Report on First Season of the Barqa Landscape Survey, South-West Jordan

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The Barqa Landscape Survey, directed by Russell Adams (McMaster University, Canada) and co-directed by James Anderson (North Island College, Canada), undertook an archaeological survey of the Barqa Region of the Faynan District, between July 1-28, 2009. The project was supported by a grant from the Social Sciences and Humanities Research Council of Canada, sponsored by McMaster University and affiliated with the Council for British Research in the Levant (CBRL).

Context of the Research

Over the last decade significant progress has been made in understanding the development and spread of early copper technology in ancient Western Asia. A major centre of this research has been in the Faynan region of southern Jordan, the oldest and largest industrial landscape of the ancient world. At Faynan a number of researchers have been actively investigating the technological development of metallurgy and the implications of these developments upon social evolution during later prehistory. The technological investigation into early mining and smelting was begun by Hauptmann, whose Early Metallurgy Project (1985-1993) formed the basis for subsequent investigations (Hauptmann 2000, 2007). The archaeological investigations of early metallurgical production sites was pioneered by Adams first as the focus of a PhD thesis (1989-1993) (Adams 1999) and later expanded by the applicant as a collaborative project (1997-2002) (Levy and Adams et al. 2001).

To date these archaeological investigations have resulted in a small-scale survey focused upon the Wadi Fidan drainage and extensive excavation of two major and highly visible sites in the same wadi. The first site dates to the developmental phase of metallurgy in the mid-fourth millennium BC (3600-3300 BC), and the second is a large production centre dating to the mid-third millennium BC (2600-2300 BC). The cumulative result of these investigations has been the development of a sequence for the evolution of early metallurgy spanning this period, which suggests a change from small-scale, village-level production (Adams and Genz 1995; Adams 1999), to highly-developed, large-scale, intensive production by the end of this period (Adams 1999, 2002; Levy and Adams et al. 2002). Intensive ‘industrialized’ production emerges at the beginning of the third millennium BC (c. 2900 BC), at a time when other social changes were occurring in the Levant. Previous scholarship has noted a significant increase in the appearance of copper products at this time throughout the eastern Mediterranean, but recent work at Faynan in Jordan provides the first evidence of these processes from the perspective of the copper production sites (Adams 1999, 2002, 2003). At Faynan, the details from the excavations at these two sites have provided answers to many technical questions regarding copper production including the chaine opérateur and the social use of space within these sites, but they still remain isolated sites within the wider region. The relationship of these sites to other local copper production centers and the overall scale and intensity of metal production remains poorly understood.

The overall scale of these activities is hinted at by the preliminary results of the ancient mining surveys undertaken by Hauptmann (2000, 2007) which revealed extensive mining in the Faynan region during the third millennium BC. There is also evidence of slag deposits throughout the landscape in various locations, at several of the dedicated primary smelting sites that have been investigated at Khirbat Faynan and elsewhere in the region (Hauptmann 2000, 2007). To date, however, we lack a robust quantitative analysis of data which will allow us to determine the overall scale and distribution of production activities during the third millennium BC.

The best preserved and last remaining prehistoric landscape in the Faynan region lies to the south of the Wadi Faynan, in the region of Barqa, an area of approximately 100 square kilometers, along the edge of the Arabah rift valley. During the early 1990s Hauptmann’s ‘Early Metallurgy Project’
conducted limited excavations in the Barqa region at the site of Barqa al-Hatiye (another highly visible site). Exposure there of a well preserved building radiocarbon dated to the earliest phase of intensification of copper production (2900-2700 BC) suggests that the Barqa region will provide further evidence of this transitional phase of copper production (Fritz 1994a, 1994b; Adams 1999, 2003). The results of a very limited and undocumented reconnaissance revealed that the surrounding landscape was densely populated during the third millennium BC and contained numerous structures and features with archaeological finds similar to those found at the third millennium BC site at Khirbat Hamra Ifdan, the largest and best preserved copper production centre in the Old World (Levy and Adams et al. 2002). This reconnaissance suggests that numerous metal processing activities took place in the Barqa region at this time, as evidenced by visible building remains, slags, and extensive metallurgical production waste. The Barqa region is therefore a key zone for the understanding of copper production at Faynan, and may provide important data towards understanding the context of the intensification of copper production during the third millennium BC.

Theoretical Overview

To date there has been an overemphasis upon looking at the adoption and early spread of metals in society from the consumption end of the metallurgical cycle, largely through metal objects derived from ‘elite’ burials. The recent research at Faynan described above has begun to redress this imbalance, with research efforts focused upon the technological advances and intensification of copper production during the third millennium BC — a pivotal time in the advancement of both complexity in the region and in the adoption and spread of metallurgy. A great deal has been learned from surveys of mines, analysis of ancient smelting furnaces and associated ores and slags and from limited excavations of large visible sites related to copper production. We have been able to ‘fingerprint’ the ores of the region through isotopic analysis and have begun to trace both copper ores and metal throughout the region and to understand the complex trading networks which developed to distribute these metals (Hauptmann 2000, 2007; Adams 2006). On the basis of this evidence it has been possible for the first time to develop a model for this phase of expansion of copper production, from the copper production zone, and to delineate specific changes in social processes and technologies that accompanied this expansion in the use of metals (Adams 1999, 2002). However, our model building is at best only preliminary, since most evidence to date has come from a limited number of large sites: These isolated excavations provide only a snapshot of events and processes without enough contextual evidence to prove that they are representative of copper production sites and activities across the Faynan landscape during the third millennium BC.

The evidence to date from excavated sites suggests that copper producing activities which had remained small-scale/low intensity operations throughout the fourth millennium BC suddenly and very rapidly changed during the early third millennium BC to large scale/high-intensity operations conducted by specialists. One possible reason for these changes and the resulting re-organization of production activities and scales of production may have been the increasing consumption of copper by emerging elites. Possible models for production range from some form of a hierarchical organization of production such as attached specialization (Costin 1991; Adams 1999, 2002) at one end of the spectrum to a heterarchical organization at the other (Crumley et al. 1995). To date, without the evidence that is available from the less visible sites in the region the data are insufficient to fully support either of these models. In order to build up an accurate picture of these social and technological changes it is important to have a broad sample of data from production, habitation and other types of sites. The ability to provide this contextual background relies upon the collection of less visible and less easily accessible evidence in the landscape. Therefore in order to advance our understanding of this phase of metallurgical development it is imperative to be able to understand the distribution of and relationship between all types and sizes of sites related to production and related activities across the landscape. The Barqa Landscape Survey (BLS) has been designed to fill this gap in our knowledge through investigation of the archaeological and environmental evidence for intensification of copper production across the broader landscape.
Objectives

To date, investigation of early metallurgy at Faynan has concentrated upon mining and smelting sites (Hauptmann 2000, 2007) and upon limited evidence from only a few large and highly visible sites (Adams 1999, 2000, 2002, 2003; Levy and Adams et al. 2002). The Barqa Landscape Survey seeks to expand our understanding of the scale and intensity of copper production by documenting the environmental impact of copper production in the wider region from a variety of natural and archaeological contexts (cf. Grattan et al. 2003a, 2004, 2005, 2007). Our intention is to move the common research paradigm away from hypotheses which focus on site-based problems and solutions and instead encourage hypotheses which explore critical aspects of human development which can be enlightened by a landscape based approach (Wilkinson 2003).

Theoretical models for the intensification and changes in technology of copper production suggest that the processes which are observable in the larger production sites should be discernible in the wider landscape, with a number of production centers of similar (or differing) types (Adams 1999, 2002). The Barqa Landscape Survey seeks to test this model of intensification of production through an analysis of the less archaeologically visible production sites in the region, and to identify the nature and distribution of these sites in the landscape.

Using a combination of archaeological survey, space-borne multi-spectral analysis, sampling excavations and geochemical mapping we are examining this early industrialization from the production residues and palaeoecological materials preserved across and within the ancient landscape. The geochemical analysis of dated contexts will inform us about the ore bodies being exploited at different periods, the efficiency of the smelting process and the impact of these activities on the environment. These chemical fingerprints will enable us to identify the magnitude and intensity of these activities at different periods and the organization of the landscape in support of them.

Similar research already has been undertaken successfully in the eastern Faynan basin (adjacent to the Barqa region), in order to explore and document the impact of Imperial Roman mining and smelting activities (Grattan et al. 2003b; Hunt et al. 2004; McClaren et al. 2004; Pyatt and Grattan 2002a, 2002b, 2005; Pyatt et al. 2000). This prior research has allowed us to develop the key techniques and methods which can be employed in looking at the prehistoric landscape in similar detail, and with equal success.

The copper ores of the Faynan region are infused with lead — which is unusual — and as a result pollution and health problems stem from the release of lead and other associated suites of very dangerous metals (beryllium, cadmium, chromium, arsenic, nickel, mercury) whilst smelting copper. The Faynan evidence indicates that these metals accumulate and stay in biological systems causing substantial health problems. To date, geochemical analysis of Holocene sequences in this region suggest a model of increasing environmental degradation from the third millennium BC onwards. Through extensive sampling of a variety of sites and geographic locations identified through the survey and excavations, this project seeks to identify correlations between areas of maximum pollution intensity, metal extraction and smelting, and settlement and industrial patterns. This evidence is important to understand the patterns of human activity, industry and natural processes in this region over the span of the third millennium BC, and are also equally important to understand continuing problems of environmental pollution up to the present time (Grattan 2003; Grattan et al. 2003a, 2005; Pyatt and Grattan 2005).
The Barqa Landscape survey runs cardinally (True North) and has the following coordinates (WGS84 spheroid): NW corner: Northing = 3389910.253; Easting = 726438.631; NE corner: Northing = 3389910.253; Easting = 736438.454; SE corner: Northing = 3379910.253; Easting = 736438.454; SW corner: Northing = 3379910.253; Easting = 726438.454. The survey area comprises 100 square kilometers, and is divided into four quadrants (Figure 1).

An initial control survey was conducted in the North-West quadrant to establish highly accurate monuments across the Northwest quadrant of the Barqa Landscape Survey area in order to spatially reference archaeological data to be collected in subsequent phases. The coordinates of the first monument of the control survey were established with known points in Google Earth. The corners of four houses in the southernmost area of the town of Qurayqira were given placemarks with geodetic coordinates, and then saved in a kml file. These were then converted into Cartesian coordinates and entered into a data collector. Having found the four houses on the ground with the Magellan hand-held GPS, we conducted a four point re-section with the Total Station of the house corners to establish in three dimensional space the first control monument, RB 51. From RB51, RB 52 on the top of a nearby Jabal was tied in with the Total Station. RB54 was then tied in from RB52, and so on until we reached RB63. From there we tied in our original station RB51, and compared the starting and terminal coordinates. As the Relative Precision of 1:11,000 was acceptable, we then adjusted the survey control net through a Compass Rule adjustment.

The survey work this year was primarily confined to an area of about 5 square kilometres in the North-West quadrant of the survey zone (see Figure 1). The project began with a systematic, random and stratified pedestrian survey (See Figure 2) which recorded visible archaeology in the landscape, including architecture, pottery, flint and other artifacts. Each quadrant of the survey zone was divided into 500m squares, and every second of these was allocated for survey. These selected 500m squares were divided into one hundred 50m ‘units’, which were chosen at random. The number of ‘units’ to be surveyed in each 500m square was chosen based upon ‘Areas of Interest’ identified with the aid of Hyperion satellite data and also by geographical landforms. Areas of interest identified by Hyperion satellite data were allocated ten 50m units, areas with large outcroppings of granite/dolomite, or obvious sand dunes were accorded two 50m units, and all others five 50m units (see Figure 3). This initial phase of survey was followed by a Phase Two comprised of a more intensive survey of areas that had produced the most artifacts and sites in the NW quadrant.

The survey was divided into two teams, Red and Green, consisting of about 8 people, led by a survey leader and an assistant. Team Green was accorded the squares in the western half of the NW quadrant, and Team Red the eastern half. Each team used hand-held GPS units which were uploaded daily with the NW and NE corner of each 50m unit to be surveyed. Each team would find the NW corner of the 50m unit to be surveyed with the aid of the hand-held GPS, and using a compass set due south (accounting for a 3° 56ʺ declination), the team leader would align the team from north to south. The team leader would then orient the team towards the next (NE) waypoint. Each member of the team then would move directly east over the 50m unit, scanning the ground in front and to either side for artifacts lying on the surface. These artifacts would be collected and accorded to the 50m unit, unless they belonged to a specific site (see below). Each team would designate one member to write tags and bag artifacts from the unit being surveyed.

When a site was identified, the centre point was given a waypoint, the dimensions measured with a tape measure, and a photograph taken. All of the artifacts collected from the surface then would be accorded to the identified site.

Once the survey team had arrived back at the clean lab, the site waypoints would be downloaded from the handheld GPS receivers and entered into the GIS (see below). The artifacts collected on the survey would be submitted to the ‘dirty’ lab for processing and analysis.

Once Phase 1 of the survey methodology had been completed, Phase 2 comprised a more intensive survey of areas that had produced the most artifacts and sites in the NW quadrant. The area around the ‘Barqa houses’ excavated in 1990 and 1993 (Fritz 1994a, 1994b; Flender nd.)
produced the most artifacts, and it was around this area that an intensive (full coverage) survey was undertaken (see Figure 4).

**GIS Methodology**

The basis of the GIS analyses performed during this field campaign rested on a combination of spatial data (the survey grids and sampling areas, collection and analysis points, and sites), and tabular data (site records, ceramic analyses, XRF data, etc.). These various data were housed in several specific geodatabases and manipulated via Microsoft Access (see Figure 5).

Spatial data consisted mainly of data generated by the survey teams (described above) using handheld GPS units (a Garmin etrex Vista and a Magellan Triton 400) and control data from total station survey stored in AutoCAD formats. AutoCAD maps and corresponding data, such as the survey grid and control points prepared during Phase 1 of the survey, were brought into the GIS and transformed into geodatabase formats. During the pedestrian surveys of Phases 2 and 3, GPS waypoints were taken when survey teams located archaeological sites, significant landscape features, modern fields, or when specific non-site collection areas were recorded (for example along the north slope of Barqa hill). All new GPS points were downloaded daily from the handheld units, using MapSource 6.15.6 and Vantage Point 1.60 software packages, and incorporated into the appropriate geodatabase. Sites and collection areas became part of the Survey2009 geodatabase in both point (center point) and polygon (boundary) form. Waypoints corresponding to XRF reading locations became part of the pollution study geodatabase, and landscape features became part of a control geodatabase.

In addition to the spatial data, these various databases also house the tabular data generated by this field campaign, available as tables through Microsoft Access. Site record forms were entered daily into a master table designed to store this information. Other information was entered as needed or once analysis had been completed.

By combining the spatial and tabular data in various ways within Access, and then marrying these results back into the visual component of the GIS, we are able to analyze data quickly and comprehensively. The tabular and spatial data were combined by building a series of queries within the geodatabase using Access, joining the quantifiable table data and spatial locations through unique identifier fields such as survey unit or site number. We have also used Access queries to recombine and select specific categories of data relevant to the research hypotheses. By keeping the unique identifier of each piece of spatial data involved in the joins, the results of each query were easily made visible in the GIS software. We have thus used the analytical power of Access and the visualization power of GIS software to effectively attribute spatial information to tabular data and vice versa.

Particularly for the pollution study and XRF data, the ability to visualize results daily within the GIS allowed for in-field testing and modification of research hypotheses. For the pedestrian survey, the use of GIS allowed us to update survey phases to more effectively utilize project time and resources.

**Results of Season One of the Barqa Landscape Survey**

**Environmental studies**

The focus of the environmental research in the 2009 season was to establish baseline parameters whereby phases of chemical enrichment and environmental impact of ore processing activities could be identified confidently. Our research design was based extensively on prior knowledge of the nature of the metals cycling in the local environment developed over 15 years of research in Jordan (cf. Grattan et al., 2003, 2005; Pyatt and Grattan 2005). Our research focused primarily on mapping the lateral extent of the metal working signature from known locales such as the Barqa smelting site, and by exploiting vertical sedimentary exposures in the survey area we were able to identify ancient land surfaces and assess their palaeoenvironmental potential. Our research was enhanced by the first archaeological use of a NITON hand held XRF instrument. This allowed us to accurately determine the geochemical content of sediments *in situ*, without the need to excavate or
collect samples. In this brief field season we analysed over 1400 samples and were able to develop our research and sampling methodology constantly, informed by the results of our testing and sampling regime.

Baseline sampling

To establish the pre metal working geochemical signature, the Faynan Gravels, a Pleistocene fluvial unit exposed in the modern Wadi Faynan and mapped by Hunt et al (2005, 2007), was analysed. These sediments were found to contain mainly strontium, rubidium and iron, which are ubiquitous indicators of natural erosion (Grattan et al., 2007) and no detectable concentrations of copper, zinc, manganese, arsenic, lead, antimony or tin, which suggests that where these metals are detected in association with each other in the survey area they may indicate metal processing activity and not the fortuitous accident of natural erosion and deposition.

Firepits exposed in a pipeline trench adjacent to Barqa Hill

A reconnaissance was made of a long trench (Lat 30.595878° Long 35.378344°) dug by the Aqaba Development Authority to carry a new water pipeline. The section exposed within the trench consisted of a upper layer approximately 5 cm thick which consisted of a chert scree which sealed wind blown sand exposed to a depth of at least 1 metre. Within this trench several firepits were identified within the blown sand between 30-50 cm below the surface. No cultural material was found in situ, but within the spoil cast up by the excavation of the trench several Neolithic flakes were found. XRF analysis on the windblown sands and the firepits indicated the normal presence of strontium, rubidium and iron and the absence of any chemical signature indicative of industrial activity; at this point in time we may infer that the environment was uncontaminated by industrial activity and that the ore bearing strata in the region were undisturbed.

Palm Tree Pit

Three palm trees grow in the middle of a very shallow hollow (Latitude 30.603808°, Longitude 35.379978°) to which very low angle slopes lead down, several of which are relatively rich in archaeological remains. It is the current topographic low in the area. The adjacent low angle surface also supports small “cockpit dunes”, with a higher content of silt; the surfaces are crossed by linear dunes of red-brown sands. The hollow had been excavated by a backhoe (purpose unknown) with the spoil left adjacent to the site. The spoil was a grey, perhaps sediment from an anaerobic environment, as might occur at an oasis. Evidence of metal working activity in the past was detected in two palaeosols identified in a water prospection excavation trench dug within a grove of palm trees located 182 meters downslope to the northwest of Barqa Ridge, House 2. Each of the palaeosols was modestly enriched in copper (Figure 6), which conforms the potential of test pitting and pollution studies next season. The concentrations of copper in the palaeosols is similar to the concentrations of copper below 50cm depth discussed in the section below (Barqa Settlement Gully) and indicate that these may be contemporaneous events.

The oasis-pool may have occupied this location for much of antiquity, could have spread along the topographic low in which it is currently located – may have been a major focal point for people in the past, as new. Many of the low angle surfaces in the vicinity seem to lead down to it. The modern date palms provide a measure of the future well-being of the aquifer which reaches close to the land surface hereabouts.

Barqa Settlement Gulley

Between the Barqa smelting hill and the main settlement site lies a narrow wadi (Longitude 30.600185°, Latitude 35.381156°). Exposed in the wadi is a body of sediment which has been provisionally identified as a flood loam, overtopped by blown sands. Our field observations suggest that this deposit is formed from two major floods in a desertic environment in which there was much silt and sand to be eroded. The later stages of each flood caused the surface of the flood deposit to be reworked. Sand dunes then accumulated over the flood deposits. The dune surface eroded, with a stream moving east, eroding a linear gully, parallel to the ridge of Barqa Smelting
The surface of the sand dune unit consists of copper ore, copper prills, pottery and crushed slag fragments. The exposure was analysed to determine the history of metal working in this location, specifically whether the obvious metal processing debris visible in the uppermost horizon was the only evidence of metal working.

It is clear from Figure 7 that a considerable history of copper processing is present. Between 300 and 76cm depth, copper is present at concentrations generally below 125 ppm. This suggests that copper was present and being distributed across this landscape, but that the activity was small scale and probably not in the immediate vicinity. As noted above these concentrations are similar to those seen in the palaeosols identified in the Palm Tree Pit. From 76cm depth to 32 cm it can be seen that the concentration of copper cycling in the environment generally increases until a profound increase in the copper values to well over 1000 ppm concentration at 30cm. Our current interpretation is that this indicates a significant increase in the scale of copper smelting activity and that this activity is close by. It is interesting to note however that there is no archaeological evidence for this activity in the sediment: this activity phase is identified only by the geochemical signal. This intense phase of activity appears to reduce somewhat at 14cm depth until 5cm depth, when the 5cm thick surface deposit is encountered. In this deposit, for the first time, archaeological material, slag, ash, pottery, copper prills and ore are encountered and attributable to the Early Bronze Age, roughly the early third millennium BC. Analysis in the field of the copper content of pot sherds lying on this archaeological surface revealed copper values of between 32-165 ppm. The metalworking history indicated in this wadi gully reveals a hitherto unknown depth to the story and confirms the value of palaeoenvironmentally focussed geochemical reconnaissance studies.

Barqa Smelting Hill – lateral pollution dispersal study

Earlier research by Grattan et al., at Khirbet Faynan (Grattan et al., 2007) has identified significant dispersal of pollutants from the copper smelting activity at this site. Guided by this experience the dispersal of copper from the main smelting site at Barqa Hill was investigated. Several transects were walked with analyses of the sediment chemistry being conducted every 50 metres. The results of this investigation are presented in outline form in Figure xxx, but in summary broad conclusions may be reached. Much of the north facing slope of Barqa hill is profoundly contaminated by copper and other heavy metals, such as cadmium, and manganese. In contrast the south facing flanks are uncontaminated, with the exception of two gullies which drain south from the smelting carpet on the summit ridge. To the north of Barqa hill, metal contamination reaches just beyond the ridge where Barqa houses 1 and 2 lie, but peters out quite quickly beyond these to the topographic low occupied by the palm trees discussed above. To the north west it was possible to identify the Bronze Age settlement on the basis of its significant metal content, whilst it is worth noting that the adjacent Iron Age settlement is largely uncontaminated. This may confirm suggestions that Barqa is not being used as a smelting or processing site during the Iron Age, it may also indicate that a Bronze Age settlement may underlie the Iron Age material.

Summary

These explorations represent the first ever use of a Niton hand held XRF in geoarchaeological research. We have established that the pre metal working environment was essentially pristine, with no heavy metals cycling. This picture changes profoundly from at least the Early Bronze Age with copper, lead, cadmium, manganese, antimony and nickel released into the environment at this time and continuing to cycle throughout the environment until the present day.
Archaeological Survey Results

The Results of the Pedestrian Survey

The pedestrian transects of random 50 x 50 m survey units during Phase One of the survey helped to define a total of 107 sites, most of which were concentrated in the NW quadrant. The survey teams located a wide variety of types of sites, including concentrations of flint and pottery, architectural, funerary and industrial sites. The definition of site perimeters was undertaken every time a site was found, and these were mapped using the hand-held GPS units. When during the survey no archaeological sites were found or defined, background collections of artifacts were bagged for each 50 x 50 m unit. The collections of archaeological materials were therefore logged as “site” or “unit” collections for further processing.

Each archaeological site defined by the survey teams was logged on a site sheet and standardized information was recorded about each site, including: GPS Waypoint, Site Dimensions, Site type, Wall construction information, types of archaeological materials collected, Aspect, Slope, Position on slope, Geomorphology, Drainage, Preservation, details of photographs taken and a general description of the site with a sketch plan where possible.

Once in the “dirty lab” archaeological materials were logged into the Master Survey Register. Metallurgical finds were categorized and weighed and counted, and flint and pottery were washed and re-bagged. In the absence this season of a flint specialist, the flint was prepared for storage and processing next season.

The pottery from “sites” was weighed and counted and sorted into diagnostic and non-diagnostic categories and analyzed to provide MNI data by period and pottery form. The “unit” pottery was similarly analyzed to provide background readings of the survey units by period. Information from both “sites” and “units” was entered into a Microsoft Access database, and this tabular information was used by the GIS Analyst to provide visual maps of the distribution of the pottery collections by period (Figures 8-11). The latter was particularly helpful for Phase 2 of the survey, during which an intensive, full coverage survey was undertaken of the region directly north of the Barqa Smelting Hill (Figure 4). The ongoing analysis of the ceramics through the GIS program allowed real-time analysis of the location of archaeological periods in the landscape. Although the primary focus of this research program has been the Bronze Age landscape and pollution intensities associated with it, the pedestrian archaeological survey also recorded a wide range of periods including the Early Bronze Age, Iron Age and Roman periods as well as a pre-Holocene occupation of the Bara region.

The Early Bronze Age Landscape north of Barqa Smelting Hill

The presence of Early Bronze activities in the Barqa region have been known since the work of Hauptmann and Fritz in 1990, when a prominent hill with evidence of smelting and large amounts of slag was investigated (the Barqa Smelting Hill site), and an adjacent structure on the flint knoll just to the north of this hill was excavated to reveal a well preserved, burnt structure dating to the Early Bronze Age II. Other smaller “cuts” were undertaken by the German Mining Museum team in the direct vicinity, but never published. The Barqa House 1 (according to Hauptmann’s site numbering) has been published by Fritz (1994a, 1994b), and later a more detailed analysis has been published by Adams (1999, 2003). The site is unique not only due to its prominent location near to the smelting hill, but also for its unusual architecture and surrounding wall, and the possibility that it may have served a cultic function.

Aside from noting that there was evidence of copper processing in the gully between the smelting hill and the Early Bronze Age building, Hauptmann and his team paid comparatively little attention to the surrounding landscape at Barqa. The survey results of the 2009 season of the Barqa Landscape Survey contextualize the work carried out by Hauptmann and show quite clearly that Barqa House 1 is not an isolated structure, but that there are concentrations of material, especially pottery and archaeometallurgical finds which attest to a much larger Early Bronze Age landscape to the north of the Smelting Hill and House 1 (Figure 8). This is confirmed also by the pollution sampling around Barqa, as well as in the Gully and the Date Palm pit (discussed above). One of the interesting aspects of this landscape is that it seems intermittent, but this may in fact be a function
of later Iron Age occupations overlying it (as in the case of BLS Site 21, below) as well as recent dune activity which seems to be more recent than anticipated.

**The Iron Age Landscape north of Barqa Smelting Hill**

Similarly to the Early Bronze Age, the Iron Age has been known since the 1990 excavations of Hauptmann and Fritz at Barqa House 2. House 2 is a large, multi-room structure, which is likely domestic in nature. The site was notable since the excavations produced both Midianite pottery and one radiocarbon date to the late tenth century BC. Unlike the Bronze Age, however, Hauptmann’s survey recorded a number of other buildings to the west and north-west of House 2. Although these were mapped, they were not surveyed and no collections were made (Figure 12).

The Barqa Landscape Survey recorded several large sites with significant amounts of Iron Age pottery. The most notable of these was Site 21, which covers an area of approximately 300 x 400 meters and which has obvious wall lines of buildings, numerous stone-built tombs, and large numbers of diagnostic Iron Age pottery (Figure 4). Mixed in with the Iron Age pottery, however, were concentrations of Early Bronze Age pottery, suggesting that the Iron Age site may overlay an earlier Bronze Age landscape. Site 21 and the other evidence of Iron Age ceramics in the vicinity of the other buildings to the north-west of House 2 suggest that this area was densely occupied during the Iron Age (Figure 9). Of interest however is the fact that little metallurgical evidence was found in conjunction with the Iron Age ceramics, suggesting perhaps that the Iron Age landscape here, as also suggested by the pollution analysis, was not primarily a metallurgical production zone at that time.

**The Roman Landscape north of Barqa Smelting Hill and Sites 87 and 67 in the NE Quadrant**

The survey throughout the NW quadrant of the survey area returned significant amounts of Roman/Byzantine pottery, spread over discreet “sites” and also from survey “units” (Figure 10). Although not surprising given the extent of Roman and Byzantine occupation at Faynan, it adds further evidence to the extensive nature of Late Antique occupation of the region. The widespread nature of Roman/Byzantine pottery in the Phase 2 total survey coverage area, suggests that this area, much like the Faynan Basin further north, was subjected to agriculture during this time. One hint at this may be the small and extremely fragmented pottery sherds found throughout this area, perhaps evidence of spreading manure.

The largest Roman site found in the survey zone was discovered through inspection of the Barqa Survey zone using Google Earth. Overviews of the area highlighted several interesting sites with clustered buildings, stone circles, and various other architectural features. Site 87, in the NE Quadrant was by far the largest of these and was very obviously a large complex field system, not unlike that along the Wadi Faynan, albeit on a smaller scale (Figure 13). An initial reconnaissance on July 1 revealed a large wall system fed by an elaborate hydraulic system, and pedestrian survey began in this area on July 3, 2009.

**Survey methodology**

The Google Earth image was geo-referenced in AutoCad into the WGS84 reference ellipsoid, and ‘wall systems’ were identified and labeled chronologically, beginning in the north-east and moving to the south-west. The first draft of the wall system was produced in AutoCad. The field walkers then used the first generation map in the field as a guide, and identified many walls and features not apparent on the Google Earth image. The artifacts were labeled according to the field units on the map (Figure 13). The edits made in the field were incorporated into Google Earth as far as was possible.

A Total Station survey was conducted to incorporate those features identified on the ground and not visible on Google Earth. Using corners of features visible on Google Earth, a 3 point resection established the 3-dimensional coordinates of a survey monument. Once done, three ‘intakes’ were tied in, as well as five cross-sections, as well as graveyards and wall features in the south-east corner of the wall system. All of these features were incorporated into Figure x, and the intakes and cross sections drawn as separate figures.
The mechanics of the Roman period field system at Site 87

Roman period long walls were constructed to direct water sources from the adjacent wadi through three intakes in the extreme north-east area of the overall wall system (Figure 13). Once into the system, an elaborate system of walls directed the course of water to areas directly in front of ‘field systems’. Although there is much infilling across Intakes 1, 2, and 3, their requisite cross-sections reveal narrow openings that perhaps were controlled by sluices. Intake 1 permitted water to run in a channel between the wall systems in the southern part of this area, and Cross-section 4 profiles this channel. Intake 2 allowed water through a channel directly to the north of the Intake 1 channel. The field complex is characterized by short walls enclosing on four sides (for the most part) discrete units identified as field terraces. For the purpose of the pedestrian survey each of these was given its own number in order to record finds in each area, ranging from 1 through 86.

Site 67 building complex

A building complex in the north central aspect of the wall system seems situated just north of a point at which water was directed along two discrete channels, one flowing westerly, and the other south-westerly. This series of connected buildings and the area directly around them had by far the largest concentrations of pottery (Figure 13).

West aspect Channels

i. Northern area in west quadrant

The first channel runs to the north and splits into a northern and southern channel. The northern channel runs north of wall system ‘81’, and the southerly channel runs south of wall system ‘81’. Both of these channels empty into an area in the extreme north-west of the wall system area.

ii. Southern area in West Quadrant

The second main channel runs to the south of the BAS building, and splits into three channels. Beginning with the most northerly, a channel runs north of wall system ‘67’, the second north of wall system ‘68’, and the third south of wall system ‘68’. Each of these channels coalesces in the extreme north-west area of the wall system.

Cross-sections 1 and 2

These cross-sections profile the wadi channel immediately north of the NE part of the wall system. There was found to be much in-filling of this wadi with material ranging from gravel to cobble-sized stones (Figure 14).

Cross-section 3

This cross-section allows a ‘south facing north’ perspective of the entire water flow of the wall system area. The drop from east to west is 3.8% and is consistent throughout (Figure 14).

Summary

An elaborate hydraulic system at this site consisted of long walls directing the course of flowing water from the adjacent wadi into ‘intakes’ which siphoned water through discrete water channels, to ‘field systems’ delineated by shorter walls. This system was designed not only to attain a water source, but also to direct it through a system that would maximize its use, and perhaps retaining it for future use through a system of dams and perhaps reservoirs.

The Late Pleistocene Landscape north of Barqa Smelting Hill

Perhaps the most unexpected outcome of the Barqa survey was the discovery of a series of sites north of the Barqa Smelting Hill which were extremely dense in surface finds of flint tools and debitage. These sites, which include BLS sites 61, 62, 63, and 66, were all extremely similar in character, and although the flint appears on initial inspection to vary in density of artifacts within and between sites, they all have a wide range of tool types which in general terms are comparative
(Figure 15). Team Green spent a significant amount of time defining the boundaries of each site, and the end result appears to be that for the most part the site boundaries between sites appear to be the presence of either large sand dunes, as in the case between sites 62 and 63, or shallow sand fields as in the case between sites 63, 61, and 66. As a result of this, one possibility is that all of the sites are connected, but simply overlain by the sand dunes and fields, which post-date the archaeological site. If this is the case the site may be as large as 12-16 hectares in size, making it one of the largest prehistoric sites in the Wadi Arabah. Collections from these sites were inspected by two independent experts who both suggested that the sites are likely Early to Middle Epi-Palaeolithic in date (22,000 – 15,000 BP), and hence are an example of the late Pleistocene occupation of the region, a period as yet not known from other surveys in the Faynan district. Certain sites appear to have a significant number of microlithic tools, including some which may indicate a Natufian occupation, and hence suggest a long occupation history at these sites.

In order to try to counter any bias in surface collection away from the absence of microliths in the pedestrian pickup, it was decided to do a random total collection from the surface of 5 squares in Square D4, Unit 42. The five 1 x 1 meter squares were scraped clean of the 1cm surface flint, which was bagged and later sieved and then wet sieved in the “dirty lab”. These collections resulted in a much higher percentage of microliths and await further analysis in the coming year.

The horizontal distribution of these sites is likely explained by the reconstruction of the palaeo-channels from radar images which suggest that they occur on what appears to be a gentle slope down to what was likely a permanent, slowly moving stream directly to the south of the site. This palaeo-channel is the same modern drainage in which the Date Palm Pit is located, suggesting that the ground water still flows through this area. The reconstruction of the Pleistocene environment will be the subject of future investigations next year, but the working hypothesis is that these Epi-Palaeolithic sites likely were deposited in what was a lush, savannah-like environment, which had plenteous water, plant and perhaps animal resources. The sites are unlikely to all be contemporary, but likely represent long-term, annual, perhaps seasonal re-use of the site. The very significant amount of debitage suggests a very large amount of tools construction at the site, and the variety between different parts of the site may reflect chronological variation across the site.

Last of all a small existing pit in Site 63 (purpose unknown) allowed for the investigation of a small profile of part of the site, and an initial reconstruction of site depth, chronological phasing and soil characterization deposition. This is of course a fortuitous event, but also requires further additional study in other parts of these sites to check on this year’s results.

Analysis of the Indurated surfaces beneath extensive flint scatters of BLS Sites 61, 62, 63 66

An extensive carpet of worked flint, preliminarily dated to the Middle Epi-Palaeolithic was identified (see below). It is clear in the field that modern linear dunes are rolling over this collection of sites, but that the flint carpet has armoured the archaeological surface and prevented its erosion. The indurated layer is composed of fine sand and silt which does not appear to have been significantly disturbed by the people working upon it. The indurated layer of sediment below the flint working debris was interpreted as being the contemporary surface and was extensively analysed using the Niton XRF. In all these analyses strontium, rubidium and iron were identified, but no chemical signature for metal working could be identified.

Within the area of Site 63 an existing hole dug into the landsurface (Waypoint 743, purpose unknown) provided an opportunity to examine the topography and lithostratigraphy in detail.

Topography of the location

There are three components. (1) A low angle surface, ~7-8 degrees, dipping SW for at least 200-300m, which leads down to the topographically low level that is the location of the palm trees. This surface is littered with primary and secondary flakes made of chert, producing a carpet of debitage. There is at least 1 small blade per 5 cm²; many areas have a much denser coverage. Occasionally, there is some pottery attributed to Bronze Age I. No smelting slag was found. Nowadays, sand blows across this surface, sometimes forming a very thin sheet; but it does not settle. (2) Small cockpit dunes supporting one shrub of saltbush every 10-20 m. These are variable in shape (a
mixture of “egg-shape” and cone-shape), and typically 2-3m in length and 1m in width. The sand on the top edges of these small features is mobile. (3) Linear dunes, in excess of 100m length, typically much longer; 10-20m wide and 5-10m high. Google Earth shows these linear dunes are ~parallel. The sand on the surface of these linear dunes is mobile. The topographic relationships between these landforms show that the low angle surface is oldest, and that it has been later covered by the linear sand dunes and the cockpit dunes.

The age relationships between the small cockpit dunes and the linear dunes are unclear, but the linear dunes appear to be fed with sand in much greater quantities and from further afield than the cockpit dunes, which appear to reflect silt and fine sand derived from the low angle surface.

Two lithostratigraphic units, here termed lithofacies (following Reading book), were visible in a small exposure left by an earlier pit which indicate the nature and stratigraphic relationships of the cockpit dune and the low angle surface.

Lithostratigraphy

Cockpit dune lithofacies

Description: 0-50 cm, thins to edge of dune. Fine sand and silt; fairly well sorted: these form couplets of the laminae that are more silt-rich and better-sorted fine sands, each 1-3 mm thick. The silt-rich material can be slightly indurated. Twenty six such couplets cropped out in the exposure. These are sometimes flat-bedded in the centre of the dune, but increase in dip to ~35° on the steeper slope of the dune, before gradually decreasing slope to ~0° at the edge of the dune where its thickness thins to zero. The strike of these couplets varies around the dune. The colour of the dune has not been determined by reference to a formal guide. In the prevailing light at the exposure, the colour appeared grey-yellow. The lithofacies was penetrated by roots of the saltbush, 1 root of 0.5cm width per 100cm² of exposure; but there was no other evidence of bioturbation, or of any other biological or archaeological remains within it. The base of the lithofacies was always sharp, and undulating over 1-5 cm. Parts of the surface of his dune are eroding. The topography is described above. The assumption is that these cockpit dunes are relatively young and transient features in the landscape, but the only current evidence is that they overlay the materials in the lithofacies below.

Interpretation: These are small dunes accumulating around saltbush, the fine sand and silt deriving from adjacent surfaces.

Pit lithofacies

Description: thickness greater than 20 cm. There are two visible components.

Uppermost – Pit Silt Layer. 1-3 mm thick, silt or very fine sand- well sorted, forming a distinctive layer throughout the exposure. This layer also appears to be the surface of the low-angle surface that led towards the palm trees. It appeared grey in the prevailing light, was perhaps indurated, and was harder and protruded slightly from the exposed face. The upper surface of this layer was visible beneath the cockpit dune lithofacies, where it was sharp; the base of this layer was also sharp and undulated parallel to the upper surface, gently over 1-3 cm. The relationships between this layer and the many flint artefacts present suggest to these observers that it was, or was stratigraphically very close to the stratigraphic source of many of those artefacts. The exposure revealed no evidence of bioturbation, nor desiccation cracks, or other disturbance. Interpretation – a layer of silt that was deposited by the wind across the site. Duration – likely to have been brief: age relationship - older than the base of overlying cockpit dune.

Pit Sands: thickness >20 cm. Sand; two fractions – fine sand, sorted, which appeared yellow in the prevailing light; and a smaller component of coarser sand; coarser faction to 1+mm, with light coloured fragments darker grains. But overall, it also appears to be a pale red/brown – is this slight weathering, rubification? Weak, poorly developed lamination sometimes locally present, individual laminae ~1mm; but overall, in the exposure the stratum appeared relatively homogeneous; perhaps even structureless in places. Lower boundary unseen. No evidence seen in exposure of bioturbation, desiccation, pits, or reworking; neither was charcoal found. Very characteristic was a layer of flint.
artefacts, ranging in size from 2mm to 2 cm observed, that formed a layer that was 3-4 cm beneath the land surface. These were flat-bedded and displayed no evidence of disturbance or reworking. Occasional roots of saltbush penetrated this layer beneath the cockpit dune. The layer is older than the Cockpit Dune Lithofacies and equivalent in age to the two (?) layers of flint artefacts (surface-near surface, ~3-4 cm) that appeared in this exposure.

Interpretation

The upper surface of a sand sheet that slowly led down to the level of the palm trees, upon which people worked flint on at least two occasions, but did not materially disturb the aggrading sand surface. Subsequently, these sands weathered slightly.

Overall

Oldest: The upper surface of a sand sheet that slowly led down to the level of the palm trees, upon which people worked flint on at least two occasions, but did not materially disturb the aggrading sand surface, as sand blew across the site. A thin layer of silt blew over the site; again this accumulation was associated with people. The landscape included dunes and blown materials – presumably it was arid, but it is not clear how arid. Subsequently, these sands weathered slightly.

At a currently unknown point in time, linear dunes accumulated across parts of this low angle plain; occasionally pottery fragments were dropped in Bronze Age and Roman times. From unknown point(s) in time, fine grained materials – perhaps sometimes richer in silt, collected in pulses episodically to form the cockpit dunes around salt bushes.

Last of all, this site, and other adjacent Pleistocene sites require a micromorphological study, OSL dating of the dunes, sedimentological study, and radiometric dating as well as other detailed studies. As these sites may be very important locations in the environmental history, a reconstruction of the ancient landscape is a priority for the second season of the Barqa Landscape Survey.

Barqa Landscape Survey: Summary and Plans for the Second Season

The first season of the project has been unusually successful, and resulted in the collection of a large sample of data from both the pedestrian archaeological survey and the pollution analysis. The project is now in a position to benefit from this season’s results and to continue with the planned detailed pollution analysis planned for the Second Season. Several unexpected outcomes, such as the presence of large numbers of Iron Age sites, and the Late Pleistocene sites and flint scatters will require minor adjustments to next year’s plans, since both of these are important enough to investigate further.

The second season will therefore broaden its approach to look at both long-term environmental changes, landform changes in the Holocene and the extent and characterization of both the Bronze Age and Iron Age landscapes north of the Barqa Smelting Hill. Also planned for the forthcoming year is a detailed analysis of the Prehistoric flint recovered from the survey and a detailed analysis of the Roman/Byzantine pottery by a pottery specialist of this period.

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Pyatt, F.B. and J.P. Grattan


Wilkinson, T.J.
List of Figures

Figure 1: Faynan Area Surveys, 2009.

Figure 2: Survey Area, Barqa Landscape Survey, 2009, Phase One.

Figure 3: NW Quadrant, Barqa Landscape Survey, 2009, Phase One.

Figure 4: Barqa House Area Site Survey, Phase One and Two.

Figure 5: GIS workflow and data structure.

Figure 6: Depth vs Copper Concentration PPM Histogram I.

Figure 7: Depth vs Copper Concentration PPM Histogram II.

Figure 8: Barqa Archaeological Site Environs, EBA Pottery.

Figure 9: Barqa Archaeological Site Environs, IA Pottery.

Figure 10: Barqa Archaeological Site Environs, Roman-Byzantine Pottery.

Figure 11: Barqa Archaeological Site Environs, EBA, IA, and Roman-Byzantine.

Figure 12: Barqa Archaeological Site Environs, 2009.

Figure 13: Wall System, NE Quadrant, Barqa Landscape Survey, 2009, BLS Sites 87 and 67.

Figure 14: BLS Site 87 Cross Sections.

Figure 15: Pleistocene Prehistoric site locations and Phase 1 and 2 survey.
Survey Sites

Site Boundaries

Proposed Fieldwalking

Phase 2, surveyed

Phase 1, surveyed

Scale: 0 50 100 200 300 400 Meters
BLS Site 87 Cross Sections