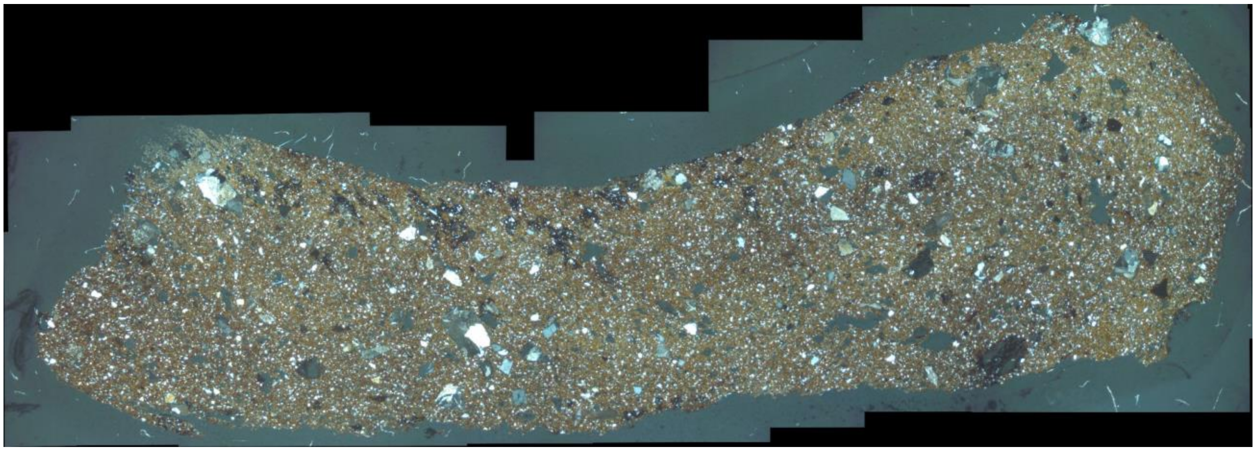

Figure A.26: Thin-section of Sample KAJ21, XPL. This Sample is part of Ware Group 3.

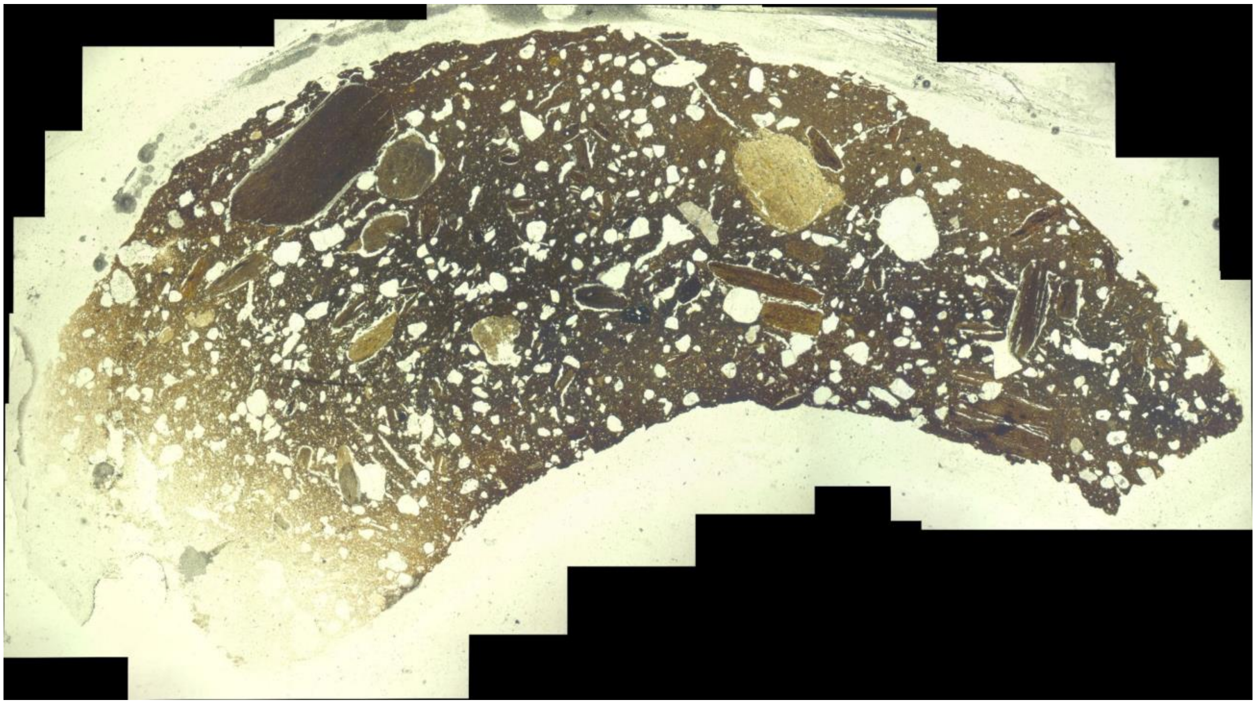

Figure A.27: Thin-section of Sample tKAJ23, PPL. This Sample is part of Ware Group 1, Subgroup A.

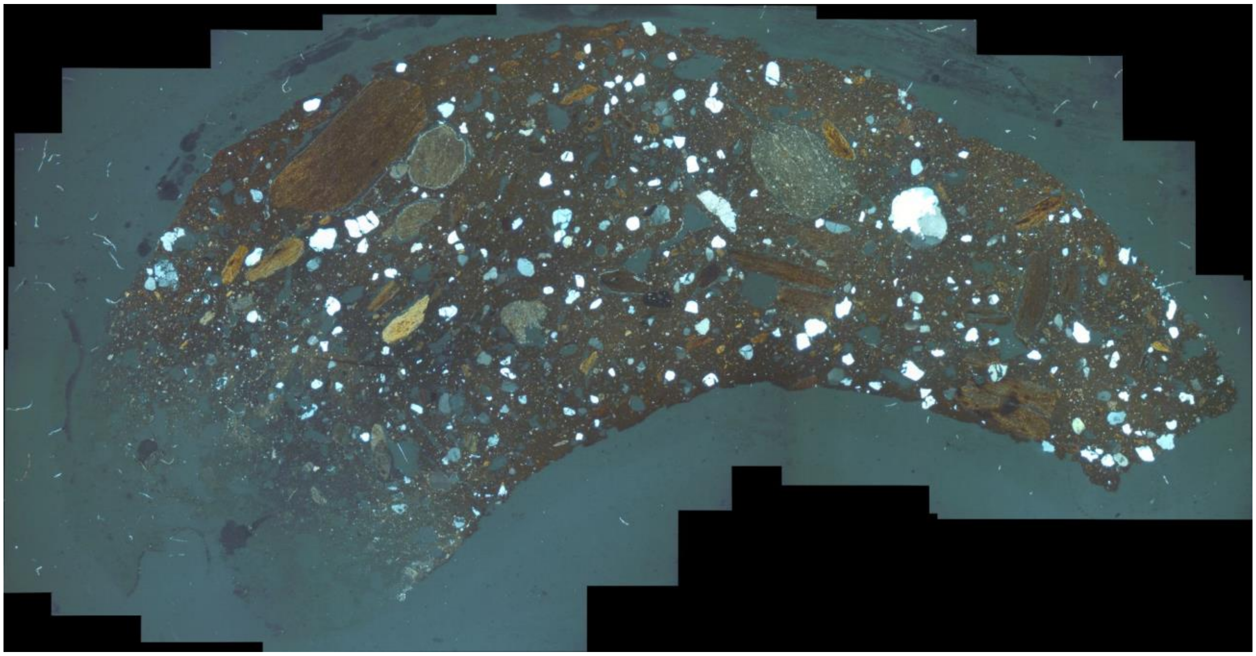

Figure A.28: Thin-section of Sample KAJ23, XPL. This Sample is part of Ware Group 1, Subgroup A.

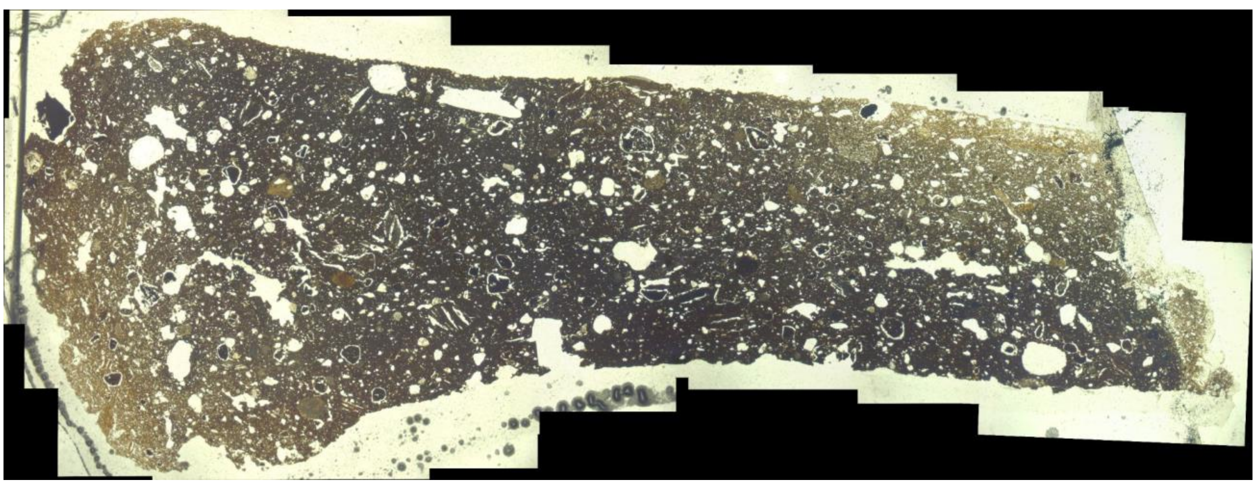

Figure A.29: Thin-section of Sample KAJ24, PPL. This Sample is part of Ware Group 1, Subgroup A.

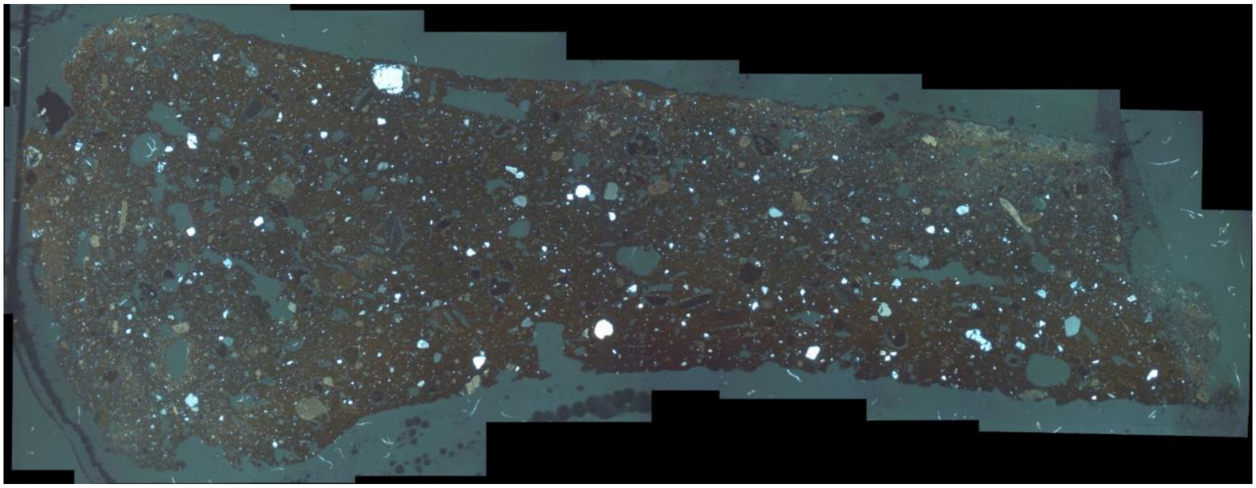

Figure A.30: Thin-section of Sample KAJ24, XPL. This Sample is part of Ware Group 1, Subgroup A.

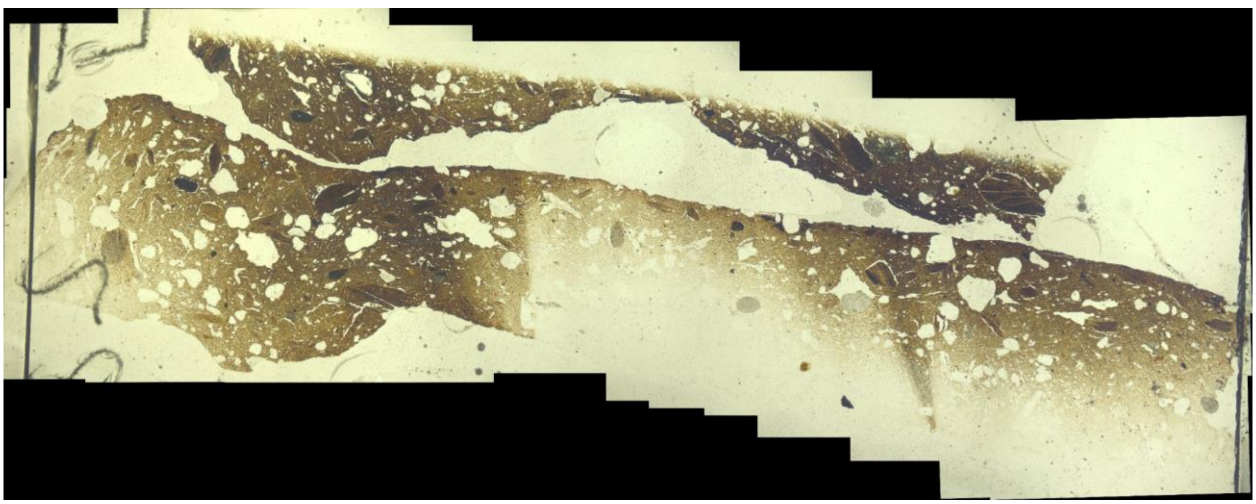

Figure A.31: Thin-section of Sample KAJ28, PPL. This Sample is part of Ware Group 1, Subgroup A.

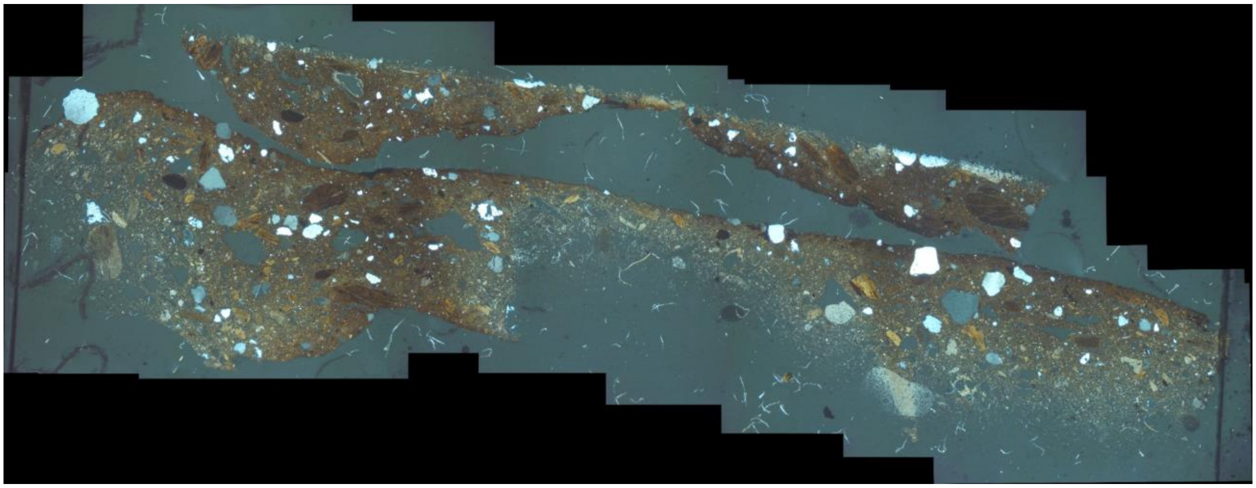

Figure A.32: Thin-section of Sample KAJ28, XPL. This Sample is part of Ware Group 1, Subgroup A.

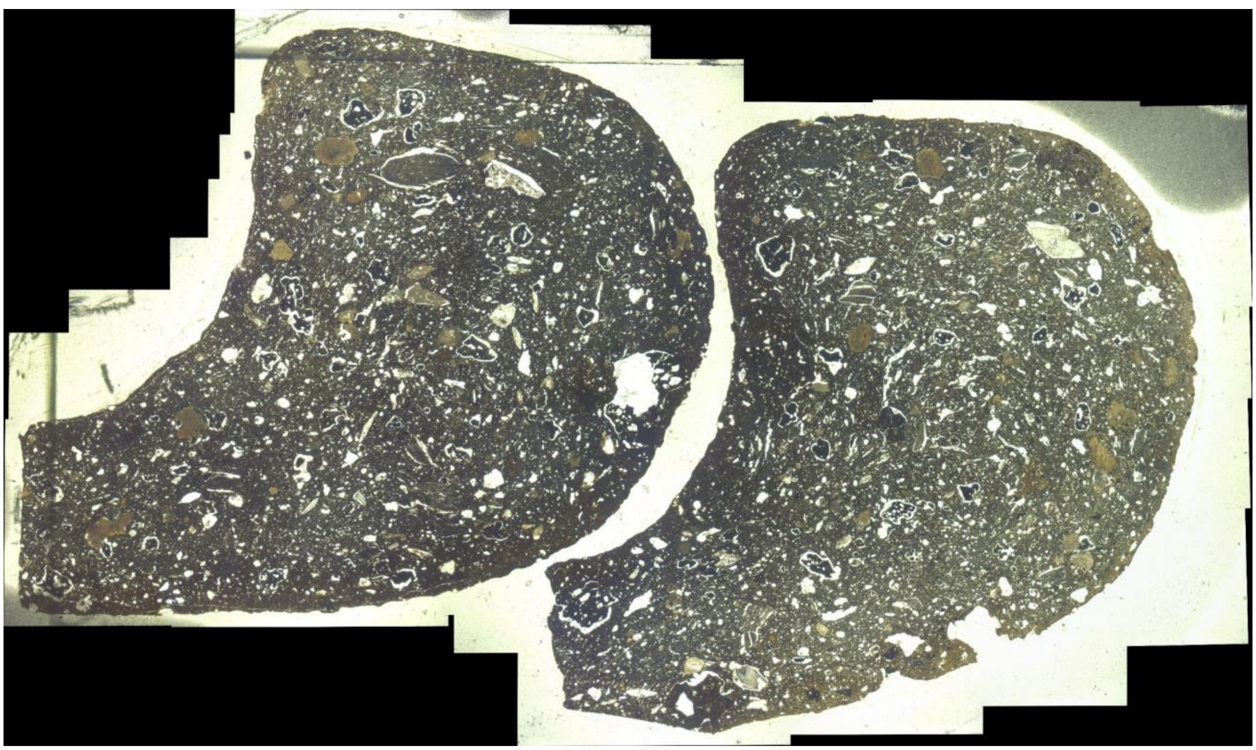

Figure A.33: Thin-section of Sample KAJ30, PPL. This Sample is part of Ware Group 1, Subgroup B.

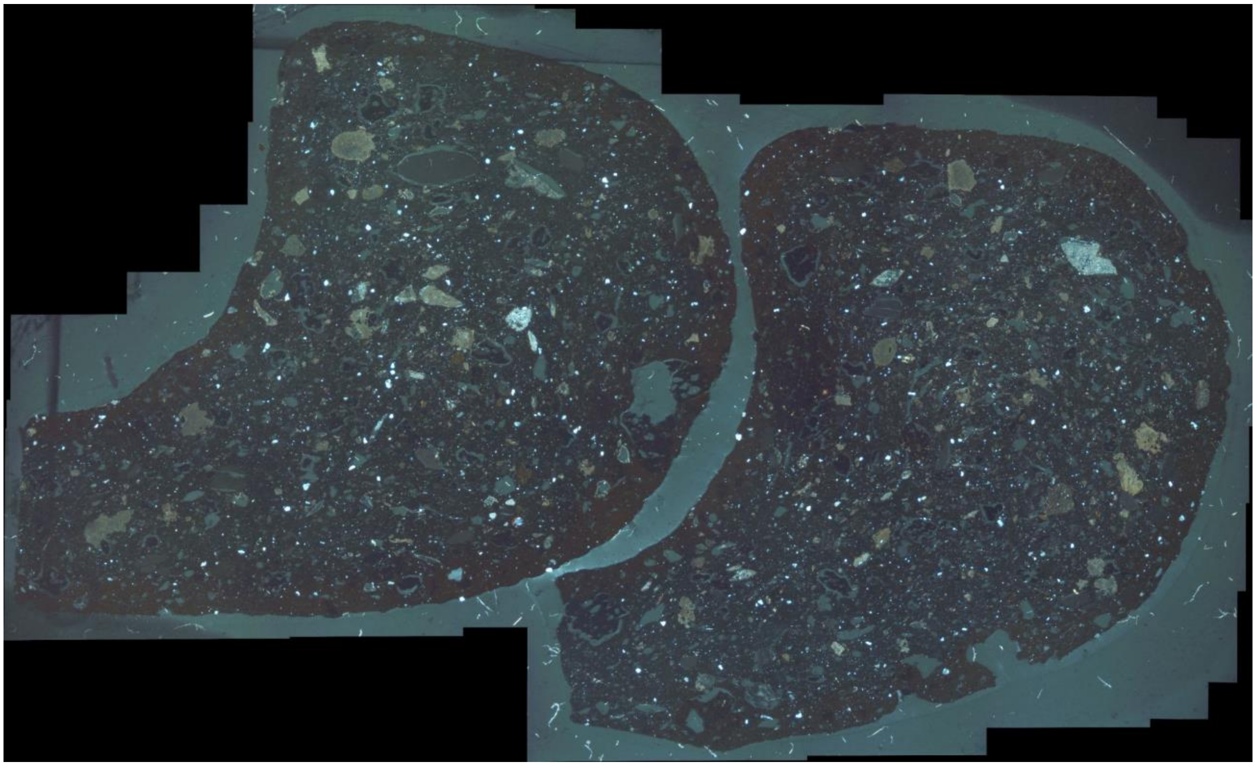

Figure A.34: Thin-section of Sample KAJ30, XPL. This Sample is part of Ware Group 1, Subgroup B.

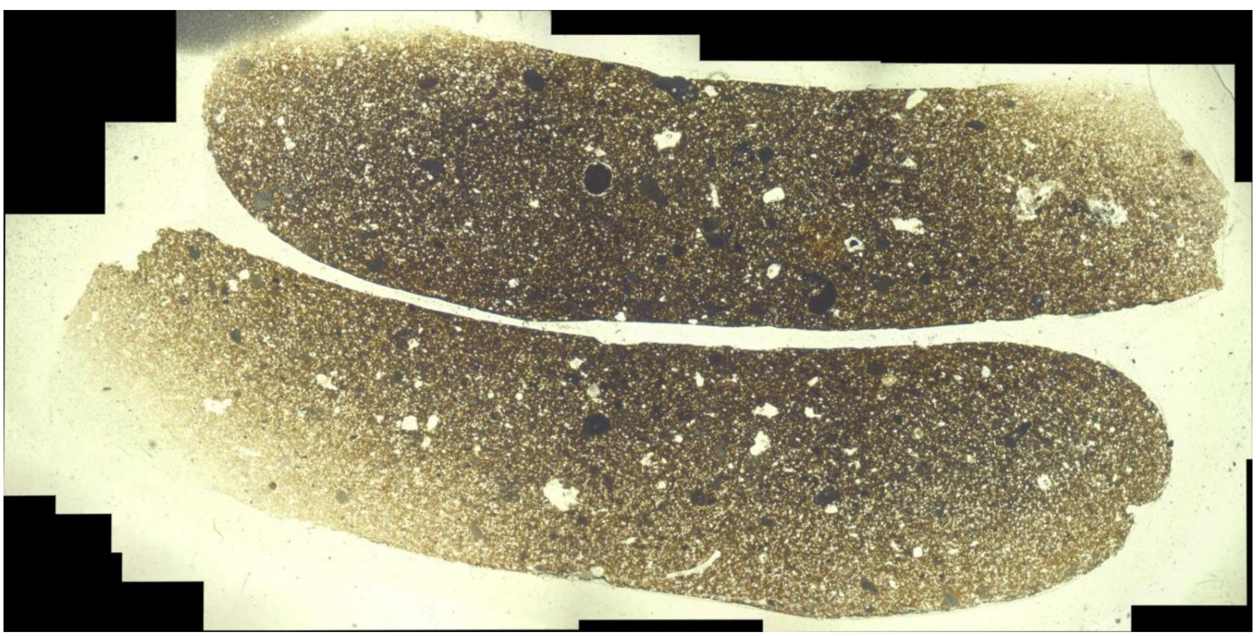

Figure A.35: Thin-section of Sample KAJ34, PPL. This Sample is part of Ware Group 3.

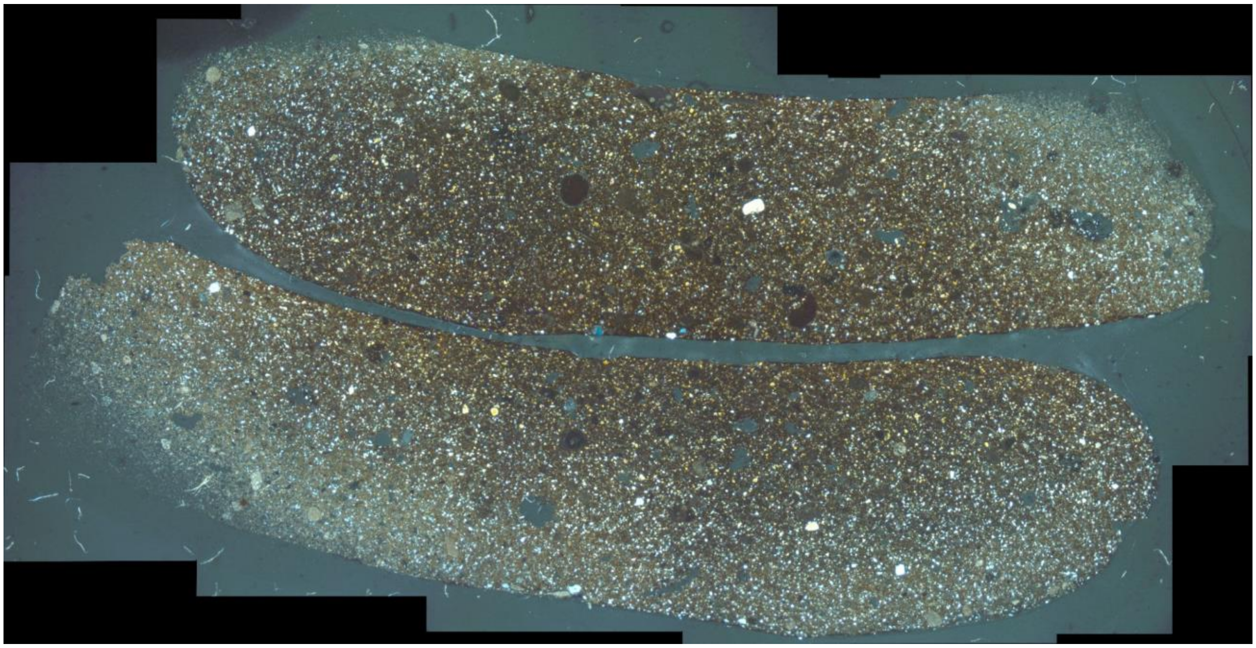

Figure A.36: Thin-section of Sample KAJ34, XPL. This Sample is part of Ware Group 3.

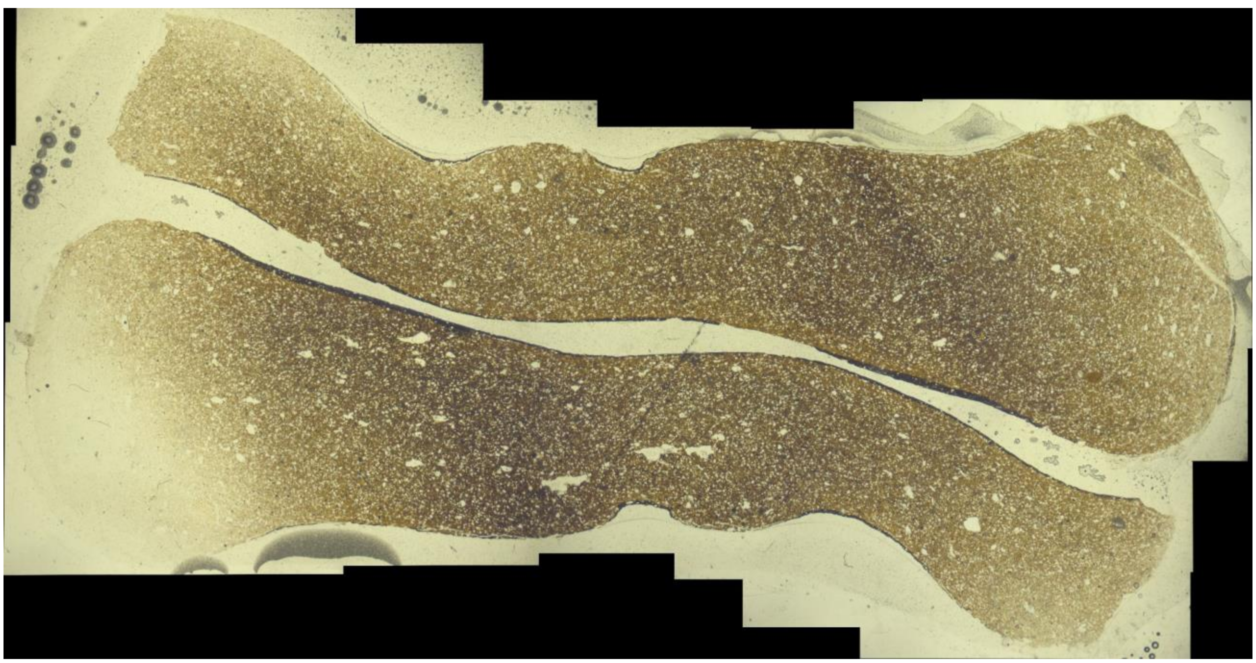

Figure A.37: Thin-section of Sample KAJ35, PPL. This Sample is part of Ware Group 3.

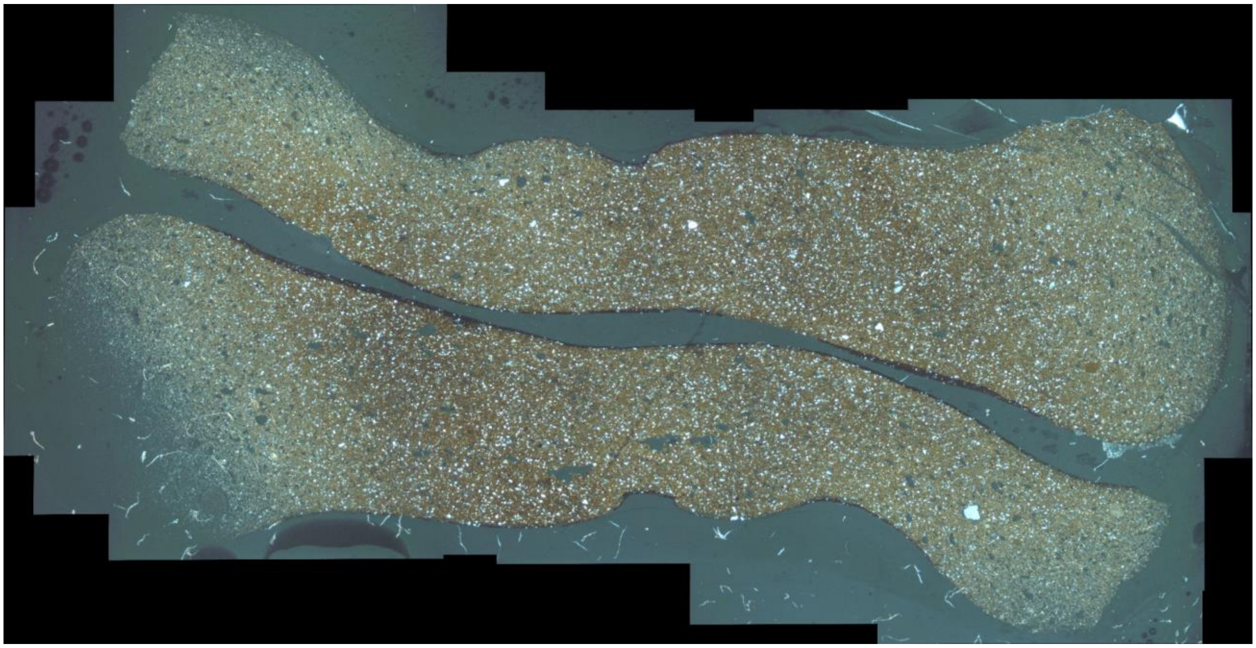

Figure A.38: Thin-section of Sample KAJ35, XPL. This Sample is part of Ware Group 3.

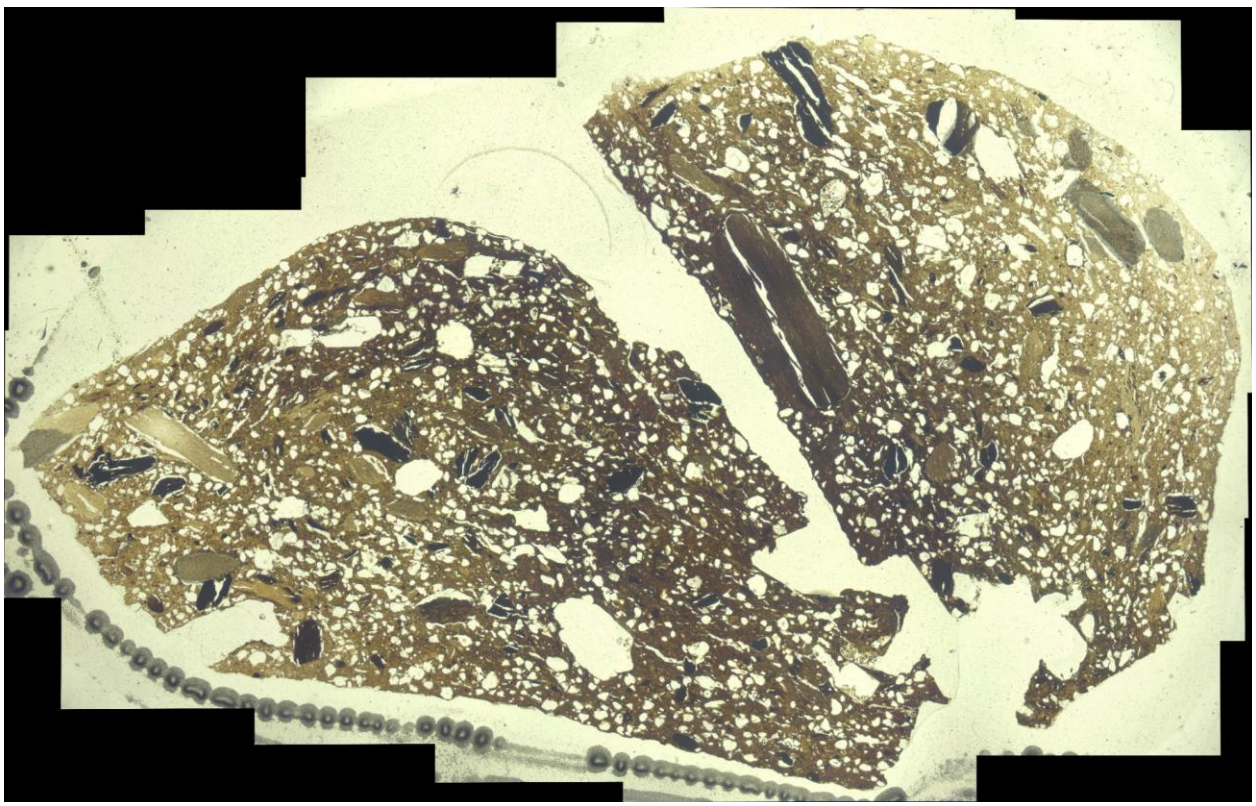

Figure A.39: Thin-section of Sample KAJ37, PPL. This Sample is part of Ware Group 1, Subgroup C.

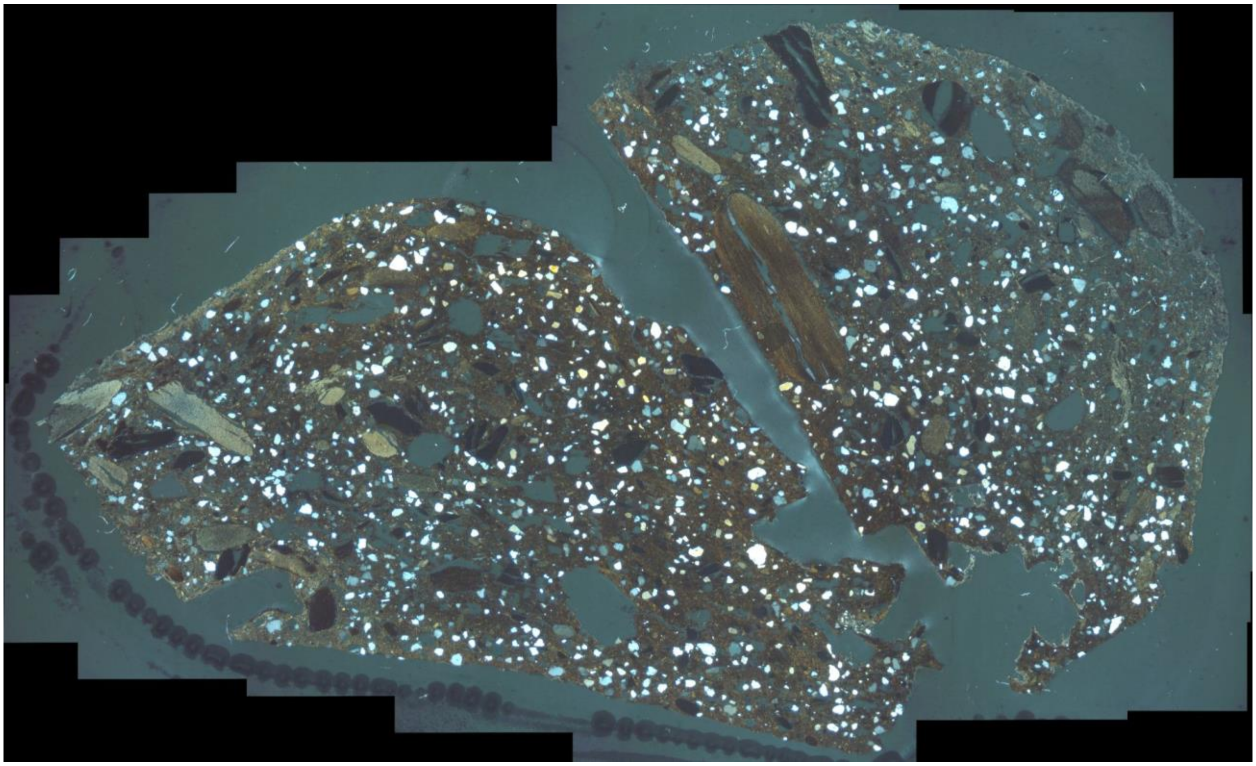

Figure A.40: Thin-section of Sample KAJ37, XPL. This Sample is part of Ware Group 1, Subgroup C.

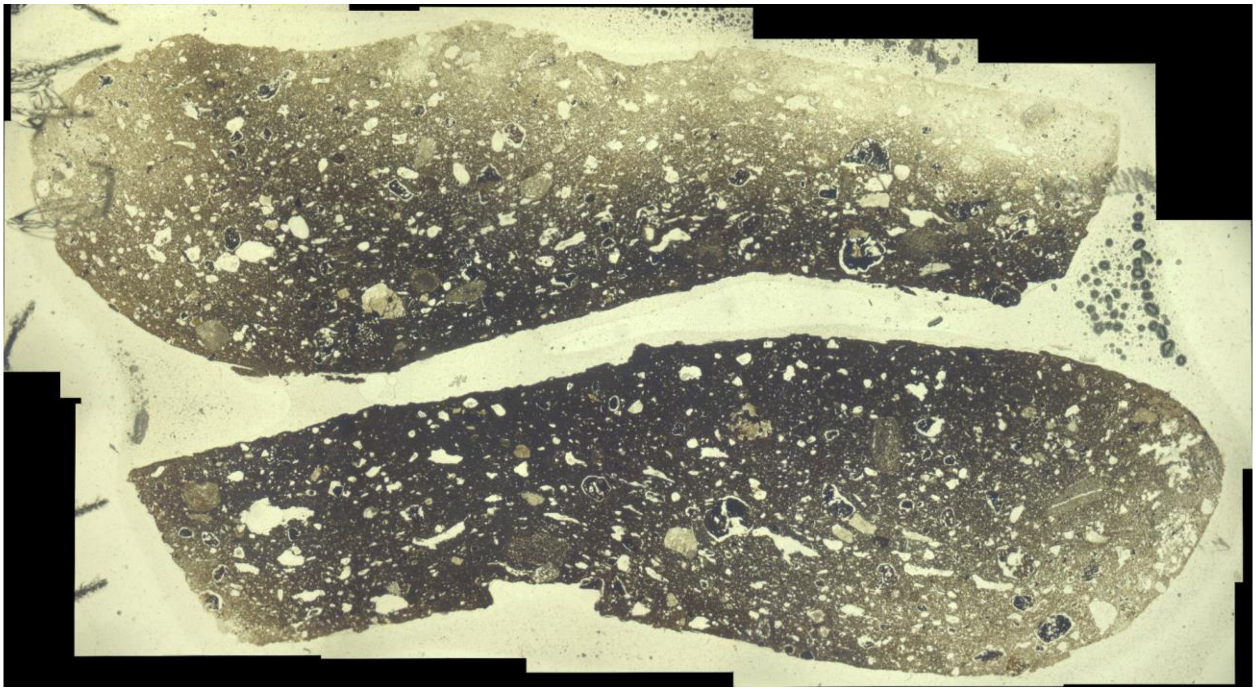

Figure A.41: Thin-section of Sample KAJ41, PPL. This Sample is part of Ware Group 1, Subgroup A.

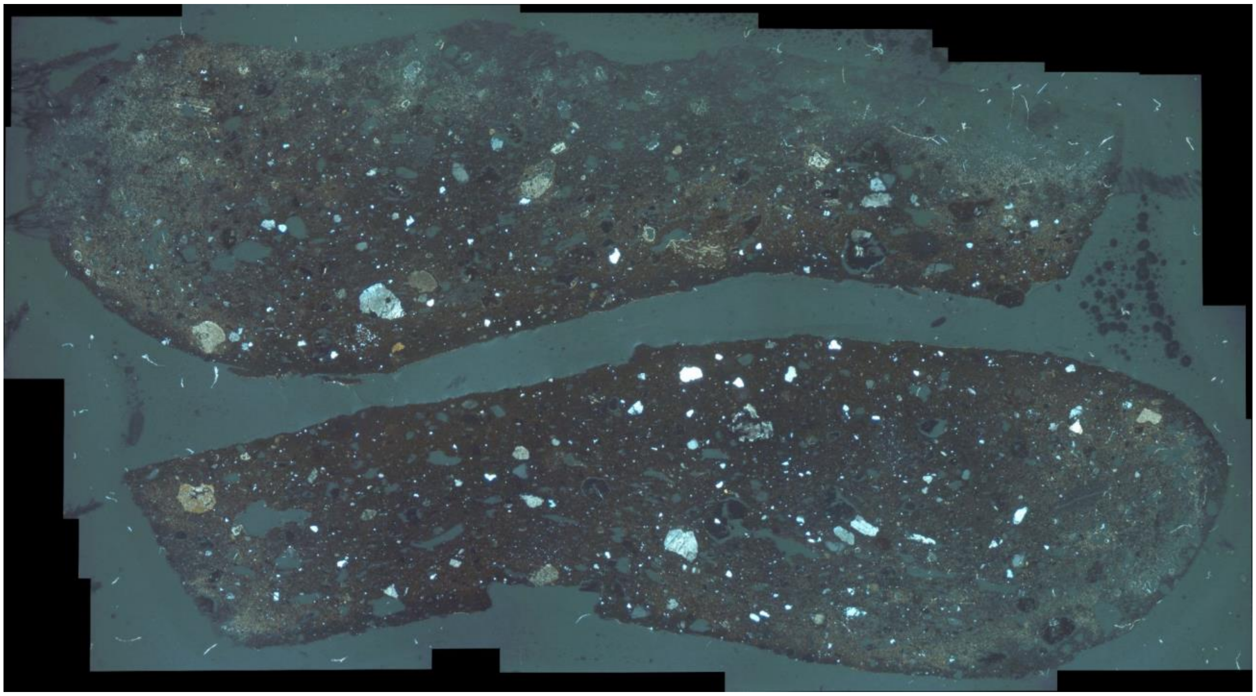

Figure A.42: Thin-section of Sample KAJ41, XPL. This Sample is part of Ware Group 1, Subgroup A.

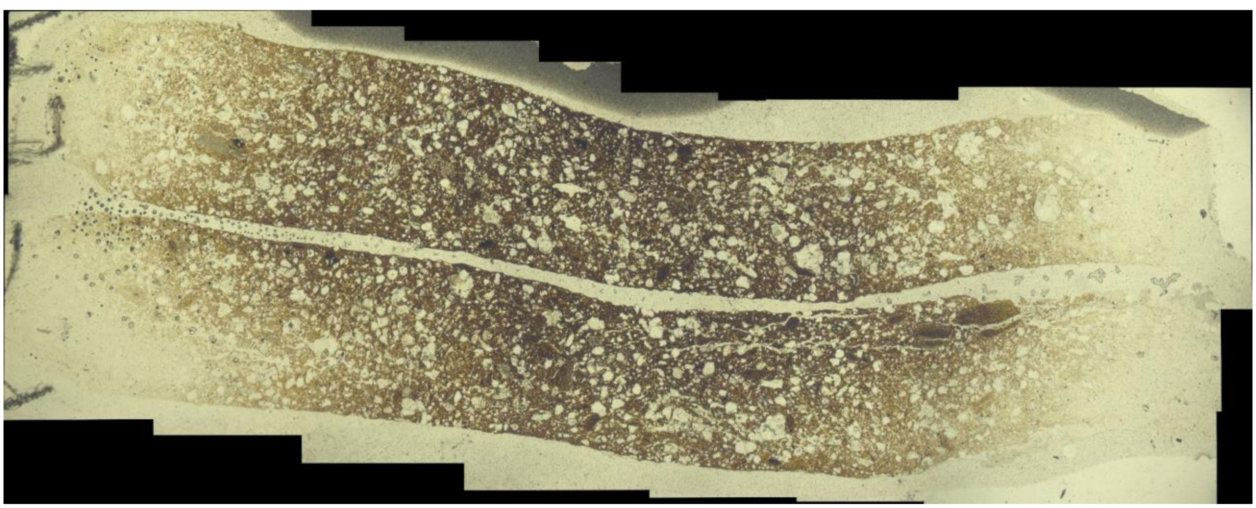

Figure A.43: Thin-section of Sample KAJ49, PPL. This Sample is part of Ware Group 1, Subgroup D.

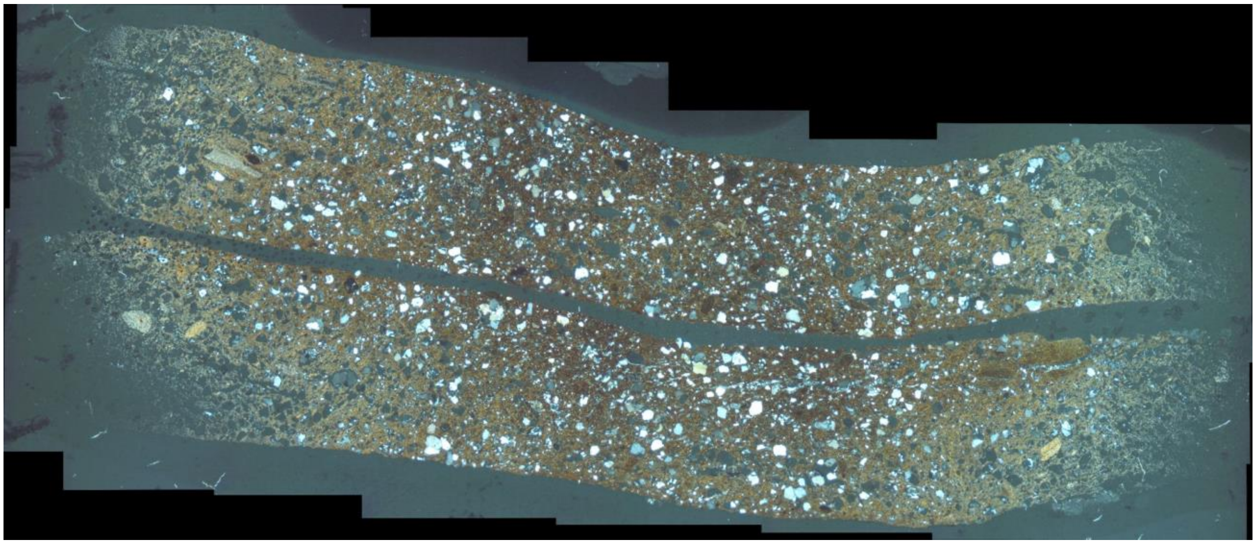

Figure A.44: Thin-section of Sample KAJ49, XPL. This Sample is part of Ware Group 1, Subgroup D.

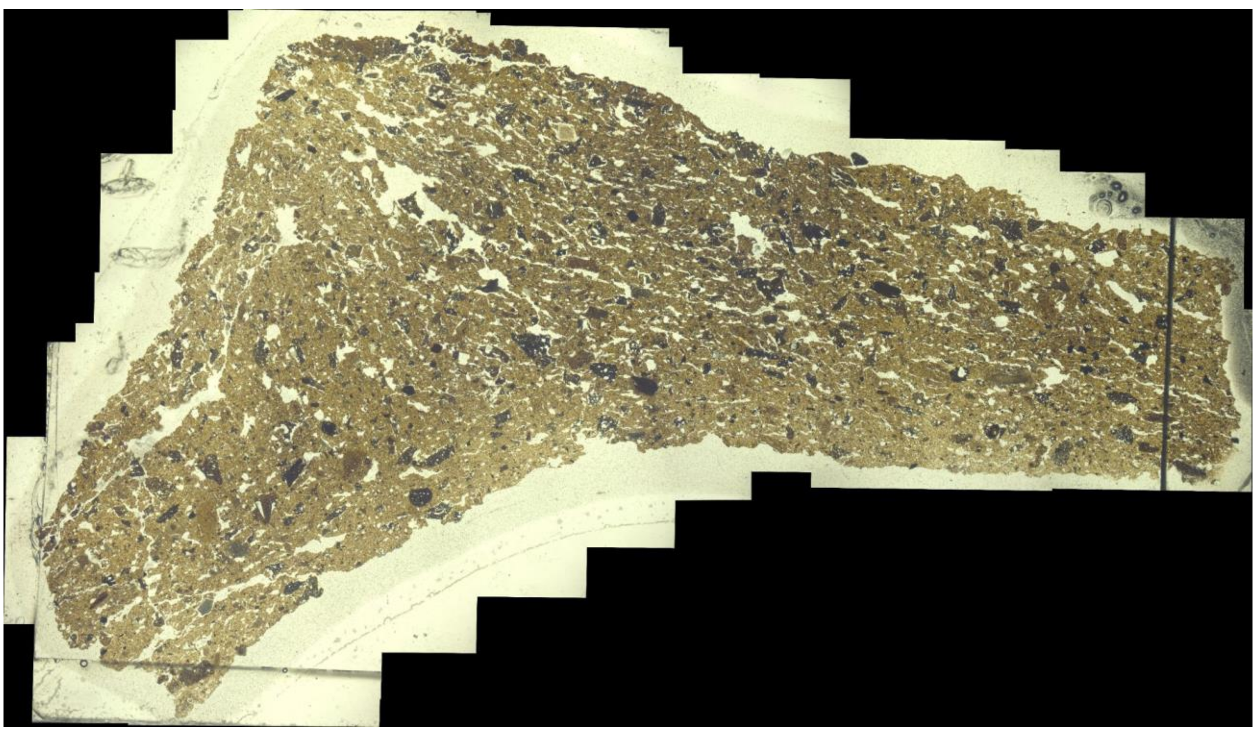

Figure A.45: Thin-section of Sample KAJ53, PPL. This Sample is part of Ware Group 1, Subgroup F.

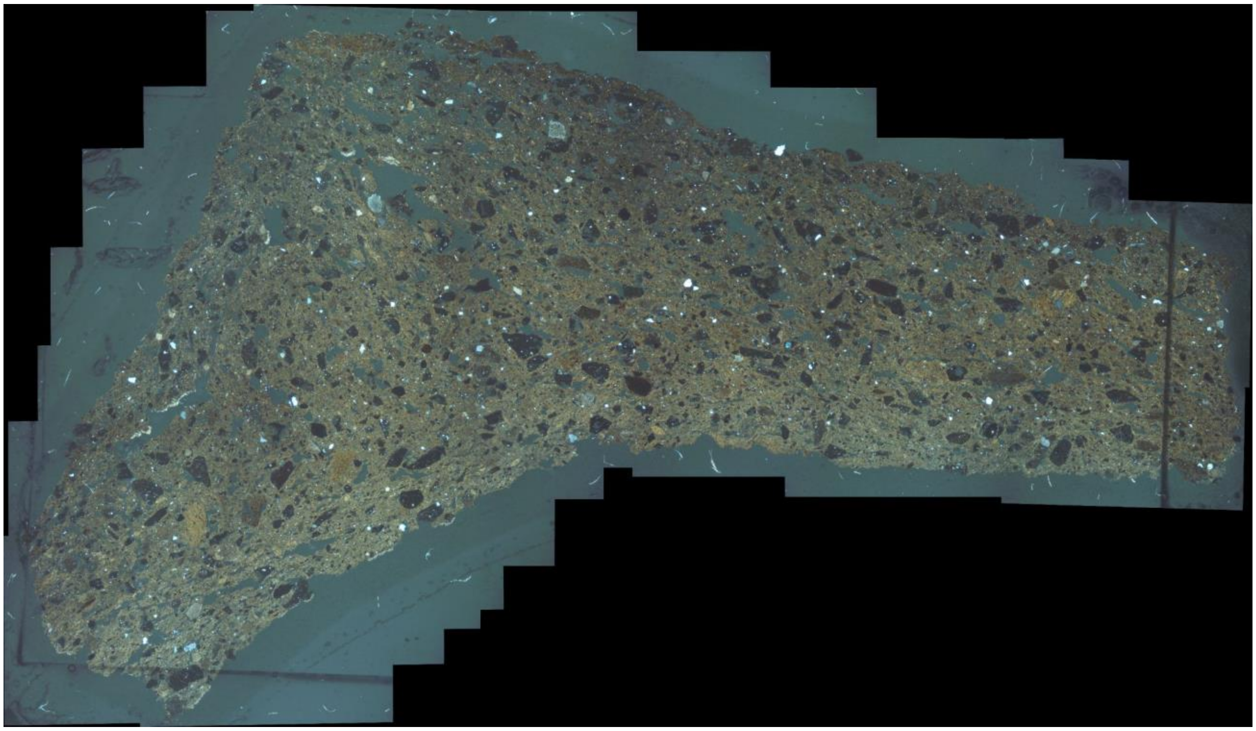

Figure A.46: Thin-section of Sample KAJ53, XPL. This Sample is part of Ware Group 1, Subgroup F.

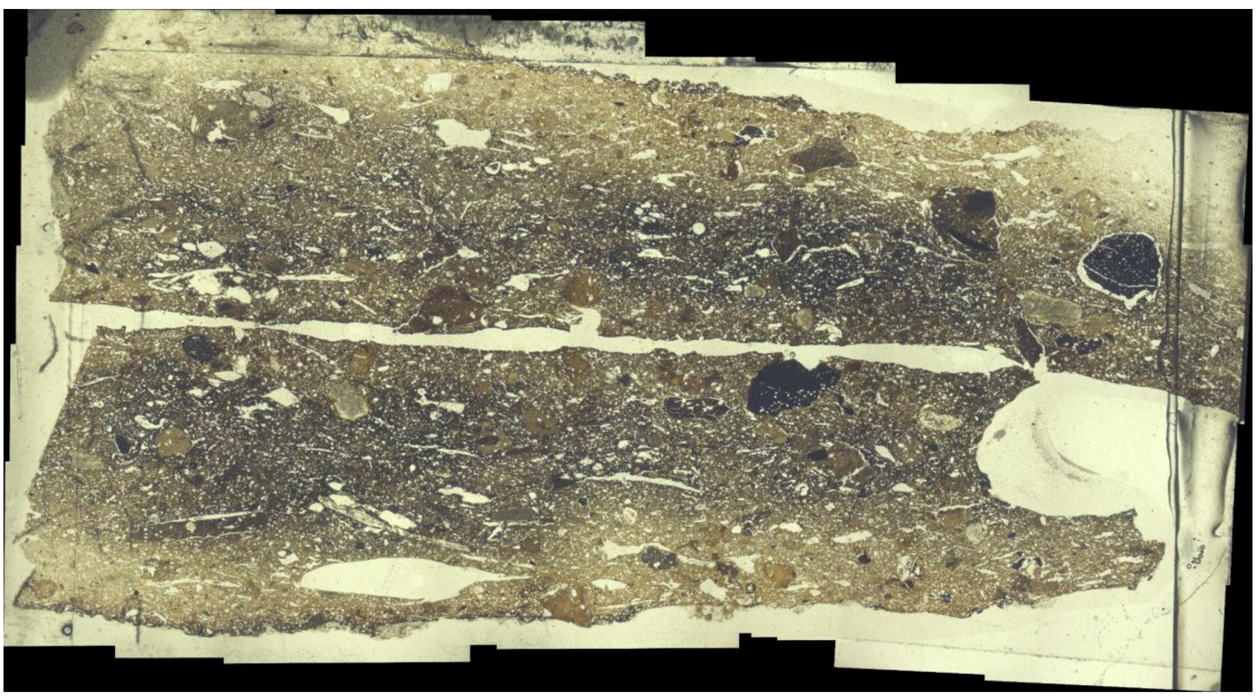

Figure A.47: Thin-section of Sample KAJ62, PPL. This Sample is part of Ware Group 1, Subgroup F.

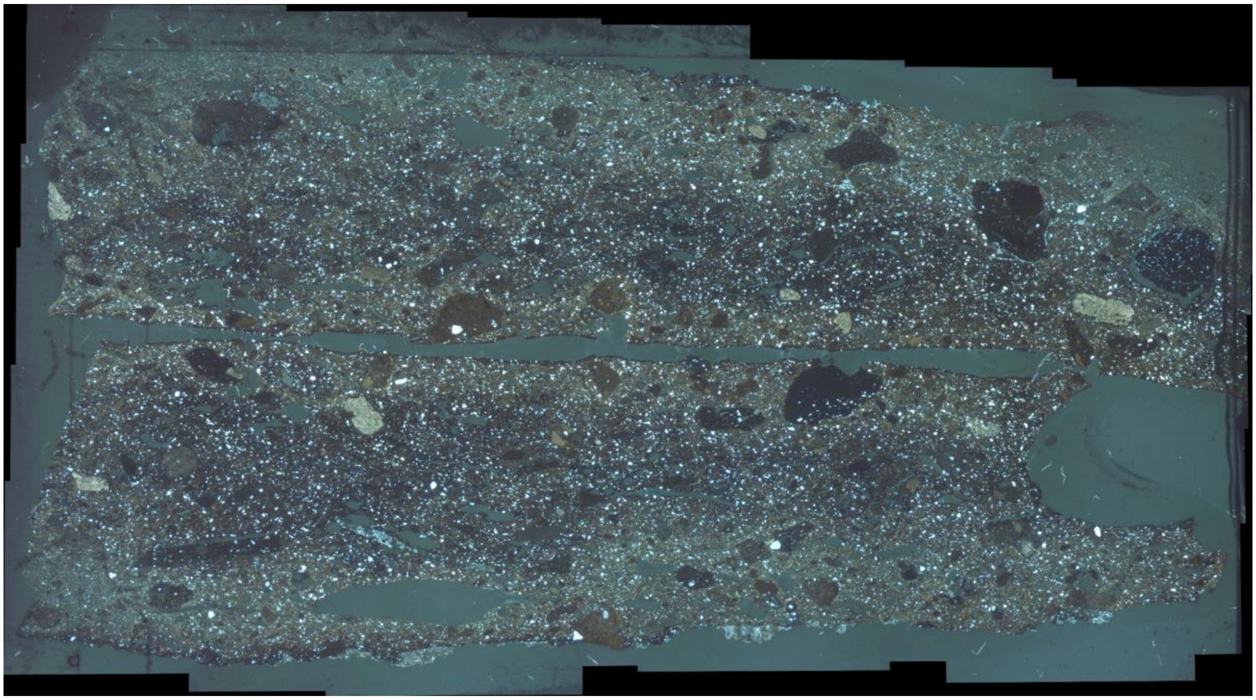

Figure A.48: Thin-section of Sample KAJ62, XPL. This Sample is part of Ware Group 1, Subgroup F.

Appendix B: Petrographic Descriptions

Ware Group 1: Shale-tempered Fabrics

Subgroup A: Shale-Tempered Fabrics with Quartz and Calcareous Sand Inclusions

Table B.1: Samples in Ware Group 1, Subgroup A

Sample	**Area/Stratum**	**Locus**	**Basket**	**Surface Color**	**Surface Treatment (Macroscopic)**	**Surface Treatment (Microscopic)**	**Vessel Form**
KAJ5	B1c	536	10275	10YR 7/3 Very Pale Brown	Possible white slip?	Possible white slip, ca. 30 µm, optically active	Krater 1
KAJ8	C2b	534	10385	10 YR 7/3 very pale brown	White Slip	Not visible	Krater 2
KAJ9	B2a	542	10407	10YR 7/3 very pale brown	White Slip	Possible white slip, ca. 50 µm, optically active	Krater 2
KAJ11	C2a	529	10272	10YR 6/3 pale brown	None	None	Krater 2
KAJ12	B2a	550	10462	7.5 YR 6/6 Reddish Yellow	None	None	Krater
KAJ15	B2b	518	10123	2.5YR 5/8 Red	White Slip	None visible	Krater 4
KAJ19	B2a	542	10357	7.5YR 8/4 Pink	White Slip	White slip, ca. 50 µm, optically	Jar 2

						active	
KAJ20	B2b	543	10526	7.5YR 5/2 Brown	White Slip	White slip, ca. 70 µm, optically active	Jar 3
KAJ23	B1c	537	10335	2.5YR 6/8 Light Red	White Slip	Not visible	Jar
KAJ24	B2b	543	10577	2.5YR 6/8 Light Red	White Slip	Not visible	Krater 1
KAJ28	C2c	535	10419	7.5YR 4/3 Brown	White Slip	Not visible	Jar
KAJ41	B2a	542	10366	5YR 7/2 Pink	White Slip	White slip, ca. 30 µm, optically active	Jug

Microstructure:

Few voids, mainly meso-vugs with and meso- to macro-planar voids also present. Voids are generally double- to open-spaced. There is no apparent preferred orientation to the orientation of voids, shale inclusions have a preferred orientation along the axis of the sherd. Shale inclusions, in many cases, are surrounded by meso-planar voids.

Groundmass:

There is some variation in the color and optical activity of the groundmass. The matrix tends to have slight to moderate activity. The color of the groundmass ranges from yellowish-red to dark reddish-brown in PPL and reddish-brown to dark reddish brown (rarely dark yellowish brown) in XPL. Sample KAJ28 features high optical activity of the matrix and is yellowish-red in PPL and reddish yellow in XPL. Samples KAJ5 and KAJ9 are light olive brown in PPL and olive brown in XPL.

Generally the matrix is somewhat silty, with a quartz silt making up about 5% (Sample KAJ20 is highly silty, with quartz silt making up ca. 10% of the matrix). Iron oxide rhombs are also present throughout the matrix.

Inclusions:

$c:f:v_{200\mu}$ 25:65:10 to 35:55:15

The inclusions are generally poorly-sorted, sometimes poorly sorted. Inclusions are generally <2mm with a mode of 0.5 mm. There appears to be a bimodal grain size distribution. The coarse fraction consists primarily of rounded, elongated red or gray shale inclusions and rounded to sub-rounded calcareous coarse sand. In some cases, rounded quartz coarse sand is also present as part of the coarse fraction. The fine fraction consists primarily of rounded to sub-rounded monocrystalline quartz grains.

Table B.2: Inclusions in Ware Group 1, Subgroup A, categorized by amount

Frequent to Common (15-30%):	*Lithic shale inclusions* - these rounded inclusions are typically argillaceous and sometimes ferruginous. Texturally they range from purely argillaceous to featuring quartz silt.
	Rounded to subrounded quartz grains, mode ca. 300 µm.
	Calcareous Coarse Sand; often large, ca. 1 mm rounded to sub-rounded grains.
Few (5-15%):	*Subrounded plagioclase feldspar;* ranging from ca. 200 µm to 1 mm. These plagioclase grains often show signs of alteration to clay.
	Shell fragments ranging from 300-600 µm on average.
Very Few (2-5%):	*Epidote*, mean size ca. 200 µm.
	Subhedral clinopyroxene; mean size ca. 100 µm though Sample KAJ12 displays a ca. 2 mm grain.
	Chert; in one case a large, ca. 1 mm inclusion.
	Biotite grains ca. 50-100 µm.
Rare (0.5-2%):	*Grog*
	Calcareous microfossils.
	Rutile.
Very Rare (<0.5%):	*Gypsum;* sometimes as infilling in pores. Gypsum is very rare except in Sample KAJ11, in which elongated grains of ca. 300-2000 µm are Frequent.
	Sandstone inclusion, ca. 400 µm.
	Limestone with microfossils; one large (ca. 2 mm) inclusion found in KAJ 23.
	Granite, one ca. 600 µm example in KAJ24.
	Pores evidencing *Organic Temper*, present in KAJ5 and KAJ9.

	Perthite (?), one 600 µm example in KAJ9.
Textural concentration features (i.e. clay pellets) are frequent. These are rounded and often feature iron oxide rhombs and sometimes quartz silt. In some cases (KAJ5, KAJ9, KAJ41), apparent clay pellets have an isotropic appearance (in PPL and XPL) with circular vesicles. These bear further investigation.	

Comment

This is a semi-coarse fabric, with the exception of Sample KAJ28, which is coarse. The characteristic inclusion is shale, each fabric contains at least Common shale inclusions. Shales range from reddish to dark gray, and some are ferruginous while others are not. These shales are almost always argillaceous, in some cases they feature quartz silt. In some samples, there are Few rounded sand-size grains of quartz and calcareous sand, in other samples these are Frequent (e.g. KAJ23). These sand grains (and shell inclusions) may have been used as intentional temper, given a generally bimodal grain size distribution. Halos of calcite in pores suggest firing above 750 degrees C in most cases or secondary calcite infilling (cf. Al-Shorman 2009; Fabbri et al. 2014). One exception is KAJ28 which was likely fired at low temperatures given high optical activity of the matrix. Sample KAJ 15 features many small (ca. 40 µm) calcite rhombs, some of which are stained with iron oxide (Figure 11.2; cf. Al-Shorman 2009: 203).

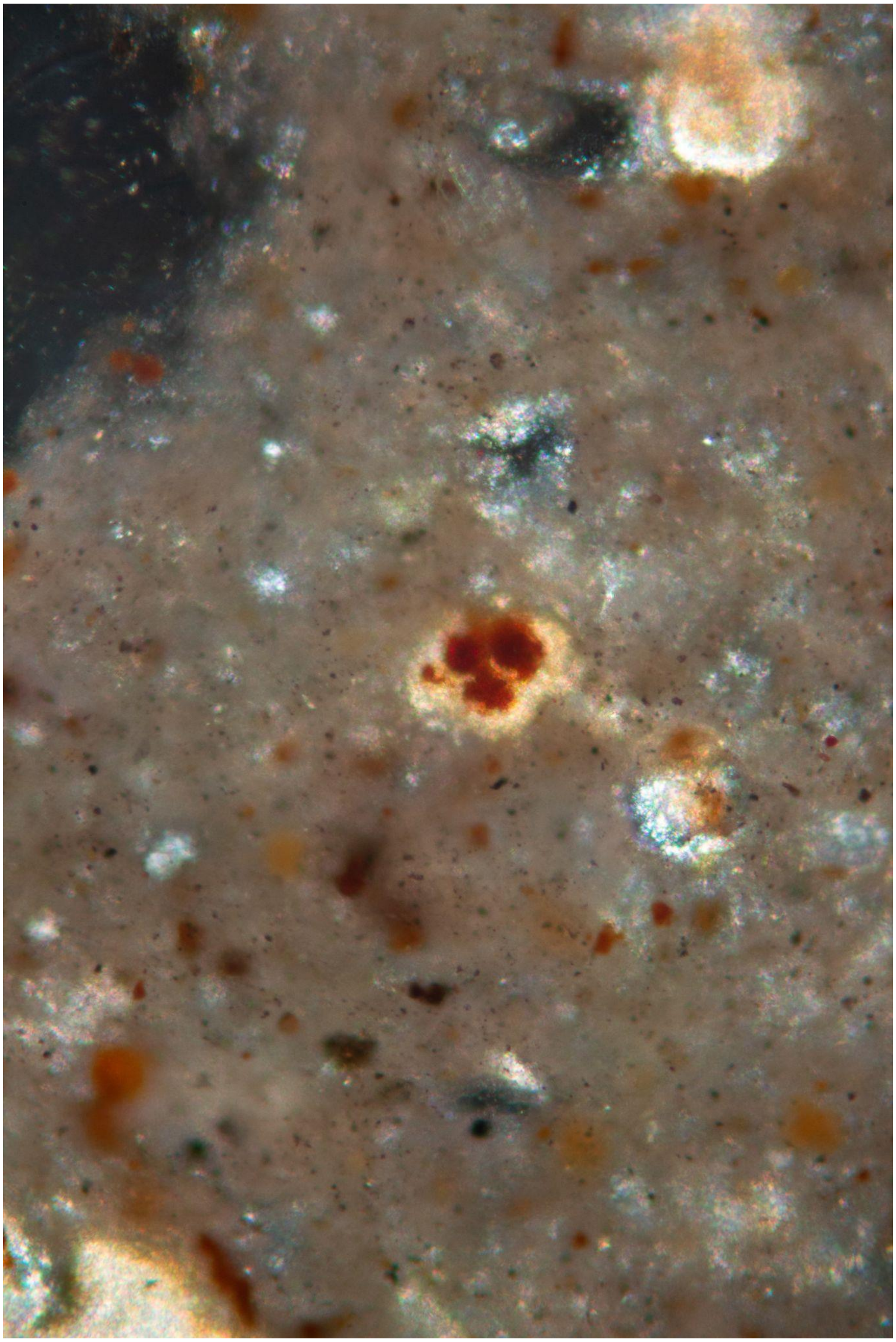

Figure B.1: Iron Oxide-stained calcite rhomb present in Sample KAJ15 (XPL, 400x magnification).

Subgroup B: Shale-tempered Fabric with Slag, Quartz, and Calcareous Sand Inclusions

Table B.3: Samples in Ware Group 1, Subgroup B

Sample	Area/Stratum	Locus	Basket	Surface Color	Surface Treatment (Macroscopic)	Surface Treatment (Microscopic)	Vessel Form
KAJ30	B2b	565	10688	5YR 6/6 Reddish Yellow	None	None	Jar

Comment

This semi-coarse fabrics is similar to those of Subgroup A. This sample is olive brown in PPL and is slightly optically active and very dark grayish brown in XPL. The factor that differentiates this fabric from Subgroup A is that this fabric contains inclusions of copper slag. The slag inclusions are ca. 800 µm on average and typically subrounded, though they appear to be fragments of larger pieces in man cases. Most of the slag inclusions feature round or circular vesicles (cf. Martin et al. 2013: 3783). This fabric also contains ca. 10% (of inclusions) gypsum, both as grains and as secondary infilling of pores.

Subgroup C: Shale-tempered Cooking Pot Fabric

Table B.4: Sample in Ware Group 1, Subgroup C

Sample	**Area/Stratum**	**Locus**	**Basket**	**Surface Color**	**Surface Treatment (Macroscopic)**	**Surface Treatment (Microscopic)**	**Vessel Form**
KAJ37	B2a	542	10405	2.5YR 6/6 Light Red	None	None	Cooking Jug 1

Comment

This lone cooking pot is a coarse fabric within the range of variation of shale-tempered Ware Group 1. This fabric is differentiated by the exclusive presence of medium quartz sand, and shales. KAJ37 samples contains Frequent to Dominant subrounded to subangular medium quartz sand (mean size ca. 250 µm). Macroscopically, this fabrics have grayer cores, 5YR 7/1 Light Gray for Sample KAJ37, suggesting this vessel was fired in reducing conditions. Sample KAJ37 does not show any evidence of calcareous temper. High optical activity of the matrix suggests lower firing temperature. This sample features a highly ferruginous matrix and very poorly sorted Frequent ferruginous, argillaceous shale inclusions, ranging in size from ca. 400 µm to 4mm. The consistent size of quartz grains within this fabric suggests that these were added as intentional temper; however, it is unclear whether the large shale inclusions represent intentional temper given a lack of bimodal grain size distribution.

Subgroup D: Shale-rich Fabrics with Sandstone Inclusions

Table B.5: Samples in Ware Group 1, Subgroup D

Sample	**Area/Stratum**	**Locus**	**Basket**	**Surface Color**	**Surface Treatment (Macroscopic)**	**Surface Treatment (Microscopic)**	**Vessel Form**
KAJ16	B2a/b	548	10582	2.5YR 6/8 Light Red	White Slip	None	Krater
KAJ49	B2a	550	10462	5YR 6/6 Reddish Yellow to 5YR 2.5/1 Black (ashy/ burned part)	None	None	Holemouth Jar

Comment

These are semi-fine to semi-coarse fabrics. These fabrics both feature shale inclusions. Sample KAJ49 features Few shale inclusions, which are argillaceous. These fabrics are differentiated into Subgroup D on the basis of their siltstone/sandstone inclusions, which are relatively common in these two samples. Sample KAJ16 is a semi-coarse fabric. This sample features a silty (ca. 10% of inclusions are quartz silt) red (in PPL and XPL), optically active fabric with Frequent red shales, around half of which are clearly ferruginous. Sample KAJ16 is relatively unique in the overall assemblage in that the shale inclusions are not purely argillaceous—nearly all of the shale inclusions in this sample feature quartz silt. This sample features Common subangular quartz fine-medium sand, Few rounded lithic quartz arenite inclusions (ca. 800 μm), Few subangular chert inclusions (mean size ca. 250 μm, max size ca. 2 mm), Few calcareous medium sand inclusions, Very Few polycrystalline undulatory quartz grains (ca. 250 μm), Very Few subangular plagioclase feldspar grains (mean size ca. 200 μm) and one large (ca. 2mm) granite inclusion). Sample KAJ49 is a semi-fine fabric, yellowish-red in PPL and XPL and optically active. The fabric is silty, featuring ca. 15% quartz silt along with Common subrounded quartz fine-medium sand. The fabric also features Few argillaceous shales. The characteristic inclusion in this sample is the presence of Frequent fine-medium textured quartzarenite sandstone, which sometimes also features muscovite. Very Few calcareous inclusions also are present. There is ca. 10% Gypsum present as both inclusions and secondary infilling in some cases. Very Few chert inclusions are present as well (ca. 350 μm). In general, these fabrics are defined by the presence of both shale and at least Common lithic sandstone inclusions.

Subgroup E: Shale-Tempered Calcareous Fabric with Ooids

Table B.6: Samples in Ware Group 1, Subgroup E

Sample	Area/Stratum	Locus	Basket	Surface Color	Surface Treatment (Macroscopic)	Surface Treatment (Microscopic)	Vessel Form
KAJ13	B2a	556	10613	5YR 7/4 Pink	None	None	Krater

Comment

This fabric is calcareous, unlike the other fabrics in Ware Group 1. The characteristic inclusions of this subgroup are calcareous ooids (mean size ca. 90 μm) in the fine fraction of the matrix. Also present in the matrix are iron oxide rhombs. Of the coarse non-plastic inclusions, medium quartz sand grains (mean size ca. 250 μm) are Dominant. Few rounded, elongated shale inclusions (mean size ca. 800 μm) are present. These are often ferruginous. Very few coarser (ca. 300-400 μm) calcareous inclusions, including shell fragments and crystallized calcite are also present. Gypsum infilling of pores is common near the edges of the section. This sample is characterized as a shale-tempered fabric based on the presence of shale inclusions. However, the calcareous matrix bears similarity to Ware Group 3, discussed below. The optical activity of the matrix suggests low firing, and perhaps differences in the sample relate to firing conditions rather than clay type. However, further analysis of this sherd is needed to understand its relationship to Ware Groups 1 and 3.

Subgroup F: Coarse Shale-rich Fabric with Grog Temper

Table B.7: Samples in Ware Group 1, Subgroup F

Sample	**Area/Stratum**	**Locus**	**Basket**	**Surface Color**	**Surface Treatment (Macroscopic)**	**Surface Treatment (Microscopic)**	**Vessel Form**
KAJ53	B1c	537	10335	7.5YR 6/4 Light Brown	None	None	Base
KAJ62	C2a	529	10272	7.5YR 4/1 Dark Gray	None	None	Base

Comment

These coarse fabrics represent "Handmade Arabah Ware." The characteristic inclusion of this subgroup is grog, which is Dominant in both samples. The grog inclusions in Sample KAJ53 feature calcareous rhombs, iron oxides, and quartz silt, while the grog in Sample KAJ62 have similar inclusions but also occasionally feature shale. Few shale inclusions are present in each sample, almost always argillaceous and typically ferruginous. Sample KAJ62 is micaceous, featuring Very Few ca. 50 µm mica grains in the matrix. The matrix is also highly silty, with ca. 10% angular quartz silt (with Very few grains of K-feldspar silt as well), and is inconsistently fired as illustrated by a black core and optically active edges of the section. Sample KAJ53 is optically active throughout and displays a calcareous and ferruginous matrix, with Few subangular quartz grains (mean size ca. 300 µm) and Rare K-feldspar. Calcareous inclusions, sometimes calcite grains, are present in KAJ 53, as is one grain of epidote. Notably, slag inclusions are not present in either sample. These fabrics are easily identifiable in hand sample and thin section by their coarse texture and grog inclusions. Their non-plastic inclusions are within the general range of Ware Group 1, with the exception of the mica inclusions in Sample KAJ 62, which are relatively uncommon for the group.

Ware Group 2: Siliceous Fabrics with Quartz Inclusions

Table B.8: Samples in Ware Group 2

Sample	**Area/Stratum**	**Locus**	**Basket**	**Surface Color**	**Surface Treatment (Macroscopic)**	**Surface Treatment (Microscopic)**	**Vessel Form**
KAJ14	B2b	575	10827	2.5Y 8/4 Pale Brown	None	None	Krater 1
KAJ17	B2b	543	10654	2.5Y 6/3 Light Yellowish Brown	None	None	Bowl 3

Microstructure:

In Sample KAJ14, voids are Common. There are Few Meso-vugs, Very Few macro-vugs, and Very Few meso-planar voids. Voids are single- to double-spaced. The planar voids are oriented along the sherd and folded over with the rim. Sample KAJ17 has Very Few voids, which are mostly meso to micro vugs. These are double- to open-spaced with no preferred orientation.

Groundmass:

The groundmass of this Ware Group ranges from Very dark brown to light olive brown in PPL and is light olive brown in XPL. The matrix of Sample KAJ14 is optically inactive, while the matrix of Sample KAJ17 is slightly optically active. In both samples, the groundmass features a silty fraction consisting of angular to sub-angular quartz silt and occasional calcite rhombs stained with iron oxide.

Sample KAJ14 features ferruginous zones, possibly as the result of the firing of ferruginous limestone (cf. Smith et al. 2014: 151) or the inclusion of ferruginous clay pellets.

Inclusions:

c:f:$v_{200\mu}$ 25:55:20 (KAJ14) to 15:81:4 (KAJ17)

This fabric has two textures, a semi-coarse texture represented by Sample KAJ14 and a fine texture represented by Sample KAJ17. In Sample KAJ14, the inclusions are poorly-sorted. Overall, the inclusion sizes are bimodal, with many ferruginous clay pellets ca. 1mm and quartz inclusions ca. 400-500 µm. The inclusions in Sample KAJ17 are moderately sorted, with a mean size of ca. 200 µm and a maximum size of ca. 600 µm.

Table B.9: Inclusions in Ware Group 2, categorized by amount

Predominant (>70%) to Dominant (50-70%):	*Quartz* medium sand, usually rounded to subrounded. These quartz sand inclusions are present at about equal rates in both Samples but represent nearly all of the inclusions in KAJ17 given a lack of other inclusions.
Common (15-30%):	Highly fired *ferruginous textural concentration features*, rounded and averaging ca. 700-1000 µm in size, only appearing in Sample KAJ14. These appear to be clay pellets though may represent highly-fired ferruginous limestone. These inclusions are typically surrounded by a reddish ring under XPL.
Few (5-15%):	*Calcareous Sand*, as rounded ca. 1 mm inclusions, possibly secondary calcite infilling.
	Angular to subangular *quartz silt.*
Textural concentration features are common in Sample KAJ14, as discussed above.	

Comment

This fabric has one example of fine-ware (Sample KAJ17) and one example of semi-coarse ware (Sample KAJ14). The characteristic coarse inclusion of this ware group is a dominant to predominant rounded quartz sand with angular to subangular quartz silt present in the fine fraction. The matrix displays evidence of iron oxides, which are seen in seen both in the matrix and in ferruginous textural concentration features in Sample KAJ14. The lack of other unstable minerals as inclusions suggests a mature geologic origin.

Ware Group 3: Highly Silty Calcareous Fabrics

Table B.10: Samples in Ware Group 3

Sample	**Area/Stratum**	**Locus**	**Basket**	**Surface Color**	**Surface Treatment (Macroscopic)**	**Surface Treatment (Microscopic)**	**Vessel Form**
KAJ21	C2c	535	10419	7.5YR 5/2 Brown to 7.5YR 3/1 Very Dark Gray	None	None	Jar
KAJ34	B2b	561	10665	2.5YR 4/8 Red	Red slip and burnish	Red Slip, ca. 80 µm. Moderately optically active	Bowl 1
KAJ35	B2b	561	10704	2.5YR 4/6 Red	Red slip and burnish	Red Slip, ca. 80 µm. Moderately optically active	Bowl 2

Microstructure:

These fabrics have few to very few voids. All samples have Very Few micro-vugs, Samples KAJ34 and KAJ35 have Very Few meso-vugs as well while Sample KAJ21 has Few meso-vugs. The voids in samples of this group are double- to open-spaced with no preferred orientation.

Groundmass:

Samples in this ware group feature a highly-optically active calcareous matrix. The color of the groundmass is generally yellowish red in PPL and XPL. The matrix is highly silty—ca. 15% of the matrix is composed of well-sorted silt, which is primarily angular to subangular quartz. Other silty inclusions are feldspar, augite, and hornblende. In Sample KAJ21, groundmass is isotropic in PPL and XPL in some sections.

Inclusions:

$c{:}f{:}v_{200\mu}$ 10:80:10 to 3:93:4

Samples KAJ34 and KAJ35 are fine-wares, while KAJ21 is medium-fine ware. The inclusions in KAJ 35 are very well-sorted, in KAJ34 well sorted, and in KAJ21 moderately sorted. Each of the fabrics is highly silty, as discussed above. Coarse mineral inclusions in the two finewares are predominantly rounded quartz grains, maximum size ca. 300 µm. Sample KAJ34 displays a higher diversity of inclusions, with shell, calcareous sand (potentially *nari*, a local and chert all present. Sample KAJ21 features coarser inclusions of quartz, weathered feldspars, and granite of up to 2mm.

Table B.11: Inclusions in Ware Group 3, categorized by amount

Predominant (>70%) to Frequent (30-50%):	*Calcareous sand*, possibly *nari* (mean size ca. 400 µm) and shell (ca. 200-600 µm). These calcareous inclusions are primarily present in Sample KAJ34, where they are Predominant. Very Few calcareous inclusions, possibly shell, in KAJ35.
	Rounded *Quartz* fine sand, Predominant in Sample KAJ35 where coarse fraction is almost entirely quartz, Common in Samples KAJ21 and KAJ34.
Common (15-30%):	Rounded to subrounded *weathered feldspar* (mean size ca. 400 µm), only present in KAJ21.
	Rounded, weathered *granite* inclusions (mean size ca. 750 µm), only present in KAJ21.
Few (5-15%):	Subrounded *Chert*.
Two apparently ferruginous textural concentration features are present in Sample KAJ34.	

Comment

These three fabrics are grouped together on the basis of their very similar silty matrix, featuring predominantly angular quartz silt. However, the coarse inclusions in each fabric vary and are suggestive of more specific geologic origins. Samples KAJ34 and KAJ35, the two red-slipped and burnished fine-wares, both feature similar quantities of rounded fine quartz sand. However, the predominant inclusions in Sample KAJ34 are calcareous. The calcareous temper consists of rounded calcareous grains, possibly *nari* (aka calcrete), as well as rounded calcareous sand similar to that seen in Ware Group 1 and shell fragments. Sample KAJ21 is dissimilar from the other two samples. This sample is a coarser, more friable ware in hand section with a brown appearance rather than a reddish color. Microscopically, KAJ21 contains coarse granitic inclusions, suggesting a different geologic origin than Samples KAJ34 and KAJ35.

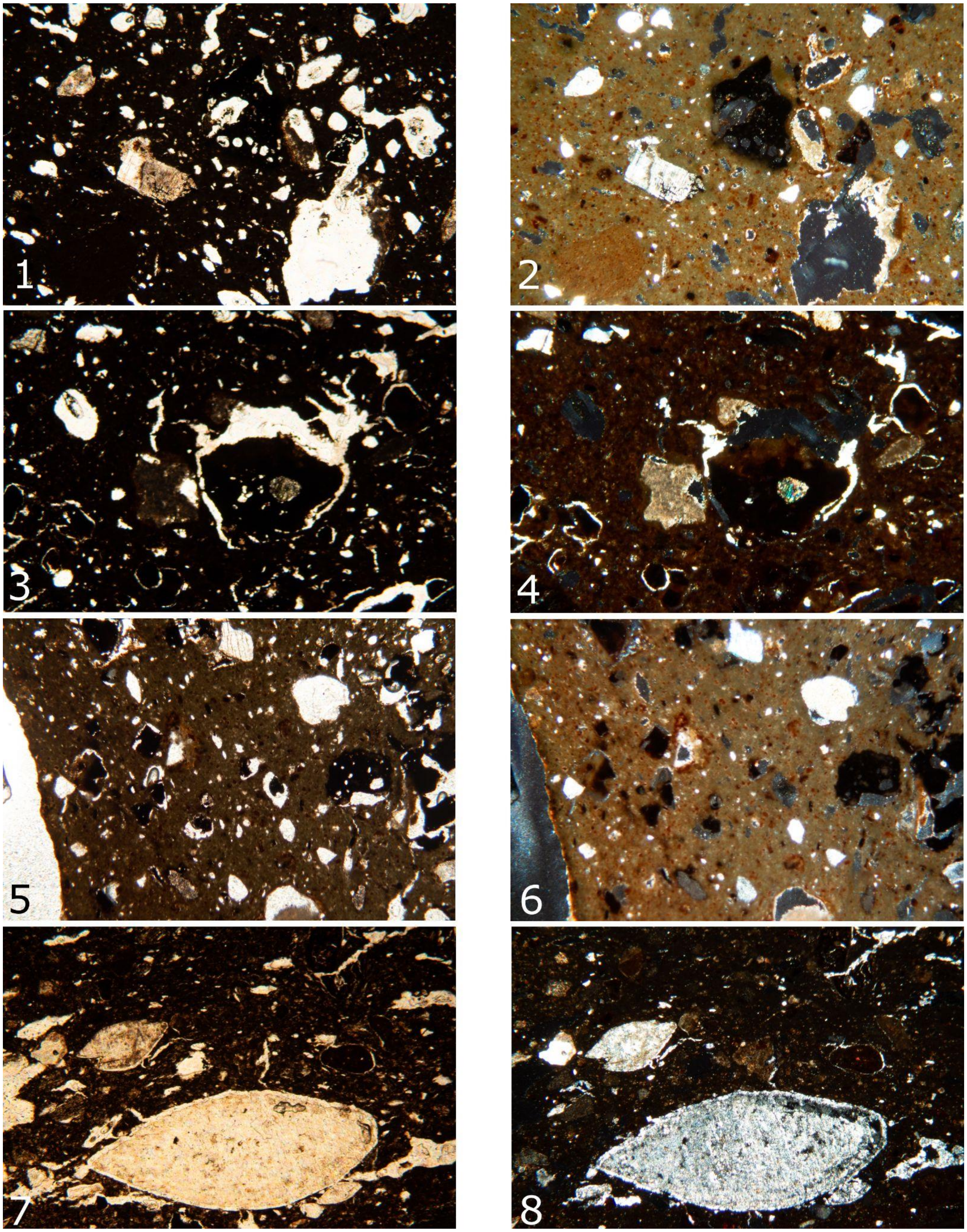

Figure B.2: Samples described in Table B.12, PPL(l) and XPL(r) 40x magnification. These images represent ceramics in Ware Group 1, Subgroup A. Images 7 and 8 show elongated gypsum grains in Sample KAJ11.

Table B.12: Samples illustrated in Figure B.2, PPL/XPL 40x magnification

Image Num.	Sample Num.	Area/Stratum	Locus	Basket	Vessel Form	Ware Group	Subgroup	Magnification	PPL/XPL
1	KAJ5	B1c	536	10275	Krater 1	1	A	40x	PPL
2	KAJ5	B1c	536	10275	Krater 1	1	A	40x	XPL
3	KAJ8	C2b	534	10385	Krater 2	1	A	40x	PPL
4	KAJ8	C2b	534	10385	Krater 2	1	A	40x	XPL
5	KAJ9	B2a	542	10407	Krater 2	1	A	40x	PPL
6	KAJ9	B2a	542	10407	Krater 2	1	A	40x	XPL
7	KAJ11	C2a	529	10272	Krater 2	1	A	40x	PPL
8	KAJ11	C2a	529	10272	Krater 2	1	A	40x	XPL

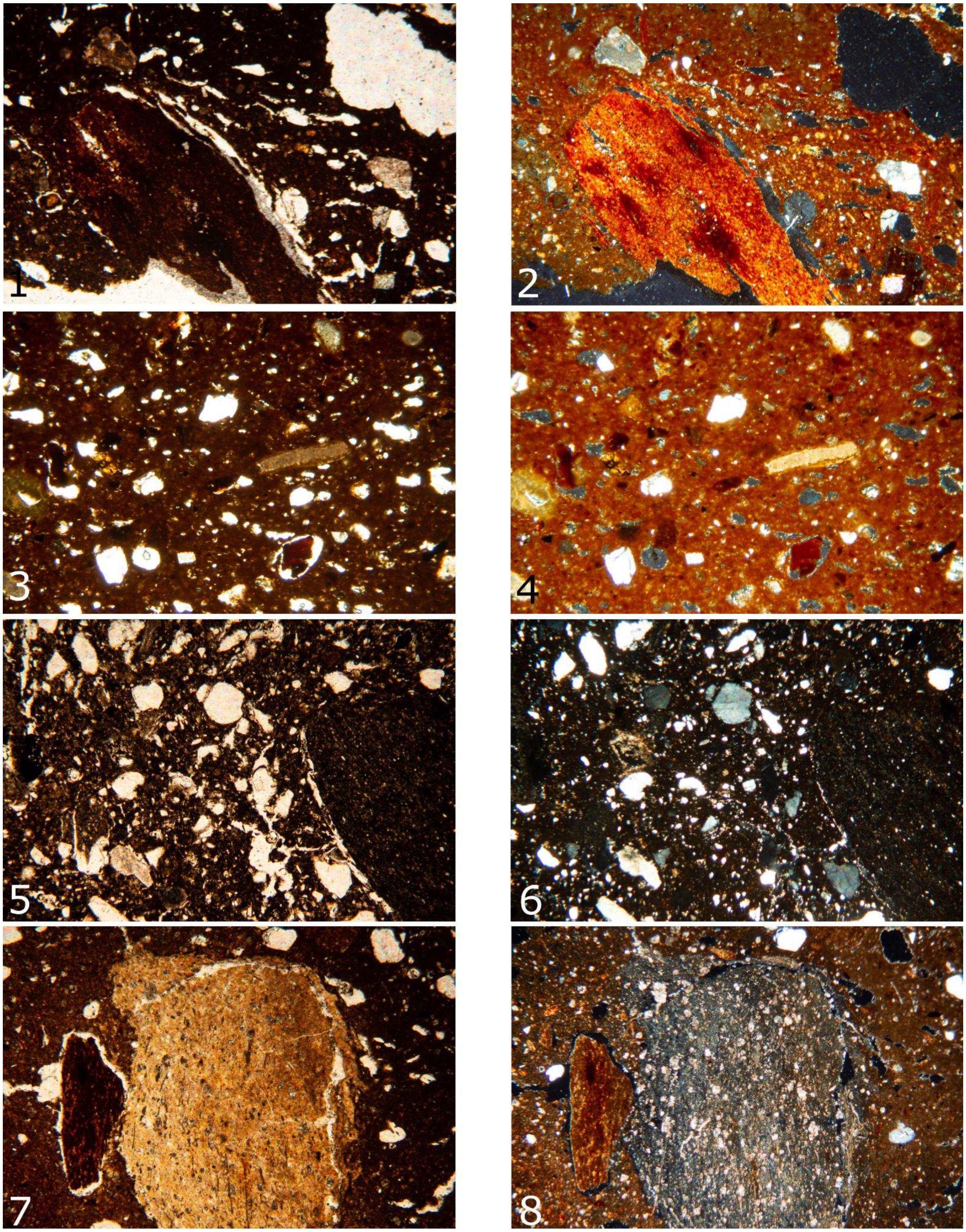

Figure B.3: Samples described in Table B.13, PPL(l) and XPL(r) 40x magnification. These images represent ceramics in Ware Group 1, Subgroup A. Images 1 and 2 show the ferruginous shale common to this ware group. Images 7 and 8 depict fossiliferous limestone, somewhat unique to Sample KAJ23.

Table B.13: Samples illustrated in Figure B.3, PPL/XPL 40x magnification

Image Num.	Sample Num.	Area/Stratum	Locus	Basket	Vessel Form	Ware Group	Subgroup	Magnification	PPL/XPL
1	KAJ12	B2a	550	10462	Krater	1	A	40x	PPL
2	KAJ12	B2a	550	10462	Krater	1	A	40x	XPL
3	KAJ19	B2a	542	10357	Jar 2	1	A	40x	PPL
4	KAJ19	B2a	542	10357	Jar 2	1	A	40x	XPL
5	KAJ20	B2b	543	10526	Jar 3	1	A	40x	PPL
6	KAJ20	B2b	543	10526	Jar 3	1	A	40x	XPL
7	KAJ23	B1c	537	10335	Jar	1	A	40x	PPL
8	KAJ23	B1c	537	10335	Jar	1	A	40x	XPL

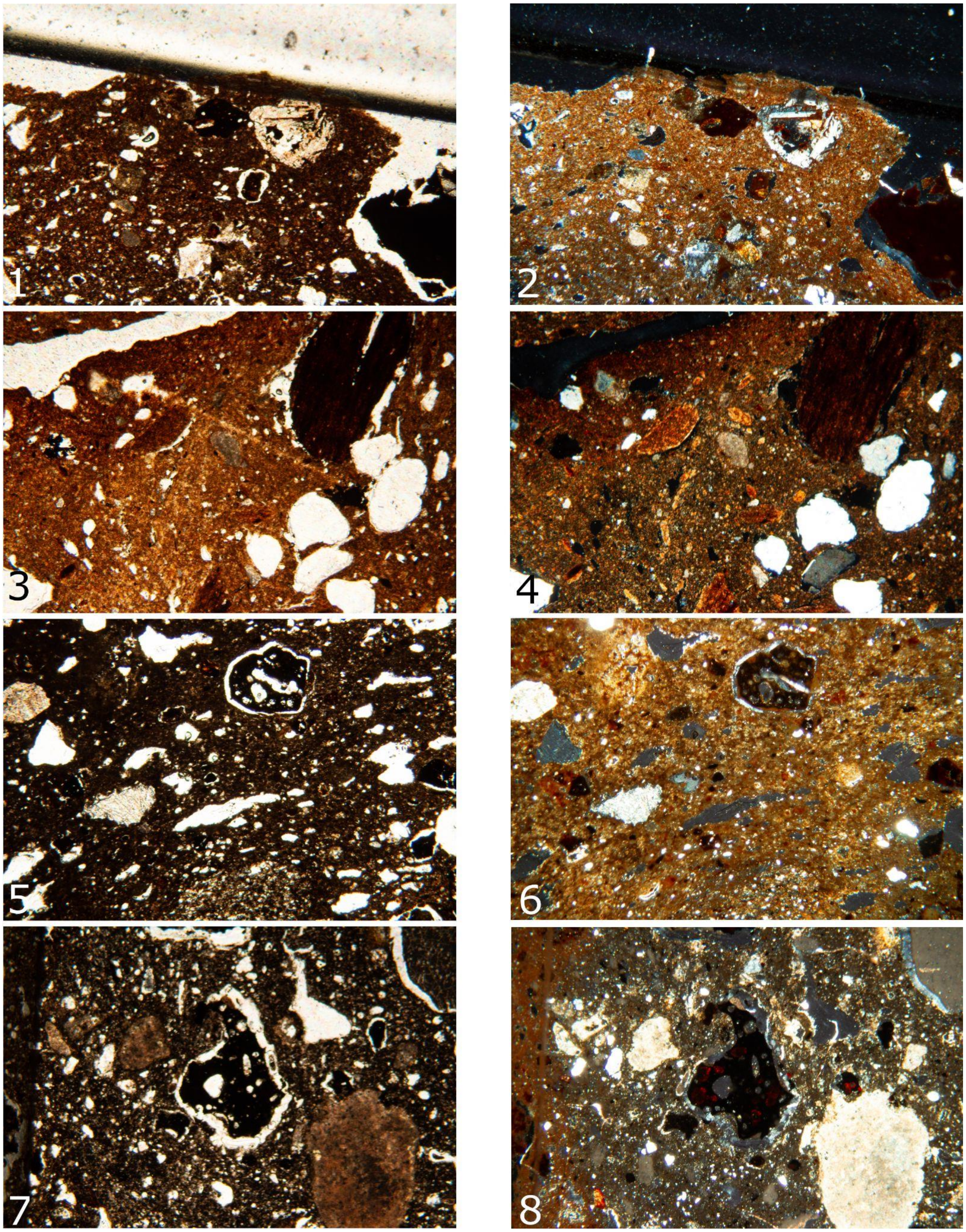

Figure B.4: Samples described in Table B.14, PPL(l) and XPL(r) 40x magnification. Images 1-6 represent ceramics in Ware Group 1, Subgroup A. Images 7 and 8 show a likely slag inclusion in Sample KAJ30, representing Ware Group 1, Subgroup B.

Table B.14: Samples illustrated in Figure B.4, PPL/XPL 40x magnification

Image Num.	**Sampl e Num.**	**Area/S tratum**	**Locus**	**Basket**	**Vessel Form**	**Ware Group**	**Subgrou p**	**Magnific ation**	**PPL/XP L**
1	KAJ24	B2b	543	10577	Krater 1	1	A	40x	PPL
2	KAJ24	B2b	543	10577	Krater 1	1	A	40x	XPL
3	KAJ28	C2c	535	10419	Jar	1	A	40x	PPL
4	KAJ28	C2c	535	10419	Jar	1	A	40x	XPL
5	KAJ41	B2a	542	10366	Jug	1	A	40x	PPL
6	KAJ41	B2a	542	10366	Jug	1	A	40x	XPL
7	KAJ30	B2b	565	10688	Jar	1	B	40x	PPL
8	KAJ30	B2b	565	10688	Jar	1	B	40x	XPL

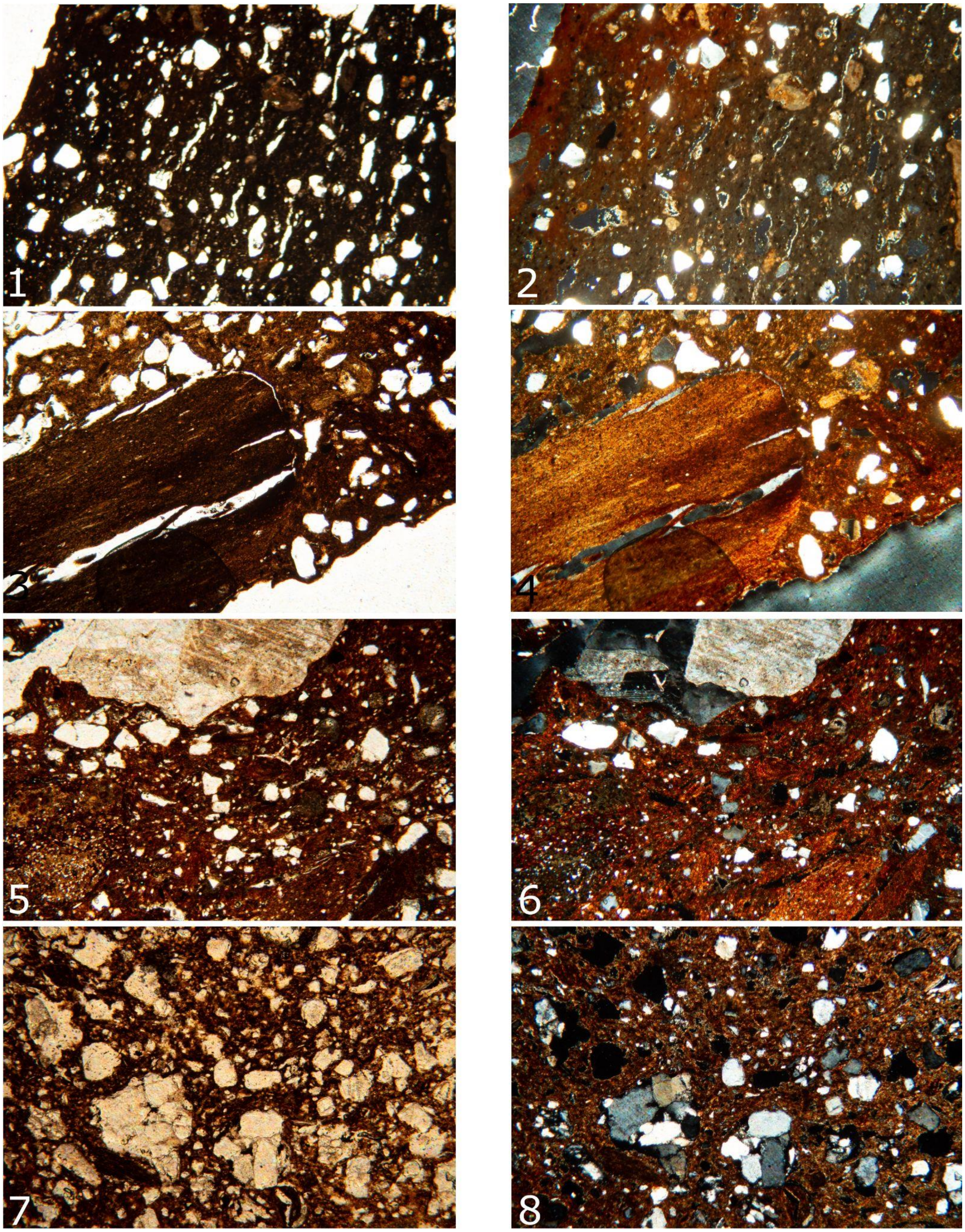

Figure B.5: Samples described in Table B.15, PPL/XPL 40x magnification. Images 1-4 represent ceramics in Ware Group 1, Subgroup C. Images 5-8 depict the sandstone inclusions in Ware Group 1, Subgroup D.

Table B.15: Samples illustrated in Figure B.5, PPL/XPL 40x magnification

Image Num.	Sample Num.	Area/Stratum	Locus	Basket	Vessel Form	Ware Group	Subgroup	Magnification	PPL/XPL
1	KAJ15	B2a/b	518	10123	Cooking Pot	1	C	40x	PPL
2	KAJ15	B2a/b	518	10123	Cooking Pot	1	C	40x	XPL
3	KAJ37	B2a	542	10405	Cooking Pot	1	C	40x	PPL
4	KAJ37	B2a	542	10405	Cooking Pot	1	C	40x	XPL
5	KAJ16	B2a/b	548	10582	Krater	1	D	40x	PPL
6	KAJ16	B2a/b	548	10582	Krater	1	D	40x	XPL
7	KAJ49	B2a	550	10462	Holemouth Jar	1	D	40x	PPL
8	KAJ49	B2a	550	10462	Holemouth Jar	1	D	40x	XPL

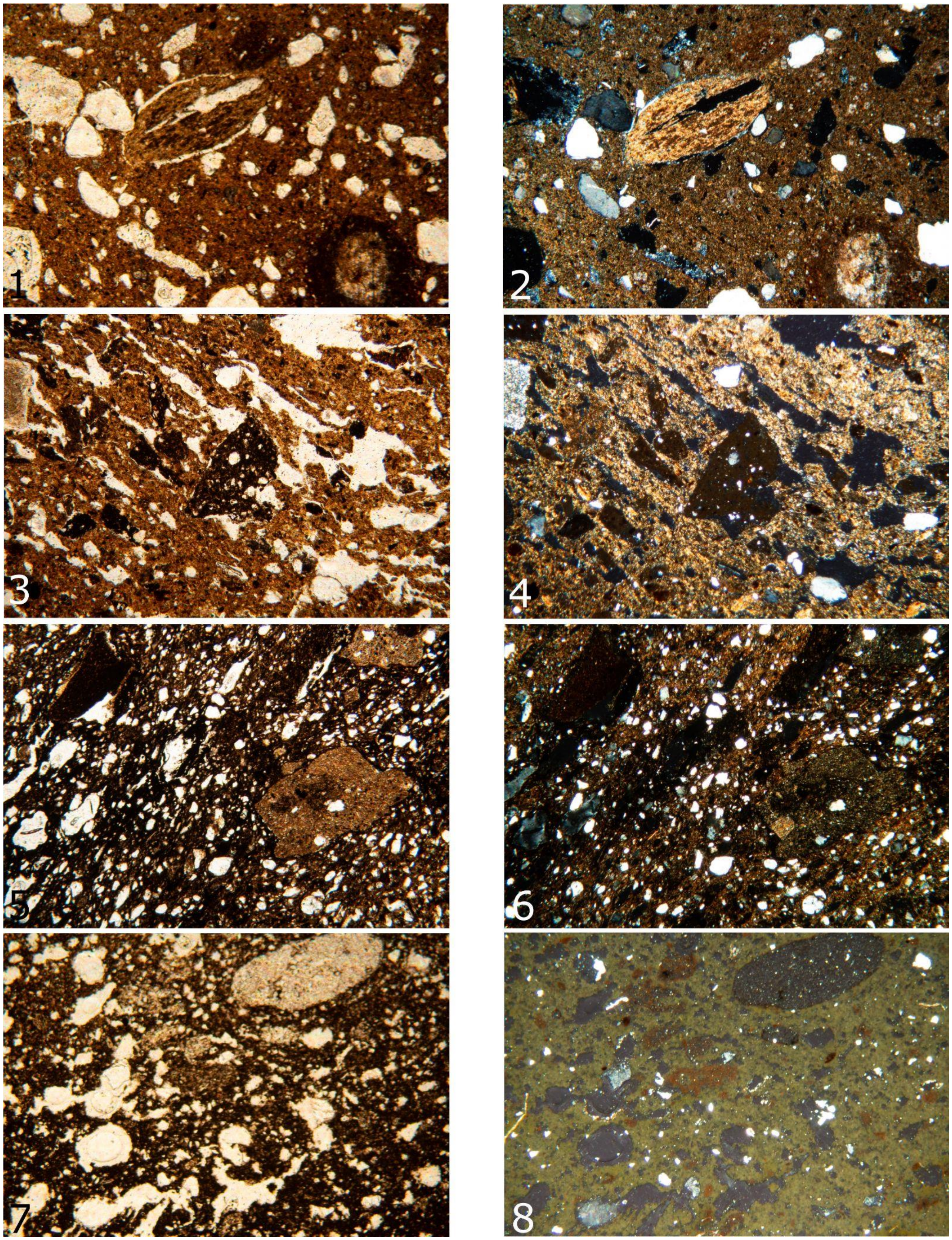

Figure B.6: Samples described in Table B.16, PPL/XPL 40x magnification. Images 1-2 represent ceramics in Ware Group 1, Subgroup E, illustrating the calcareous fabric. Images 3-6 depict the grog inclusions in Ware Group 1, Subgroup F. Images 7-8 illustrate Sample KAJ14 of Ware Group 2.

Table B.16: Samples illustrated in Figure B.6, PPL/XPL 40x magnification

Image Num.	**Sample Num.**	**Area/Stratum**	**Locus**	**Basket**	**Vessel Form**	**Ware Group**	**Subgroup**	**Magnification**	**PPL/XPL**
1	KAJ13	B2a	556	10613	Krater	1	E	40x	PPL
2	KAJ13	B2a	556	10613	Krater	1	E	40x	XPL
3	KAJ53	B1c	537	10335	Base	1	F	40x	PPL
4	KAJ54	B1c	537	10335	Base	1	F	40x	XPL
5	KAJ62	C2a	529	10272	Base	1	F	40x	PPL
6	KAJ62	C2a	529	10272	Base	1	F	40x	XPL
7	KAJ14	B2b	575	10827	Krater 1	2	n/a	40x	PPL
8	KAJ14	B2b	575	10827	Krater 1	2	n/a	40x	XPL

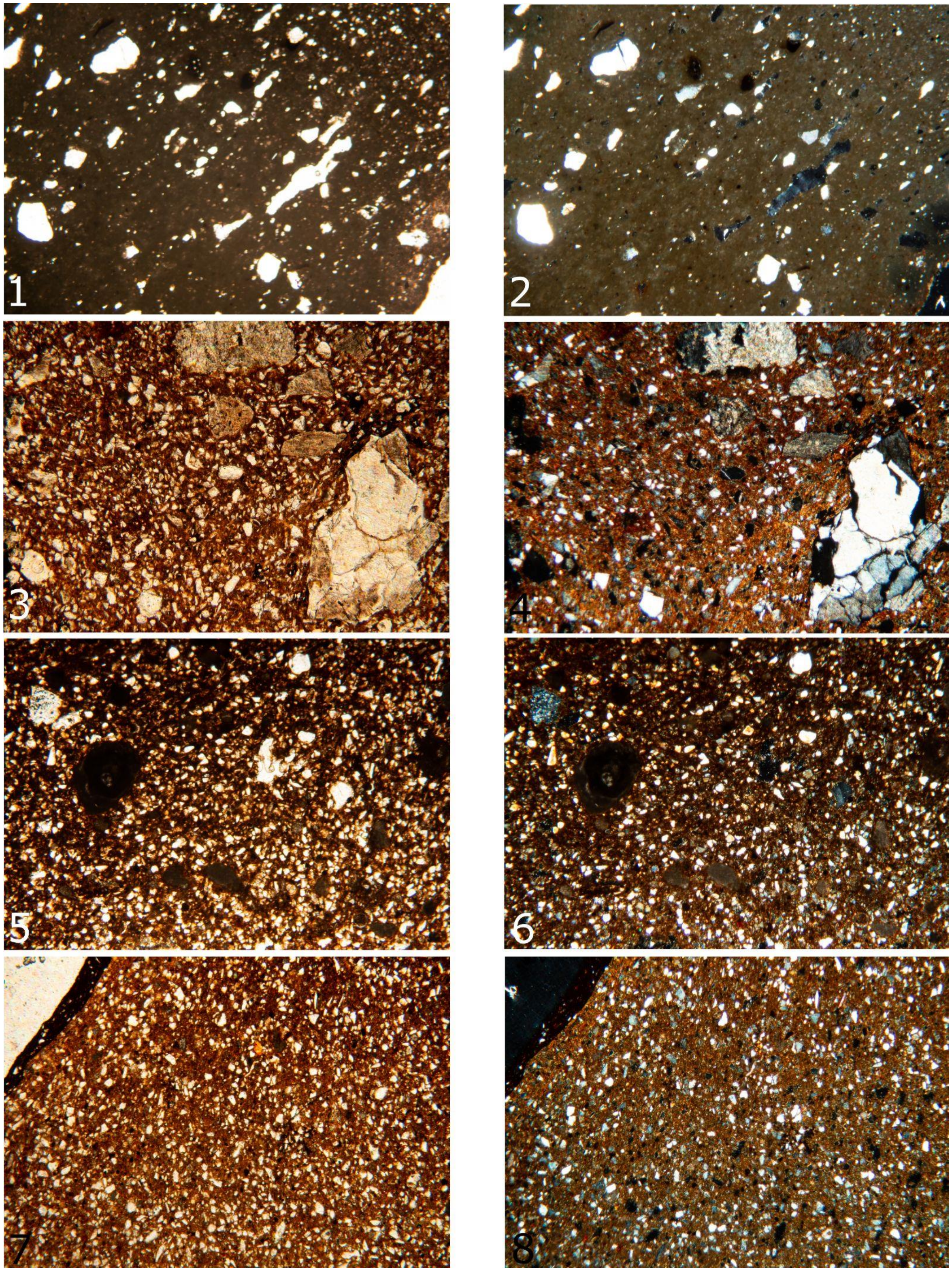

Figure B.7: Samples described in Table B.17, PPL/XPL 40x magnification. Images 1-2 represent Sample KAJ17 of Ware Group 2. Images 3-8 depict the silty calcareous fabric of Ware Group 3.

Table B.17: Samples illustrated in Figure B.7, PPL/XPL 40x magnification

Image Num.	Sample Num.	Area/Stratum	Locus	Basket	Vessel Form	Ware Group	Subgroup	Magnification	PPL/XPL
1	KAJ17	B2b	543	10654	Bowl 3	2	n/a	40x	PPL
2	KAJ17	B2b	543	10654	Bowl 3	2	n/a	40x	XPL
3	KAJ21	C2c	535	10419	Jar	3	n/a	40x	PPL
4	KAJ21	C2c	535	10419	Jar	3	n/a	40x	XPL
5	KAJ34	B2b	561	10665	Bowl 1	3	n/a	40x	PPL
6	KAJ34	B2b	561	10665	Bowl 1	3	n/a	40x	XPL
7	KAJ35	B2b	561	10665	Bowl 2	3	n/a	40x	PPL
8	KAJ35	B2b	561	10665	Bowl 2	3	n/a	40x	XPL

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