EASTERN BADIA ARCHAEOLOGICAL PROJECT: WISAD POOLS, JORDAN

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Pioneering research programs of survey and excavation in eastern Jordan by Betts and Garrard during the 1970s and 1980s led to the recognition that human groups occupied the steppic and arid environments during the Late Neolithic, even if limited to small, thinly spread groups. These fundamental research programs, however, were small relative to the large area of the steppe and arid zones. The Eastern Badia Archaeological Project is a joint project initiated in 2008 between Whitman College and the Oriental Institute that examines two regions in the Black Desert of eastern Jordan. These two regions are located in the southern extent of the eastern panhandle, close to the border with Saudi Arabia. Both regions are now arid desert utilized by a few Bedouin families during the wetter winter months, accessible in part due to deep wells created by the government.

In the first region, the Wadi al-Qattafi, basalt-capped mesas rise about 40–60 meters above the surrounding wadi floor. One site in particular, Maitland's Mesa, is the focus of our research in that region and was reported in the *Oriental Institute 2012–2013 Annual Report*. The other region, Wisad Pools, was most recently investigated in 2013 (fig. 1). Located approximately 107 kilometers to the east of Azraq and 17 kilometers north of the Saudi Arabian border, the area around the pools includes hundreds of structures that have never been documented archaeologically. Like the mesas along Wadi al-Qattafi, Late Miocene basalts dominate the landscape, covering limestone formations and interspersed with short, shal-

Figure 1. Map of eastern Jordan

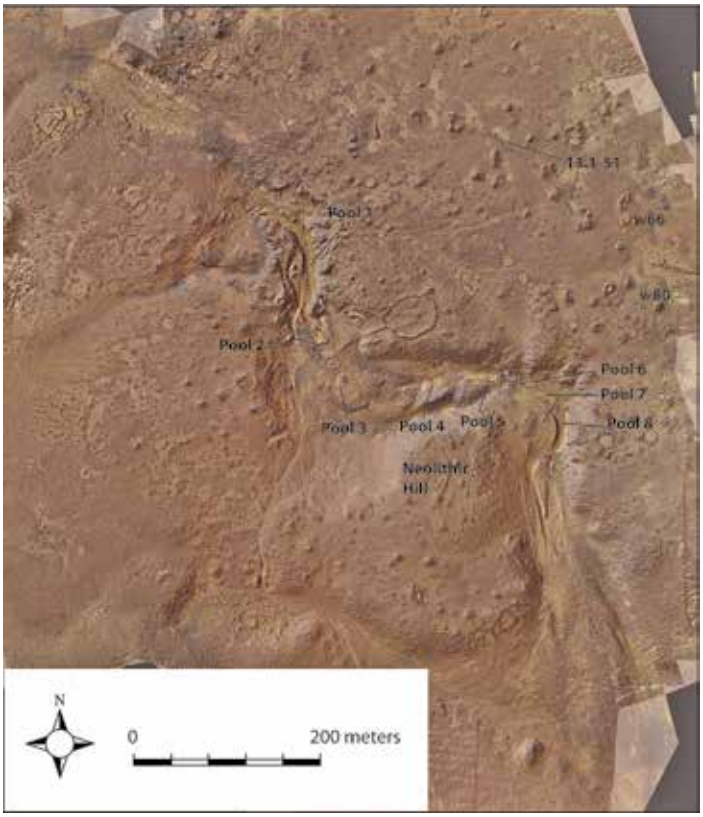

Figure 2. Orthomosaic of the Wisad Pools central area (map by A. C. Hill and W. Abu-Azizeh)

low wadis and *qeʾan* (mudflats, or playas). One wadi forms a series of natural basins that collect runoff rain water into a series of approximately nine pools extending from the edge of the basalt to the nearby *qaʾ* after a vertical drop of only about 12–14 meters.

For several kilometers surrounding the pools, sites dating from the Epipalaeolithic to the early first millennium CE were noted (fig. 2); corrals and other larger structures are more apparent, particularly near the pools. In an area of approximately one square kilometer around the pools, there are hundreds of structures constructed of the rectangular and irregular local basalt, with density decreasing farther away from the pools. The outline or plan of these structures is often difficult or impossible to identify, and thus their dating and function are equally difficult to surmise without excavation. Based on construction techniques and remains found in looters' backdirt, the largest of these structures are tower tombs, similar to those found atop the basalt-capped mesas along Wadi al-Qattafi. In addition to these massive towers, smaller lower mounds are common. Large, possibly multichambered complexes are also found, and some are in close proximity to the long chains or "tails" of smaller (1 × 2 × 1 m) chambers, also similar to that found along the southern edge of Maitland's Mesa (see Rowan et al. 2011). Interspersed among these collapsed structures other features include pathways or low walls that continue for dozens of meters, platforms (ca. 2–4 m in diameter), and small to large enclosures that may reflect dwellings or storage facilities. Our initial assumption was that many of these mounds, chambers, and towers were mortuary in nature, with various features and installations that may or may not be associated with the more substantial structures.

Dating these structures is difficult. Surface artifacts are generally rare, primarily limited to scatters of lithic debris and tools that date to the Epipalaeolithic, Pre-pottery Neolithic, or Late Neolithic. In a few places, Late Neolithic and Epipaleolithic flint tools and debitage are more dense, such as what we have termed "Late Neolithic Hill," a promontory near a concentration of the pecked rock art (discussed below) where Epipaleolithic cores, tools, and debitage are dense and overlapping with clusters of Late Neolithic chipped stone artifacts. Most of the expanse between structures, however, includes only general debitage and

occasional tabular scraper fragments that suggest a late prehistoric date that could be Late Neolithic, Chalcolithic, or Early Bronze Age.

In order to understand the function and dating of these collapsed structures, we excavated our first structure (W-66) at Wisad Pools during the 2011 season. Selected because it was apparently undisturbed and unlooted, with the collapsed large basalt blocks suggestive of a roof, W-66 included basalt slabs a meter in length and half a meter in width, such that several people were necessary to move one. Adjacent to the eastern side of the structure was a lower, curvilinear platform paved with relatively small (ca. 30–35 cm) basalt cobbles. The top of the stone rubble was almost two meters above the surrounding ground surface. Several phases of occupation were detected, with some periods of abandonment likely. The earliest phase represented by a sub-circular single cell preserved patches of gypsum plaster in the floor. This earliest floor, perhaps 35 centimeters below the original ground surface, included an elliptical plaster basin set into the floor on the western side. Charcoal samples taken from this plaster were dated by accelerator mass spectrometry (AMS) to 7690 + 40 BP (6600–6460 cal BC), supporting the Late Neolithic date suggested by the material culture. In the center, a large basalt pillar (ca. 1 m in height, 44 × 30 cm thick) functioned as a roof support (fig. 3).

Constructed of basalt slabs stacked into relatively straight sections, creating angled interior wall lines; additional stones above these were apparently corbelled toward the center of the room. We believe that these then relied on the central pillar. Many of the corbelled slabs were large, over a meter in length, and some must have weighed more than 200–300 kilograms. Based on the height of the central pillar and the low corbelling, we must assume

Figure 3. Central pillar, alcove, and plastered basin in structure W-66 (photo by G. Rollefson)

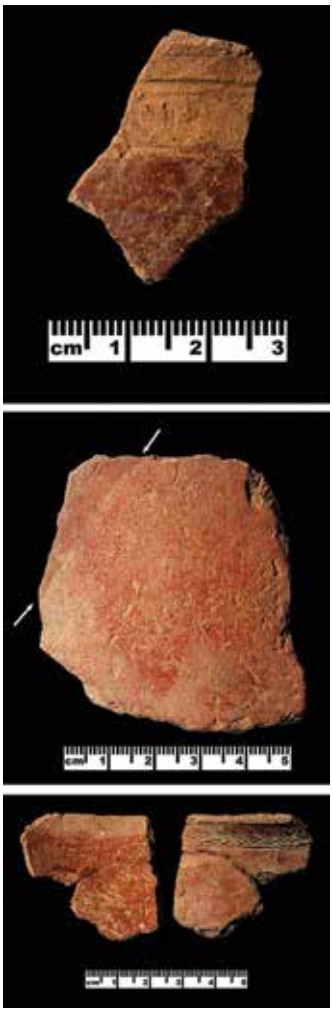

Figure 4. Vessel fragments from W-66 and W-80 (photos by G. Rollefson)

this was a low roofed structure in which the occupants had to crouch or crawl. On the northern side of the structure, an alcove measuring ca. 1.50 × 0.85 meters was plastered repeatedly, at least four times, creating a surface ca. 25–40 centimeters above the surface level of the main room.

Artifacts found in this room included over forty arrowheads, primarily transverse and Haparsa forms (Rollefson et al. 2011). Grinding slabs and handstones were also common and include a cache of eleven pestles ranging from 10 to 25 centimeters in length. Finally, a red-painted, handmade sherd with herringbone incisions represents a Yarmoukian vessel fragment (fig. 4), complementing the radiocarbon date and arrowheads. This evidence all points to a Late Neolithic date for this structure, which served a domestic rather than funerary function.

In the effort to determine whether this was an anomaly, another possible tomb was selected for excavation in 2013. Located approximately 100 meters south-southeast of W-66 was another large collapsed structure with many large basalt slabs. Unlike W-80, this structure included a later, rather hastily constructed tomb atop an earlier structure. Slabs were placed atop one another in columns, rather than overlapping, and openings between stones were large and frequent. No interior chamber construction or roof was apparent, and it seems likely the body was placed inside of the chamber. Unfortunately, the bones were very poorly preserved, and possibly disturbed by later burrowing animals. Diagnostic artifacts were lacking, with only two cowrie shell beads and a very small tubular carnelian bead found in the general fill. Construction of the tomb was placed on top of the collapsed structure for added elevation. Below this poorly constructed tomb of unknown date, a corbelled dwelling was excavated. Only the southern section was excavated during 2013 (the northern half will be our goal during 2014).

After removal of many basalt slabs, an area of rough leveling was created with basalt slabs. This appeared to be a rough division of the collapsed building, possibly reuse by later visitors. Below this, at least two major areas were discerned. The main room (ca. 4.0 m east–west; 2.90 m from south to the section) in W-80 included interior walls made of upright vertical slabs; along the interior of those slabs a bench or narrow (ca. 40 cm) platform was constructed of flat basalt slabs. A section through this bench-like construction indicated that an earlier similar feature was part of the original interior. To the west of this main room, an alcove area (ca. 1.5 m in diameter) also had multiple levels of basalt slab pavements, at least three, with traces of gypsum plaster (figs. 5–6).

Farther to the west, on the exterior of the building, an oval space (2.2 × 2.7 m) was delimited by a low line of upright stones forming a semicircular enclosure. In the center of this "porch" area, a large basalt slab with a central pecked depression (ca. 20 cm in diameter, 5 cm deep) served either as a working surface and shallow mortar, or possibly was reused as a pole support for a tent. Whether or not there was a doorway from this "porch" area into the structure was unclear by the end of the 2013 season.

Figure 5. View of W-80 after initial clearance of rubble from southern face (photo by A. C. Hill)

Figure 6. View of W-80 after excavation (photo by Y. M. Rowan)

Figure 7. Small stone installation constructed against face of external arc (photo by Y. M. Rowan)

A "fence" of upright basalt slabs with a double line of basalt pavers divided this "porch" from a larger enclosed area demarcated by a low line of upright slabs. This area, possibly paved, joins the north side of the structure. Approximately midway along this arc (fig. 7), a small stone installation is built on the exterior, with a small standing stone (ca. 32 cm in height) at the center of the open arc created with a few other stones.

A rich array of artifacts attests to the intense use of the building, possibly through a long period of time. These artifacts included evidence for stone tool manufacture (nearly 400 flint cores were recovered), grinding slabs, pestles, and beads. More than 300 arrowheads (primarily transverse types) attest to an emphasis on hunting (fig. 8), which is supported by the predominance of wild species such as gazelle and onager (Rollefson et al. in press, table 1). Other flint tools included borers, drills, notches, denticulates, tabular scrapers, and knives. The cortical tools (tabular scrapers and knives; fig. 9) may have derived from sources in the Jafr Basin, or the recently documented flint mining area near ar-Ruwayshid, about 100 kilometers to the north of Wisad Pools (Müller-Neuhof 2013). Two decorated sherds parallel Yarmoukian types; a few other non-diagnostic sherds were also recovered. Three radiocarbon dates range from 6590–6580 cal BC in the earliest excavated level, 6000–5840 cal BC from a middle level, and 5710–5610 cal BC from the latest dated stratigraphic unit.

Another aspect of the Wisad Pools project is the methodical documentation of the rock art. During the 2013 field season, the pecked rock art near the pools was the subject of mapping and recording (Rowan and Hill 2014). Approximately 450 petroglyphs concentrate around the pools, primarily pools 5–8. Most of the pecked rock art is figurative (ca. 78%), primarily horned animals such as ibex, kudu, and oryx, although a few humans are also represented. The other identifiable petroglyphs are either structures (ca. 19%) or geometric

Figure 8. Transverse arrowheads (photo by G. Rollefson)

Figure 9. Cortical tools (photo by G. Rollefson)

(ca. 3%); representations of structures seem to exclusively represent "kites," the long, low walls leading to enclosed areas and thought to have functioned as hunting traps.

Documenting the extent and typologies of the Wisad Pools petroglyphs is an important part of the larger research program to understand not only when the site was intensively occupied, but also how it functioned in prehistoric economic and pastoral systems. Photography and photogrammetry as part of the data collection process allows us to integrate the petroglyphs into the wider research program. Our spatial analysis of the petroglyphs is still underway, but part of this recording process included experimental ways to record rock art in the blinding desert light, which makes traditional photography difficult and time consuming. For each glyph we identified, three types of data were collected. Each glyph had a spatial coordinate recorded using either a Canon GPS-enabled camera or the total station; each had an entry in a field-generated database for basic figurative elements (e.g., type, subtype, orientation, style of pecking, nearby or associated figures, and any other notes or features). Finally, each was photographed at least once. In addition, several representative examples were recorded in a variety of ways, including several recorded using high-resolution 3-D photogrammetery. For these, local ground control points were recorded using a total station; overlapping photographic sets were then taken of the entire boulder on which the petroglyphs were pecked. These photo sets were then used to create geo-reference 3-D models

using Agisoft PhotoScan Pro. These models can then be exported as two different types of data, either orthophotographs or digital elevation models (DEM). Orthophotographs eliminate the distortion of regular photographs and allow real world measurements; DEMs are a grid of data that allow us to maximize the natural topographic features that may influence the petroglyph design and enhance the visibility of anthropogenic features.

A traditional tool to highlight subtle topography of small objects is raking light; a strong light source at low angles draws out subtle relief by casting long shadows. Raking light can be used to document some petroglyphs at Wisad Pools, but 3-D modeling is a more robust tool because field recording is more efficient and a variety of post-processing techniques can then be applied. Figure 10 shows four views of the same petroglyph, of the type we refer to as "geometric." The first view (*a*) shows a single image taken at night using raking light. A remote flash is fired above and behind the subject, highlighting the detail of the geometric pecking that is not visible in a daylight photograph of the same feature (see *d*). However, this technique can potentially mask important features. The other two images show visualizations of the same petroglyph based on a 3-D model built from twenty-eight photographs of the rock. In (*b*) the shape of the carving is depicted in false color from a principal component analysis (PCA) of sixteen different shaded models of the rock, incorporating the key differences from different possible light sources, including angles that would replicate (*a*). In (*c*), the direction of light on the rock is unimportant because the shape is being detected through local changes in slope rather than the direction of light.

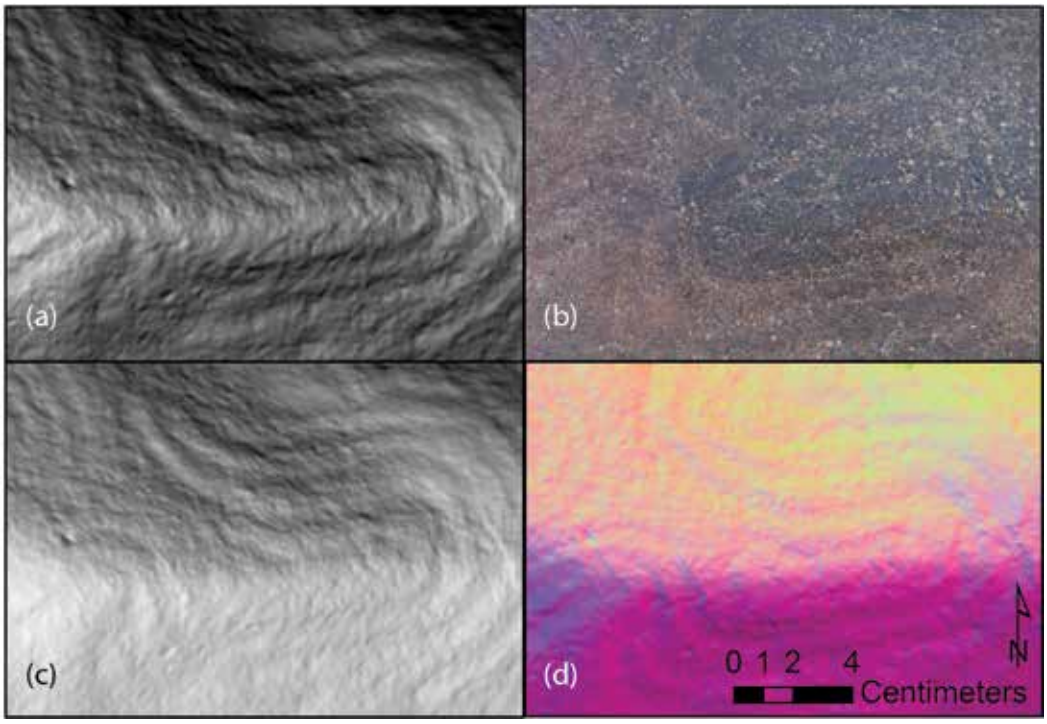

Figure 10. Geometric petroglyph; (a) raking light taken with flash at night; (b) depicted with false color from principal component analysis of sixteen different shaded models; (c) slope differences; (d) daylight photograph (photos and processing by A. C. Hill)

Constructing a photogrammetric model is a more robust way of highlighting topography than traditional photographic methods because it can be accomplished in a variety of lighting conditions, requires no special flash or other equipment, and provides more ability to visualize shape. Moreover, the 3-D model is built from many overlapping photographs, which can include close-up, high-resolution detail shots, producing a very high-resolution result. These techniques of recording and post-processing the Wisad Pools petroglyph assemblage are discussed in a recent article by Rowan and Hill (2014).

The proximity of petroglyphs around the pools would reflect where animals came to water, and hunters to hunt. Although we cannot date the petroglyphs, the rarity or absence of later motifs, such as camels, guns, and horses, suggests that much of the pecked rock art dates to earlier periods. At the same time, the interest in species such as oryx and ibex should be reflected in the faunal assemblage if they date to the Late Neolithic. Preliminary sorting suggests that the species dominating the Late Neolithic faunal assemblage are gazelle and wild onager, yet neither is represented in the faunal profile of W-80. Does this mean that the petroglyphs date to a different period? Or could the more familiar animals be those that are less interesting to peck on the rocks? Without dates for the rock art, simple explanations will be difficult.

Although limited in scale, these excavations and survey results provide surprising new insights to the late prehistoric situation in the eastern desert, a perspective that reinforces the earlier discovery of a Late Neolithic domestic structure at Maitland's Mesa (see *Oriental Institute 2012–2013 Annual Report*). Contrary to our initial assumption, the concentrations of structures at Wisad Pools and along Wadi al-Qattafi may not, in fact, be primarily related to mortuary rites. We cannot demonstrate that all these structures are contemporaneous or functionally similar, but the density of buildings near the Wisad Pools indicates that a much larger population occupied the Black Desert than previously imagined. The investment in building large structures utilizing massive heavy slabs argues against brief or temporary occupation, although some seasonality of residence seems probable. Why people spent time in this area also requires greater scrutiny; transhumant pastoralism seems possible, yet preliminary assessment of the faunal remains from W-80 suggests that primarily wild species were exploited rather than domesticates. The quantity of arrowheads supports the primary role of hunting in subsistence. At the same time, the extensive pounding and grinding equipment suggests some reliance on plants, although whether wild or domesticated species remains to be discovered.

Taken together, these suggest a much larger population in the badia than previously believed. Given the extremely arid conditions that currently prevail, and the bleak prospects for pastoralists during most of the year, we assume that different environmental and climatic conditions existed during later prehistory, specifically the Late Neolithic. In the future we hope to work with geomorphologists to determine whether or not sediments in the local playas or on the site might reveal evidence for topsoil now absent. If topsoil disappeared during the intervening millennia, grasslands that could support herds of wild animals, provide vegetation for herders, and even allow limited expedient agriculture may have existed. An entire Late Neolithic population may have occupied the Black Desert that previously was virtually invisible.

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