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EASTERN MEDITERRANEAN METALLURGY AND METALWORK IN THE SECOND MILLENNIUM BC

A conference in honour of
James D. Muhly

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edited by
Vasiliki Kassianidou and George Papasavvas

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21. New perspectives on Iron Age copper production and society in the Faynan Region, Jordan

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

Introduction

Since 2002, the University of California, San Diego’s Levantine Archaeology Laboratory has spearheaded an interdisciplinary field investigation of the role of mining and metallurgy in Iron Age (c. 1200–500 BC) societies who resided and exploited copper ore in Jordan’s Faynan district. Until 2007, this work was carried out jointly with the Department of Antiquities of Jordan. The Iron Age coincides with the rise of the first historic local state-level societies in this part of the southern Levant. As Faynan contains the largest concentration of copper ore deposits in the southern Levant it played a key role in the social and economic fabric of societies that interacted with this region during the late 2nd and early 1st millennium BC. Consequently, our research has been drawn into a wide range of anthropological, historical, ancient technology and research methodology debates. The new excavations and surveys carried out by our team both embellish and add new perspectives concerning Iron Age copper production in the southern Levant. In this paper we present a brief overview of our Iron Age work in Faynan.

Previous Iron Age research in Faynan can be characterized as literal, impressionistic, highly technical or somewhat tangential to mainstream research concerning this early historical period. The earliest researchers such as A. Musil (Musil 1907), F. Fritz (Fritz 1996) and N. Glueck (Glueck 1935) carried out brief field surveys in the Faynan region and provided mostly descriptive reports of the archaeological remains. When interpretation was given, it was based on very literal readings of the Old Testament (Hebrew Bible) related to this region known from ancient Egyptian and Biblical texts as Edom. As this work was done in the first half of the twentieth century when Biblical sources were accepted as fact, this literal approach is understandable. Archaeological surveys carried out in the 1970s and 1980s were not focused specifically on the Iron Age or Faynan but touched on these subjects (Adams 1991; MacDonald 1992; Raikes 1980). The first surveys that focused specifically on Faynan were carried out as part of a multi-period archaeometallurgical study in this part of the southern Levant by the Deutsches Bergbau Museum (DBM) during the 1980s and early 1990s (Hauptmann 2007). This pioneering work laid the foundation for all later science-based archaeological research in the Faynan region. As the DBM study was aimed at understanding the history of mining and metallurgical technology, surveys and excavations focused specifically on metallurgical contexts such as mines and smelting sites. Non-metallurgical archaeological sites such as cemeteries, roads, non-metal producing settlements, irrigation networks, agricultural field systems and other sites were not accounted for with the same degree of detail as those related specifically to archaeometallurgy. While the basic assemblages of copper production and technologies were reported, the socio-historical role of mining and metallurgy in the societies that lived in Faynan was not investigated in depth. While small scale excavations were carried out at several Iron Age sites during the DBM project (Fritz 1994, 1996), the fieldwork was fast-paced with little in-depth analysis. Historical interpretations made by biblical scholars attached to the DBM project were highly speculative because they were based on very incomplete archaeological data when Iron Age fieldwork in Faynan was in its infancy. A more social perspective on the Iron Age archaeology in Faynan began in 1995 with the Wadi Faynan Landscape Survey carried out by the Council for British Research in the Levant (CBRL). This project was primarily aimed at understanding deep-time processes of desertification spanning the Holocene rather than a focus on Faynan’s ancient metallurgy in anthropological perspective or the Iron Age in particular (Barker et al. (eds) 2007; Mattingly et al. 2007). Important and innovative studies concerning ancient pollution and the paleoenvironment were carried out by this team, some of which were related to the Iron Age (Grattan et al. 2007; Pyatt et al. 1999). While the survey results and methodologies applied are excellent, the lack of excavations carried out in conjunction with the surveys makes it difficult to date field
systems tied to specific periods and to larger problems related to archaeological datasets in the southern Levant.

UCSD’s Edom Lowlands Regional Archaeology Project (ELRAP) is an outgrowth of the Jabal Hamrat Fidan (JHF) project that since 2003 has focused primarily on surveys and excavations related to the Iron Age of Faynan. The JHF project was a deep-time study of the role of mining and metallurgy on the evolution of societies in the southern Levant. The last year of the JHF project focused on the first large scale excavations at Khirbat en-Nahas (KEN; Arabic ‘ruins of copper’) – the largest Iron Age copper production site in the southern Levant (Higham et al. 2005; Levy et al. 2004b, 2005b). The spectacular nature of the discoveries at KEN, including extensive and detailed evidence for copper smelting over a ten hectare area, one of the largest Iron Age fortresses in the desert region of southern Jordan, Israel and Sinai, deep stratigraphy at the site and the abundance of related Iron Age sites in the surrounding area, led us to establish ELRAP with its Iron Age focus. As part of an emergency archaeology study of the Wadi Fidan in 2003 and 2004, Iron Age excavations took place at several sites along the wadi which constitutes the western entrance to the Faynan district. The excavated sites included the Wadi Fidan 40 cemetery, Wadi Fidan 4 (several tombs visible on the surface of the site) and the watchtower at Rujm Hamra Ifdan (first identified by Nelson Glueck); also conducted was a survey of the unexplored portion of Wadi Fidan from the site of Khirbat Hamra Ifdan eastward beyond the oasis of ‘Ain Fidan. In 2006, the second large-scale excavation campaign was carried out at KEN that made it possible to systematically excavate one of the deeply stratified ‘slag mounds’ at the site (Levy et al. 2008). In that season a sondage was made at Khirbat al-Jariya, a second tier Iron Age copper production site located up-stream from KEN (Ben-Yosef et al. 2010a). We also surveyed and probed one of the Iron Age fortresses located high above the Wadi al-Ghuweiba near extensive mine complexes. In 2007, a survey was carried out along the Wadi Jariya to complete the work begun there in 2002 (Levy et al. 2003). A special focused survey to identify Iron Age roads leading from the Faynan copper ore district to the Edom highlands around the ancient site of Busayra was also carried out in 2007. In the same year our project’s excavations included a probe in the Iron Age ‘slag mound’ of Khirbat Hamra Ifdan. In 2009, large scale excavations were resumed at KEN completing the first phase of our investigations at the site. That season was also an opportunity to make a sounding at the newly discovered Iron Age Jabal al-Jariya mines (Ben-Yosef et al. 2009a) and the previously unexcavated settlement/production site of Khirbat al-Ghuweiba. Taken together, these surveys, large scale excavations and probes coupled with a program of rigorous radiometric dating has provided an unprecedented Iron Age database for investigating cultural and technological change in ancient Edom.

ELRAP has also become a ‘test bed’ for cyber-archaeology and a wide range of digital methodologies for archaeological field research. As the Iron Age of Edom is so closely linked to issues concerning the relationship between ancient texts and the archaeological record, the project has been at the forefront of applying high precision radiocarbon dating to the historical archaeological record. Taken together, our robust methodology that combines cyber-archaeology and radiometric dating coupled with Bayesian analyses contributes to ‘raising the bar’ in how historical biblical (or other historical) archaeologies should be practiced today. This new methodology has changed not only the Iron Age chronology of Edom, but opened the door to new social, cultural and technological interpretive models for this key period. As might be expected, our work has generated a great deal of positive scholarly debate (Finkelstein 2005; Finkelstein and Piasezky 2006, 2008; Finkelstein and Singer-Avitz 2009; Levy 2005, 2008; Levy and Higham 2005; Levy and Najjar 2006; Levy et al. 2005c; van der Steen and Bienkowski 2006). The following presents a summary of the ELRAP achievements.

**Cyber-Archaeology Methods and ELRAP**

Since 1999 our team has practiced On-Site Digital Archaeology (OSDA) at both our JHF and ELRAP archaeological excavations and surveys in Jordan. To tie all the spatial and digital data together in a manageable framework to facilitate analyses and publications, the system is rooted in Geographic Information Systems (Levy et al. 2010b; Levy and Smith 2007). The driving force for OSDA is the acknowledgement that the control of time and space (the context of material culture) are crucial for measuring social change in the archaeological record. While we depend on other laboratories for controlling time through high precision radiocarbon dating and other methods, our group focuses on developing tools to help archaeologists control the spatial context of archaeological phenomena in the field to facilitate study of cultural heritage data from the past. As there are now robust computer-based components to our research, including 3D visualization of contexts, it may be more appropriate to consider all our digital archaeology work as ‘Cyber-archaeology’ (Levy et al. 2010b). The starting place of such a system is acquiring accurate x, y, and z (elevation) coordinates of all material culture data – from artefacts to architecture. This is achieved in the field using Total Station or GPS (Global Positioning System) technologies. Over the past three years, with the establishment of the new Center of Interdisciplinary Science for Art, Architecture and Archaeology (CISA3) at UCSD’s California Institute of Telecommunication and Information Technology (Calit2), a collaborative framework has been established facilitating joint research between archaeologists, computer
scientists and engineers. The most recent approach focuses on how to improve OSDA methodology by adopting balloon based aerial photography, GigaPan photography, and LiDAR, integrated into a web-based cyber-infrastructure ‘portal-science’ community generically called the Mediterranean Archaeology Network (MedArchNet). We now use these datasets for visual analytics delivered in a suite of 2D and 3D immersive environments including the StarCAVE and NexCAVE (http://www.calit2.net/newsroom/article.php?id=1584; http://www.calit2.net/newsroom/release.php?id=1383).

The excavations at the Iron Age smelting sites of Faynan and in particular the extensive work at Khirbat en-Nahas (see below) have resulted in a large and comprehensive archaeometallurgical collection, most of which is located at UCSD. The collection consists of more than 16 tons of artefacts (none are museum quality finds) including thousands of slag fragments from various contexts, thousands of tuyère and furnace fragments, hundreds of fragments of technological ceramic (moulds, crucibles, clay bellow pipes), and hundreds of fragments of metal and ore in various conditions (corroded copper chunks, iron-copper alloys, copper prills, copper ore). There is also an extensive collection of unidentified materials awaiting future study. The collection is fully digitized and spatially-linked to the general GIS database of the excavation (see above). Most of the artefacts have exact coordinates (except in cases when they were collected as general ‘baskets’ in which they have the location data of the basket area linked to the associated locus), and all of them are tied to their digital photographs, photographs of their archaeological context, and the entire suite of relevant data (including descriptions of Area, Stratum, Locus, etc.).

This collection provides a unique opportunity for detailed investigation of the Iron Age smelting technology in the southern Levant across diachronic and synchronic contexts. Currently it is being researched by our team, but it is clear that there is potential for many future collaborative projects. As we go through the collection some research questions are solved but many more accumulate. The amount of detail is vast and the digital database facilitates comprehensive analyses. We hope to make the digital database available on-line to the scholarly community in the near future via the MedArchNet – Mediterranean Archaeology Network (http://medarchnet.calit2.net).

The Iron Age system in Faynan: new sites, new data

The region covered by UCSD’s expedition is located in the west and north-western parts of Faynan and includes some of the largest Iron Age copper production sites in the southern Levant. The main sites were occupied only during the early Iron Age, thus a wide exposure of the copper production facilities and associated architecture could be relatively easily achieved. For anthropological investigations of archaeological phenomena such as ancient mining and metallurgy, single occupation periods make it easier to carry out these studies on a regional scale because later occupation material rarely disturbs the target period of interest. For comparison, the other main Iron Age smelting remains in Faynan are probably located at and around the site of Khirbat Faynan in the main Faynan valley system; however, there they are often covered by thick layers of later, Nabataean-Roman-Byzantine occupation. The ‘jewel in the crown’ of our Iron Age expedition to Faynan has been the investigation of Khirbat en-Nahas, in which seven different areas were excavated during three 10-week field seasons (2002, 2006 and 2009). Khirbat en-Nahas (KEN) provides the chronological, cultural and technological anchor for understanding the regional dynamics of Iron Age metal production in the Faynan copper ore district. These data are complemented and contextualized by various other ELRAP Iron Age archaeological investigations of this region including a large scale excavation of the 10th century BC cemetery of Wadi Fidan 40, a number of probes in archaeometallurgical contexts of smaller production sites, detailed surveys of the landscape (recording archaeological features from all periods) and a probe into one of the newly discovered pit mines. This profusion of data enables an in-depth evaluation of the Iron Age copper production technology and a comprehensive perspective for investigating the society responsible for this mining and metallurgy enterprise during the Iron Age southern Levant. In the following we present a ‘snapshot’ of the various research and field evidence our team has investigated in the last 13 years concerning Iron Age Jordan’s Faynan district (Fig. 21.1).

Khirbat en-Nahas (KEN; 30.661394N, 35.392700E)

Khirbat en-Nahas provides the chronological, socio-economic, technological and historical anchor for assessing the Iron Age archaeometallurgy of the Faynan district. As noted above, KEN is the largest Iron Age production site (c. 10ha) in this copper ore region. It is covered with thick deposits of ancient black ‘slag mounds’ – the industrial waste from copper smelting. Prior to our investigations, scholars debated the date and significance of this site. However, since 2002 and the large scale UCSD–DOAJ excavations at the site, coupled with a programme of high precision radiocarbon dating, there is no doubt about the Iron Age date of this massive site. Seven distinct excavation areas have been opened by our team providing a rich sample of the range of construction and metallurgical activities carried out at the site (Fig. 21.2). The excavations at KEN have produced superb archaeometallurgical (Fig. 21.3), ground stone (Fig. 21.4), ceramic and other material culture collections for the study of mining and metallurgy during this period. Here a brief summary of these areas is presented.
from the 2002, 2006 and 2009 expeditions. Critical to understanding Iron Age copper production at this site is the fact that after the 9th century BC, copper production ceased at this site and its immediate surroundings.

**KEN Area A**

The gatehouse (Area A) of the fortress is situated on its western side overlooking the Wadi al-Ghuweiba (Fig. 21.2). Two main construction phases have been identified in the gatehouse that is incorporated into the main fortification
21. New perspectives on Iron Age copper production and society in the Faynan Region

Fig. 21.2. (Colour Plate 12) Aerial photograph of the Iron Age copper production site of Khirbat en-Nahas with the different excavation areas highlighted. The large square structure on the right is the fortress that measures c. 73 x 73m. Area A indicates the gatehouse. Area M is located in the bottom left of the image (view west; Photograph UCSD CISA3/Levantine Archaeology

wall. Radiocarbon dates place the initial construction squarely in the early to mid 10th century BC. In the 9th century BC, the gatehouse was ‘decommissioned’ and reconfigured as a large building with no military function. In this last phase of occupation, the gatehouse was used for metallurgical activities. The 4-chamber plan of the gatehouse at KEN is similar to other 10th century BC examples at southern Levantine sites as Ashdod 10a, Beersheba V, Khirbet Qeiyafa, and Megiddo VA–IVB (Gate 1567) (Frese forthcoming). We intentionally left one of the chambers of this gatehouse unexcavated for future researchers. Our team is currently evaluating the socio-economic role of the fortress in the organization of copper production throughout the Iron IIA–B period.

KEN Area M

One of the numerous ‘slag mounds’ at Khirbat en-Nahas was sampled by our team from surface to virgin soil, together with a structure complex that was partially covered by the top layers of the mound (Fig. 21.5). More than six metres of copper production related deposits, including interchanging horizons of various types of slag (fine-crushed, tap, and furnace in different sizes), clayey and ashy sediments mixed with tuyère and furnace fragments, were exposed (Fig. 21.6). Most of the accumulated material represents deliberate dumping of production waste (in particular primary smelting) at this location. In a few places working surfaces and installations, including a complete intact furnace base and a few stone alignments, were uncovered. In order to excavate the deep pit we had to remove the southern room of Structure 1 and leave a ‘safety step’ to prevent falling materials from the loose section (heavy slag) putting the excavators at risk (Figs 21.5, 21.6).

The metallurgical horizons present an intricate stratigraphy derived from their complex depositional process which is fundamentally different from settlement sites (e.g. Conrad and Rothenberg (eds) 1980). Thus, in addition to the detailed recording of the excavated material, we carefully studied the exposed sections of the excavation. These sections provide invaluable information regarding the history of copper production at the site and have been a basic reference for our metallurgical and chronological studies in Faynan. Basically, five major stratigraphic units were distinguished in Area M (Layers M1–M5, Fig. 21.6). These were dated with a suite of 24 high precision AMS radiocarbon dates from well controlled contexts. The basal sediments and installations belong to the last phase of the Late Bronze Age. Already in this context fine-crushed slag was present, suggesting copper production activities at the site already in its early occupation stages. Layer M4 (Iron Age I, 12th to 11th centuries BC) and Layer M3 (10th century BC) represent copper smelting activities, the latter much more intense in scale. The transition between Layer M3 and M2 represents a major change in the layout of this region of KEN. The mounds of debris were flattened to prepare the
Fig. 21.3. Examples of some common archaeometallurgical finds from Iron Age Faynan (all except F are from Khirbat en-Nahas): A) illustration of a composite tuyère; B) a front part of a tuyère (covered with slag; the inner socket has textile imprints on it); C) interior lining of clay furnace with finger imprints (a drawing and a section); D) same type of artefact as C; E) clay bellows pipe, in general a rare find with high concentration in the metallurgical workshop of KEN-Area F; F) furnace slag with embedded charcoal; G) a slab of tap slag common on the surface of Khirbat en-Nahas; H) fragments of copper ore; I) an alloy of copper and iron, most probably the raw product of the primary smelting process; J) copper prill; K) copper droplets found at the refining and casting workshop of KEN-Area F.
Fig. 21.4. Most common types of ground stone found at the smelting site of Khirbat en-Nahas: A) grinding slab (Area: T Locus: 1523 EDM: 40741_T); B) dimpled hammerstone (Area: R Locus: 1803 EDM: 30031_T); C) multiple use / sharpening stone (Area R: Locus: 1826 EDM: 30310_T); D) saddle quern (Area: T Locus: 1504 EDM: 40164_S); E) mortar (Area: T Locus: 1511 EDM: 40150_T); F) ‘ballistic’ stone (Area: R Locus: 1827 EDM: 30479_T); G) grooved hammerstone (Area: T Locus: 1541 EDM: 40493_S); H) anvil (Area: A Locus: 160 EDM: 50126_T); I) hand stone (Area: M Locus: 693 EDM: 91503_T); J) hammerstone (Area: M Locus: 732 EDM: 91674_T); K) polishing stone (Area: M Locus: 707 EDM: 91577_T); L) pestle (Area: M Locus: 701 EDM: 91523_T).
Fig. 21.5. The southern wall of the sounding, over 6.5m in depth, into the ‘slag mound’ of Area M at the end of the 2006 excavation season. The deposits represent c. 300 years of metal production at the site of Khirbat en-Nahas.

ground for a new occupation phase at the site, including the foundation of the structure complex. This transition dates to the end of the 10th century BC and corresponds to the Egyptian campaign of Shishak, suggested to be responsible for the observed disruption (Levy et al. 2008). Interestingly, at about the same time the sites of Khirbat al-Jariya and probably also the site of Khirbat al-Ghuweiba were abandoned. The new phase of copper production at KEN, represented in Area M by Layers M2 and M1, also included intense copper production throughout the 9th century BC. Sometime during this period we can recognize a major change in the smelting process with the introduction of a more efficient technology including larger installations (furnaces) and larger and different tuyères. This change has been observed in other sites (Faynan 5, Hautpman 2007; Timna 30, Conrad and Rothenberg (eds) 1980), but this is the first time we have been able to precisely date this change and to thoroughly study the details of this substantial development. This latest and most advanced technology is the one responsible for the huge slabs of tap slag visible on the surface of the site. During this time the ‘slag mound’ of Area M became so high that the weight of the debris and the heat of the smelting activities damaged the walls of Structure 1 and put some of its rooms out of use. Area M, like the rest of the site, was abandoned at the end of the 9th century BC.

KEN Area S
Situated in the central portion of the site, Area S consists mostly of a courtyard building (c. 7 × 10.5m) dating to the 9th century BC. Three smaller rectilinear rooms are situated around the courtyard. Over 350 ground stone implements of different kinds were found associated with this building along with thick layers of crushed slag around its exterior. These data indicate that specialized slag crushing activities took place here in order to extract as much copper from the slag residue as possible.

KEN Area R
Also located near the centre of the site, Area R consists of the most massively constructed building excavated to date at KEN. Measuring c. 12.7 × 15m, this was a two-story structure with a well-preserved stairwell situated in one of the six rectilinear rooms surrounding the central courtyard. Radiocarbon dates indicate that the building was constructed and used in the late 10th century BC. The entrance to the building is framed by two extension walls similar to Iron Age IIA constructions at sites in the Negev desert such as Atar HaRoah (Cohen and Cohen-Amin 2004). The massive construction, special finds, and central location of this building suggest that it was the residence of 10th century BC elites who may have been involved in the control of copper production at KEN during this period. This important building was investigated in 2006 and 2009, but the central courtyard has not been excavated.

KEN Area T
The building in Area T is situated along the eastern edge of the site in conjunction with two other unexcavated building complexes. Like Area R, this building had remains of a stairway leading to second floor. The structure measures c. 11 × 12m with four rooms built around a central courtyard. The robust construction effort that went into this structure indicates that it may also have functioned as a residence for elite members of the society that lived at KEN during the late 10th century BC.

KEN Area W
Situated in the most southern portion of KEN, two building
Fig. 21.6. A detailed drawing of the southern wall of the sounding in the ‘slag mound’ of KEN-Area M. General division into Layers is shown on the vertical bar to the right. Note the horizontal dashed line representing the location of a ‘safety step’ approximately 1.4m wide (thus there is discontinuity in the section, cf. Fig. 21.5). Key: 1) broken slag fragment; 2) fine-crushed slag; 3) silt and ash; 4) ash with some slag fragments; 5) tap slag slab/fragment; 6) solid ash horizon; 7) animal bone; 8) stone; 9) wadi sand (virgin soil); 10) silty/clay; 11) furnace fragment; 12) crushed and broken slag, poorly sorted; 13) broken furnace and tap slag mixed with furnace fragments; 14) yellow/brown ashy loess with some slag fragments; 15) tuyère fragment; 16) red wadi sand; 17) compact crushed slag; 18) silt and ash with some crushed slag; 19) plaster; T) tuyère fragment (sampled); s) radiocarbon sample; l) slag sample.
complexes were excavated in this area in 2009. They seem to represent residential functions, including storage and living spaces, as well as some cultic functions. The buildings are separated by a street c. 3.25m in width. The eastern building (c. 8.75 × 15.5m) consists of three storage rooms with a six-room structure attached to it. These smaller rooms surround a courtyard. The layout of this area coupled with special architectural elements and some cultic finds have led us to ascribe a ritual function to this part of the complex. The western building is somewhat smaller (c. 8.5 × 14.5m) and is also dominated by a rectangular courtyard, in this case with seven small rooms around it. The presence of domestic artefacts including an oven (tabun) and absence of metallurgical remains in both these building complexes, suggest that Area W was a residential area with minor cultic function for non-elites resident at KEN.

**Khirbat al-Jariya (KAI; 30.70573N, 35.452106E)**

Khirbat al-Jariya (Fig. 21.7) is the second largest Iron Age copper production site in the Faynan area, after Khirbat en-Nahas (excluding the unknown scale of Iron Age smelting linked to Khirbat Faynan). It is located in an isolated valley in the northernmost part of Faynan along both banks of the Wadi al-Jariya near clusters of copper mines dug into the northern exposure of the local ore bearing Burj formation. Archaeometallurgically, the site was investigated by the DBM team in the early 1990s (Hauptmann 2007, 131–132). Our team surveyed and mapped the site in 2002 (Levy et al. 2003) and in 2006, conducted a small excavation of a rectangular building and a nearby ‘slag mound’ (Ben-Yosef et al. 2010a). The results of this excavation complement the data from Khirbat en-Nahas. It appears, as suggested by Hauptmann based on surface finds, that the site represents the early stage of Iron Age copper production in Faynan. A set of radiocarbon dates shows that the site was occupied only in the 12th to 10th centuries BC. The peak in copper production and the technological advancement of the ninth century BC represented in KEN and the site of Faynan 5 (Hauptmann 2007, 97–103) do not have parallels in the archaeological record of Khirbat al-Jariya.

**The Ras-al Miyah Archaeological Complex (RAM East: 30.703212N, 35.486475E; RAM West: 30.701085N, 35.471208E)**

The Ras-al-Miyah Archaeological Complex is located in the mountains north of the oasis of ‘Ain al-Ghuweiba. The region is rich in Iron Age archaeological remains including two fortresses (Ben-Yosef et al. 2009c) (Fig. 21.8), extensive mining complexes and numerous architectural features probably related to the mining activities. The bulk of the archaeological remains are dated by abundant ceramic finds to the late Iron Age (8th to 6th centuries BC). This date presents a ‘problem’ as no corresponding smelting site was found in this area of Faynan dating to the late Iron Age (Iron Age IIC). Perhaps the assumption of Weisgerber (2006, 15) that these mines were not successful is correct. However, it is difficult to understand how so much construction effort reflected in these large and difficult to access fortresses would have been in vain.

**Khirbat al-Ghuweiba (KAG; 30.693455N, 35.47568E)**

The site is an extensive scatter of small fragments of slag on both sides of Wadi al-Ghuweiba and around the spring of ‘Ain al-Ghuweiba. It was surveyed by Glueck and the DBM who suggested an Iron Age date. In 2009, as part of the ELRAP field season, we excavated a building and an adjacent small mound with slag layers. The building was dated to the Roman-Nabataean period (pottery, glass) and the copper production debris to the Iron Age I–IIA (pottery) (Ben-Yosef et al., forthcoming b).

**Wadi Fidan-40 (30.673926N, 35.381107E)**

Wadi Fidan 40 (Fig. 21.9) is the largest Iron Age cemetery site in Edom and situated on a Pleistocene conglomerate terrace that forms a low plateau overlooking the Wadi Fidan where it debouches into the Wadi Araba. This terrace abuts part of the Jabal Hamrat Fidan mountain range on the eastern side of the Araba valley. The cemetery marks the western entrance or ‘gateway’ into the Faynan district. Wadi Fidan 40 was first discovered by Raikes (1980, 1985) and called Site D. It was later recorded in B. MacDonald’s survey as SGNAS 14. R. Adams probed the site in the late 1980s (Adams 1991). These early researchers dated this mortuary site to prehistoric periods ranging from Neolithic to Early Bronze Age. By 1997, our UCSD–DOAJ team initiated large scale excavations at the site (Beherec forthcoming; Levy et al. 1999, 2004a), renamed the site Wadi Fidan 40 to fit with the project’s regional survey and securely dated it to the Iron Age. In 2003 and 2004 emergency excavations were carried out by Levy and Najjar on behalf of the DOAJ (Levy et al. 2005a). The site is large and extends over an area of c. 3,450m². A total of 287 tombs and graves has been excavated to date. The exact number of graves present is difficult to estimate but may range from as low as 1500 to over 3000. The typical tomb consisted primarily of sub-surface cists lined with sandstone or cobble slabs accompanied by a circular stone-lined installation on the surface. The absence of settlement sites in the vicinity of the vast mortuary complex, the style of graves and the character of their burial remains has led our team to suggest that the cemetery belonged to a nomadic community –
perhaps the Shasu nomads known from 16th to 10th century BC ancient Egyptian texts (Levy et al. 2004a; Levy 2009). High precision radiocarbon dating indicates that most of the tombs date to the 10th century BC (Levy et al. 2005a). Preliminary toxic metal studies of the human remains from this cemetery hint at the possibility that some members of this community were actively engaged in smelting activities during the Iron Age. To date, the Wadi Fidan 40 cemetery provides the best dataset for linking a local human population to the mining and metallurgy activities carried out in Faynan during the Iron Age. The nature of this nomadic population–production relationship is just beginning to be investigated (Levy 2009).

**Wadi Fidan 4 Iron Age Tombs (30.671285N, 35.384405E)**

Wadi Fidan 4 is the best preserved Early Bronze I (c. 3600–3300 BC) village and metal-working site in the Faynan region. It is located on the south bank of the Wadi Fidan opposite the extensive Wadi Fidan 40 cemetery site. Wadi Fidan 4 was interpreted by its first excavators to be a Chalcolithic village connected with the Wadi Fidan 40 cemetery – also first interpreted as a Chalcolithic site (Adams and Genz 1995). These researchers noted the presence of a number of tumuli on the northeast edge of the site (Adams and Genz 1995, 8). Later studies by the UCSD-DOAJ team have shown Wadi Fidan 4 to date mostly to Early Bronze (Levy et al. 2001). Salvage excavations in 2003 carried out by our team revealed that the tumuli were in fact isolated Iron Age tombs. The material is currently being prepared for publication (Beherec forthcoming). Wadi Fidan 4, Tomb 1 consists of a large cairn immediately beneath which were revealed the capstones of a cist grave (Fig. 21.10). Within this grave a total of eight individuals were found with Egyptian amulets and other objects. It is possible that Wadi Fidan 4 was used during a phase of the Iron Age when the main cemetery located at WFD 40 was abandoned.

**Khirbat Hamra Idfan (KHI; IA slag mound: 30.661394N, 35.392700E)**

Khirbat Hamra Idfan (KHI) is located on the south bank of Wadi Fidan near the small oasis of ‘Ain Fidan. It was investigated by various scholars, including extensive excavations of the Early Bronze Age settlement specialized in metal production by our team in 1999–2000 (Levy et al. 2002). This work showed KHI to be the largest EB copper production site in the ancient Near East. In 2007 we conducted another season of excavations at the site focusing, in addition to the EB remains, on the large ‘slag mound’ on the eastern side of the site. Archaeomagnetic dating of the slag indicates that the smelting here was part of the Iron Age.
Age copper production activities in Faynan (Ben-Yosef 2010, 460–463) This confirms earlier dating based on survey and technological typology of the slag (e.g. Hauptmann 2007, 134). An unpublished radiocarbon date from the 2000 excavations at Area L conforms to this dating (2910±41 BP; 1192–1021 BC 68.2% and 1261–995 95.1% probability; OxCal v.4.1, © Ramsey 2010; Stratum IIIA, L. 3034, B.45344, RC23, mixed context of EBIV pottery, bones and loose sediments). While the centre of late 11th to 10th century BC Iron Age copper production was at KEN and KAJ in the vicinity of Wadi al-Ghuweiba, production at KHI was most likely part of the more ephemeral smelting that took place along the margins of the ‘Arabah valley at this time, documented in our site surveys in the Wadi Fidan area briefly described below.

**Rujm Harm Ifdan (RHI; Iron Age watchtower; 30.672203N, 35.390267E)**

During his surveys in the Edom lowlands during the 1930s, Glueck (1935) identified structural remains on a small *inselberg* on the north bank of the Wadi Fidan as an Iron Age watchtower. There has been some confusion over the name of the site (Adams 1992), however, based on Glueck’s notes and interviews with locals in the field we have called this site Rujm Hamra Idfan. The site is located at the confluence of Wadi Fidan with the secondary drainage known as Umm edh-Dhuhur. Our team made two 5 × 5m sondages at the site: a) just below the summit of the *inselberg* where Glueck had identified the foundations of a small watchtower and b) in an area adjacent to a large wall enclosure at the base of the site (for a brief report see Levy et al. 2008). The 14C results are especially important because it is the only site in the Edom lowlands where evidence of both Iron Age IIA 10th century BC and Iron Age IIC 7th–6th century BC occupations have been documented in stratified excavations. The rich ceramic assemblage for these two phases will be published (Smith and Levy forthcoming).

**Wadi Jariya survey (30.710N, 35.456E, central location)**

The areas of Wadi al-Jariya and parts of Wadi al-Ghuweiba were surveyed by our team in 2002 (Levy et al. 2003) and 2007 (Knabb et al. forthcoming). In addition to various Iron Age campsites and small cemeteries, we recorded a concentration of mines along Wadi al-Jariya and its tributaries (in 2002 with the help of the DBM team). About 50 mines have been recorded. In at least 26 mines some indicative Iron Age sherds have been reported. All of the...
Iron Age mines are dug in the lower Umm Ishrin formation to get to the ore-bearing horizon of the Burj formation (also known as the DLS unit), and in many of them there is additional evidence of earlier, Early Bronze Age exploitation, similar to the situation in Wadi Khalid documented by the DBM team.

**Wadi Fidan survey (30.669N, 38.389E, central location)**

Wadi Fidan is the western gateway to the Faynan region. In addition to the excavated Iron Age sites mentioned here (WF40, WF4, RHI and KHI), several other Iron Age sites were recorded in surveys only. The Wadi, from the ‘Ain Fidan oasis to the Arabah, was surveyed by our team in 1998 (Levy et al. 2001) and 2004 (Knabb et al. forthcoming). The detailed surveys resulted in the documenting of several Iron Age sites, including cemeteries, campsites and a few small copper production sites that demonstrate smelting on a small scale and probably with simpler technologies than those utilized by the major IA sites in Faynan. A similar phenomenon was reported recently from Timna (Ben-Yosef et al. 2010b).

**Faynan – Busayra Regional Archaeology Survey (FBRS)**

During the summer of 2007 our team conducted a regional survey aimed at tracking and recording Iron Age roads in the northern Faynan region and in the area between the lowlands and highlands of Edom (Ben-Yosef et al. forthcoming a). The main road connecting the copper production center of Ras al-Miyah in Faynan and Busayra on the Jordanian plateau was identified and documented, together with other ancient routes and scores of Iron Age and other sites.
**Jabal al-Jariya mines (JAJ; 30.695°N, 35.430°E)**

During a regional survey conducted in 2007 (FBRS, see above) our team discovered extensive pit mine fields (placer) in the region of Jabal al-Jariya (Ben-Yosef et al. 2009a). The main field, JAJ-1, is located around 30.695°N, 35.430°E. One of these pits was excavated by us in 2009 and the results of optically stimulated luminescence (OSL) dating supported its Iron Age date (Ben-Yosef 2010, 466–499). These mines introduce a new mining technology, not previously reported from Iron Age Faynan. The hundreds of pits, easily visible on a satellite image, were probably the main source of copper for sites like Khirbat en-Nahas. Interestingly, similar pits were reported from Timna Valley. Most of the c. 9,000 well-known ‘plate-like’ features in Timna were eventually interpreted as blocked mining shafts from the New Kingdom period; however, in three areas they were interpreted as pit mines (Areas A, C, and G, see Conrad and Rothenberg (eds) 1980) and demonstrate similar characteristics to the new mine fields in Faynan. The mines in Timna were tentatively dated to a much earlier period, based on the simplistic assumption that simple technology corresponds to an earlier stage in the metal exploitation of the region. We believe that re-investigation of the Timna mines is needed to further clarify their age.

**Chronological framework**

To date, more than 115 Accelerator Mass Spectrometry (AMS) radiocarbon dates have been produced from our stratified excavations of the Iron Age sites in Faynan. While most of the dates were processed in collaboration with Thomas Higham of the Oxford Radiocarbon Accelerator Unit (Higham et al. 2005; Levy et al. 2004b, 2005a, 2008, 2010a), some have been made in Groningen (Higham et al. 2005) and non-ELRAP dates in Heidelberg (Hauptmann 2007). Our work has included the systematic application of Bayesian analyses to strengthen the precision of the dating models used. The result is a new chronological framework that pushes the occupation of Edom back to the 13th century BC. Prior to our project researchers argued that the Iron Age occupation of Edom was late and only began in the 7th and 6th centuries BC (Bienkowski 1992; Bienkowski and van der Steen 2001). Consequently, our work has been at the centre of debate concerning the history and archaeology of Edom and its relations with neighbouring ancient polities (Ben-Yosef et al. 2010a; Finkelstein 2005; Finkelstein and Singer-Avitz 2008; Levy 2010; Levy and Najjar 2006; Levy et al. 2006, 2010a; van der Steen and Bienkowski 2006). Additional chronometric dating for the Iron Age of Faynan comes from our archaeomagnetic studies focused on examining changes in the intensity of the magnetic field (Ben-Yosef 2006; Ben-Yosef et al. 2008a; Ben-Yosef et al. 2008b, 2009b, 2010b). Taking all this together, the following is a summary of the chronological implications of our work:

- The majority of Iron Age radiocarbon dates for Faynan span the 12th to 9th centuries BC demonstrating industrial scale production in the Iron Age IIA–B (10th to 9th centuries) with little evidence for later Iron Age IIC (7th and 6th centuries BC) metallurgical activities. Some indications exist for small scale copper production in Faynan already in the Late Bronze Age (Ben-Yosef et al. 2010a).
- The 14C dates are coupled with stratified excavations making it possible to establish new quantitative-based Iron Age ceramic typologies for Edom (Smith and Levy 2008, forthcoming).
- While industrial copper production peaks in the 10th–9th centuries, there is a fundamental change at the end of the 10th century BC with a disruption at KEN-M; abandonment of KAJ, and associated technological changes. This may be linked to an incursion at the site by Egyptian forces under Pharaoh Shoshenq I (Levy et al. 2008). There is a major abandonment of sites in the lowlands of the Faynan district of Edom at the end of the 9th century and a shift in political centralization up to the highlands of Edom. The evidence for Late Iron Age occupation in Faynan focuses on the RAM Complex and limited evidence from Khirbat Faynan. The issue of late Iron Age metal production in Faynan is still difficult to interpret.

**Chaîne opératoire**

The basic components of the Iron Age metal production process in Faynan were established by the German Mining Museum team (e.g. Hauptmann 2007). Our ongoing research and extensive surveys and excavations in Faynan provide the social, cultural and historical context of the mining and metal production Iron Age societies. Our work provides additional data to refine previous archaeometallurgical observations on Iron Age copper production. To achieve this, we employ the chaîne opératoire approach of anthropological archaeology to help understand copper exploitation in this region throughout the entire Iron Age sequence. The basic scheme of activities, from mining and smelting to the export of the final products (copper ingots), is presented in Fig. 21.11. Preliminary results of our research include a few new insights about the arrangement and practice of copper exploitation in Faynan. For example, we have recognized that in addition to the major copper production sites, smelting was done also on a small, opportunistic scale with simpler technology in more ephemeral locations. In addition, the laboratory research, partially done in collaboration with the DBM with the kind support of A. Hauptmann, indicates a major technological change between the early part of the
Iron Age and the latest phase of copper smelting in the Arabah. In the early part, smelting was practiced with the same well-documented technology as the one documented in the Late Bronze Age Timna sites. The later, dated to the 9th century BC, is a more advanced technology with larger installations and distinct tuyères. As mentioned above, the large collection of artefacts and the database of our field work promise further detailed insights on the Iron Age practice of copper exploitation in Faynan.

**Conclusion – technology and society in the Faynan region during the Iron Age**

In light of our recent research in Faynan and the consequent new chronological framework for the Iron Age sites in this region, we suggest that the north-eastern Arabah Valley was the crucible of the Edomite polity known from the Hebrew Bible and other ancient Near Eastern texts (Bartlett 1989; Kitchen 1992; Millard 1992). It is now clear that elaborate organization of copper exploitation activities is represented in the archaeological remains already in the early Iron Age. This industrial scale organization, especially during the 10th and 9th centuries BC, could have been managed only by a complex society, which we believe consisted of the local semi-nomadic tribes (this is supported by different studies of the material culture not presented here; see Levy et al. forthcoming and references therein). The local population, triggered by new opportunities for exploitation of economically viable natural resources, went through a rapid process of social development which was the basis for the foundation of a tribal kingdom. Only later, during the Iron Age IIB–C, when the copper exploitation ceased to be profitable or a worthwhile practice (possibly because the area became a conflict zone, as may be indicated by the massive Iron Age IIB–C fortresses of RAM described...
above), the core of the Edomite polity moved up to the plateau, close to the flourishing agricultural landscape and Arabian trade routes. The late Iron Age occupation of southern Jordan is represented mostly by the administrative centre of Busarya (Bienkowski 2002), defensive sites such as Umm al-Biyara (Bennett 1966), agricultural settlements like Tawilan (Bennett and Bienkowski 1995) and other sites.

Conflict between Edom and neighbouring polities such as ancient Israel, Moab, and the centres of ancient Near Eastern civilization such as Egypt, mentioned in historical texts, cannot be ruled out. The possibility of shifting control over territory in this part of southern Jordan and the Negev desert is extremely difficult to document archaeologically and is currently under investigation by our team. However, the new chronometric dating framework for the Iron Age of this part of the southern Levant and especially the new insights concerning the nature of social organization and industrial copper production during the 10th and 9th centuries BC established by our team provide researchers with a substantial new reference for investigating the history of this important region of the ancient Near East.

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