EXCAVATIONS OF STRUCTURE W-80, A COMPLEX LATE NEOLITHIC BUILDING AT WISAD POOLS, BLACK DESERT

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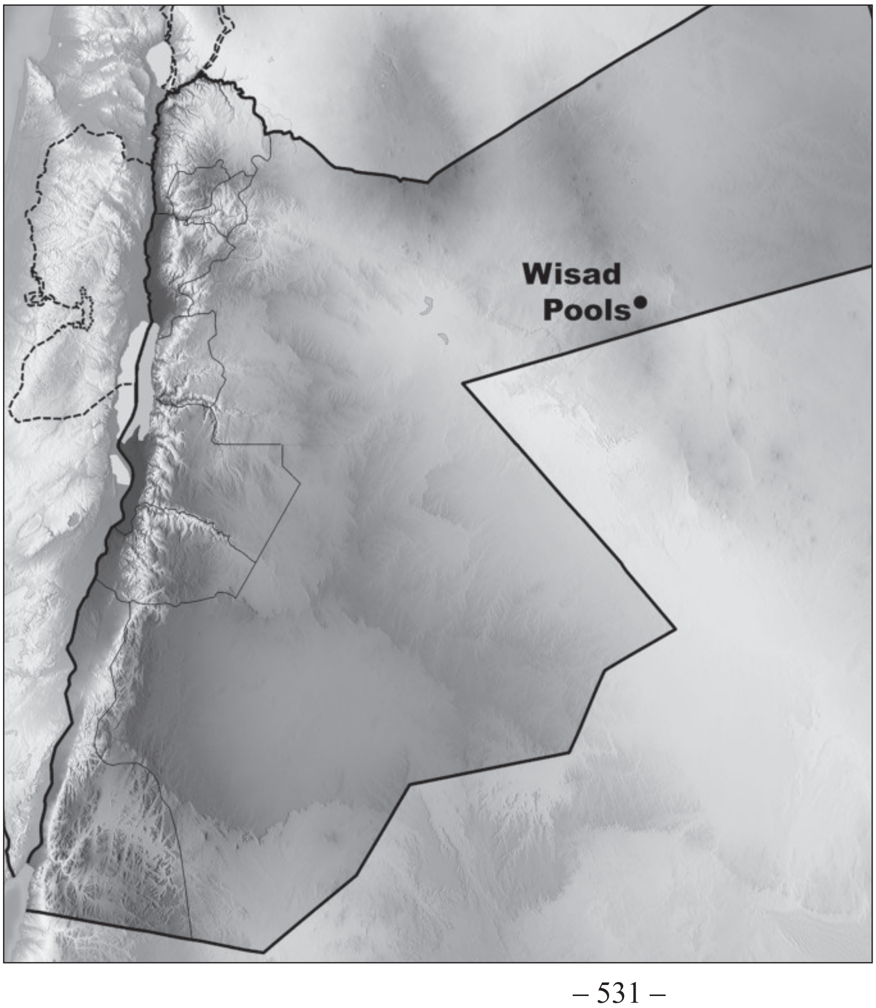
Introduction

Wisad Pools is an immense site, whose core area extends over more than 1.5 km^2 at the eastern edge of the Black Desert in Jordan's panhandle (**Fig. 1**). Within the core area there are 400-500 structures (excluding animal pens), built of local basalt slabs and boulders; among the buildings are tower tombs, large tumuli, structures of unknown function, low burial mounds, and residential houses (Rollefson, Rowan and Perry 2012; Rollefson, Rowan, Perry and Abu-Azizeh 2012). The attraction to the site was a series of natural and artificial pools in the short (c. 1 km) Wadi Wisad that led from one plateau to another one just 8 m lower in elevation. Measurements of Pool #1 (the highest in the series) revealed that it alone held more than 2000 m^2, and the lowest pool (c. a half kilometer long and 40 m wide)

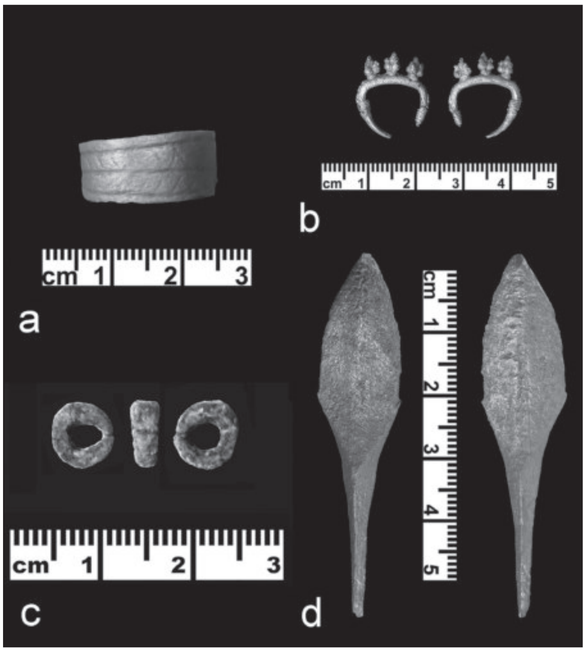


1. Location of Wisad Pools in Jordan's Black Desert.

would have held much more water during and after winter rains (Rollefson, Wasse and Rowan 2014). Excavation of two houses in 2011 revealed that some of the structures were Late Neolithic in age, with one (W-66) yielding a radiocarbon date of 6606 to 6455 calBC (±2σ, Beta-346621) (Rollefson, Rowan and Wasse 2014: 291).

In 2013, our attention turned to what appeared to be a tomb built on top of a low rubble platform: building W-80 (**Fig. 2**). Due to the logistics of working in this hyperarid desert, the crew was small, and the exposure of W-80 was undertaken over two seasons of four weeks each (2013 and 2014).

2. The partially exposed tomb on the upper part of W-80. (Photo: Y. Rowan).



3. a: Copper finger ring; b: silver ear ring; c: copper bead; d: bronze arrowhead. (Photo: G. Rollefson).

The Tomb

Clearance of the tomb showed that it consisted of a low (70 cm high), poorly constructed wall of basalt slabs. The tomb was never roofed, and the body inside had simply been covered by filling in the c. 4.5 m diameter structure with basalt boulders. Preservation of the body was very poor, in part due to burrowing animals. Grave goods included a bronze spear point, a copper finger ring, a silver ear ring, 12 biconical carnelian beads, two carnelian disc beads, a carnelian tubular bead, a copper bead[1], two frit/glass beads, and two Dabba marble "melon beads" (**Table 8, Fig. 3**). Comparisons of this cache with published material indicate that the tomb was probably later Late Bronze or early Iron I in age (Paz 2014; Yahalom-Mack 2014).

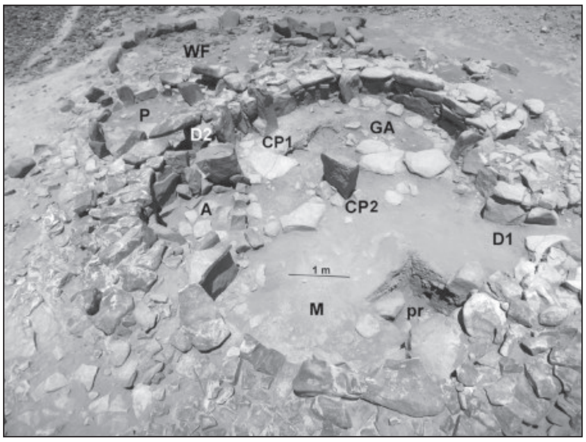
The Underlying Architecture

The "low rubble platform" on which the tomb was situated turned out to be a collapsed corbeled house, similar in some respects to W-66 excavated in 2011 (Rollefson, Rowan and Perry 2012). As has been the case in several excavated buildings, the nearly vertical basalt slabs inside the wall indicate that the corbeled roofing collapsed, possibly as a consequence of an earthquake (**Fig. 4**). Despite the collapsed roofing, the wall of the abandoned house continued to be used as a windbreak to shelter people engaged in a variety of activities, including butchering, stone tool production, grinding of vegetal matter, and bead production.

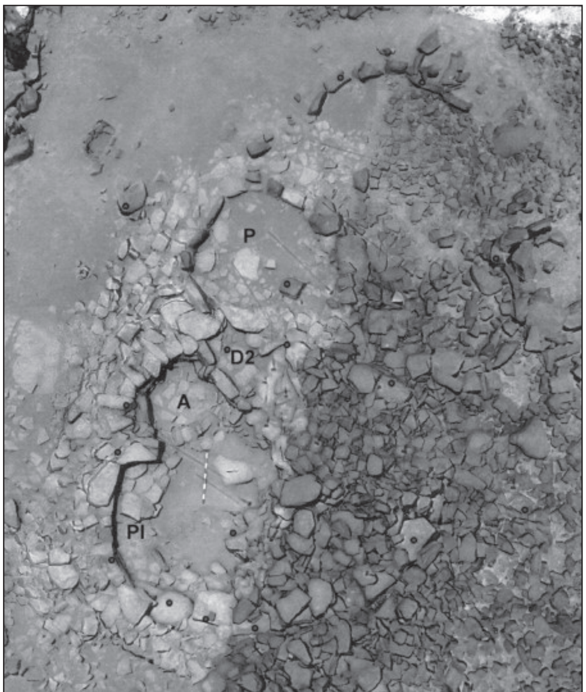
4. Excavation inside the walls revealed collapse slabs from the roof. (Photo: G. Rollefson).

1. This copper bead was found several centimeters below the tomb, and like several of the biconical carnelian beads, it appears to have moved downwards through the sandy silt, perhaps due to bioturbation.

The building underlying the tomb was relatively large c. 6.5m (NW-SE) by 5.5m (SW-NE), and it clearly had a long and complex history during and after its first construction phase (**Fig. 5**). In its final configuration, W-80 consisted of a large central room with two pillars that remained standing (CP1 in **Fig. 5** and CP2; a third may have stood at one time against the wall opposite CP1). D1 was probably the main entrance from the northeast, although a low doorway (D2) opened onto a small external work area (P, for "porch") to the southwest, which has a "fence" of basalt slabs set on edge inside a double-leaf stone external pathway (**Fig 8a**). A small alcove (A) was paved several times, and an area set aside in the northwestern part of the building for food processing activities (GA, the "grinding area"). The main room (M) was the location of a variety of work and, at a relatively late phase of occupation, had a narrow curved paved area or platform along the southern wall (**Fig. 6**). Just below "P" in Fig. 6 is a large grinding stone with a central cuphole (**Fig. 7**).

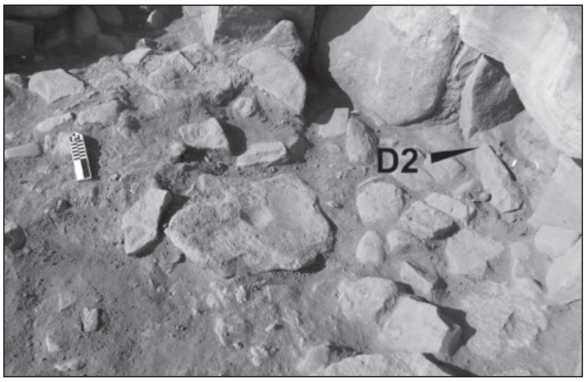


5. The final configuration of W-80. WF = western forecourt; P = "porch"; D2 is a low doorway; A = alcove; CP1 and CP2 are central pillars; GA is a grinding area, D1 is the main entrance; M is the main room; and pr is the subfloor probe. North is at the top of the image. (Photo: Y. Rowan).

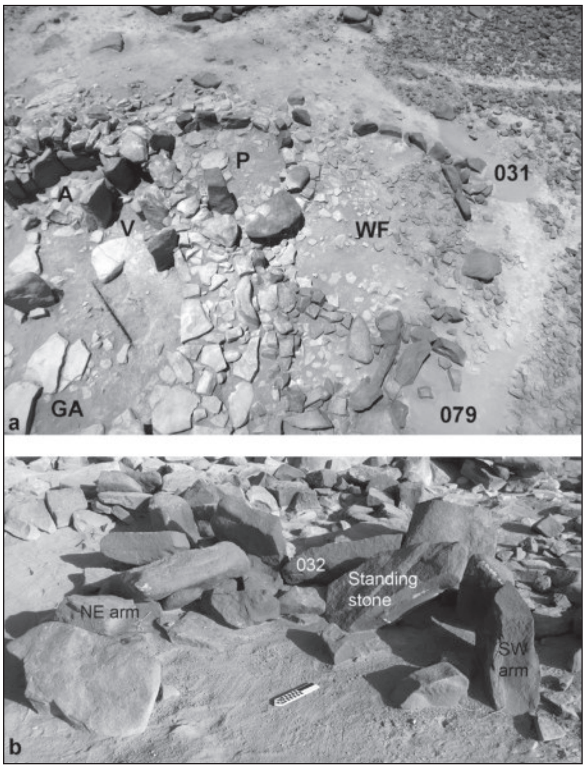


6. An aerial image from the 2013 season, showing the bench/platform along the southern wall (to the lower left) and one of the three pavement phases of the Alcove (A). D2 is the low doorway leading to the external work area (P). (Photo: A.C. Hill).

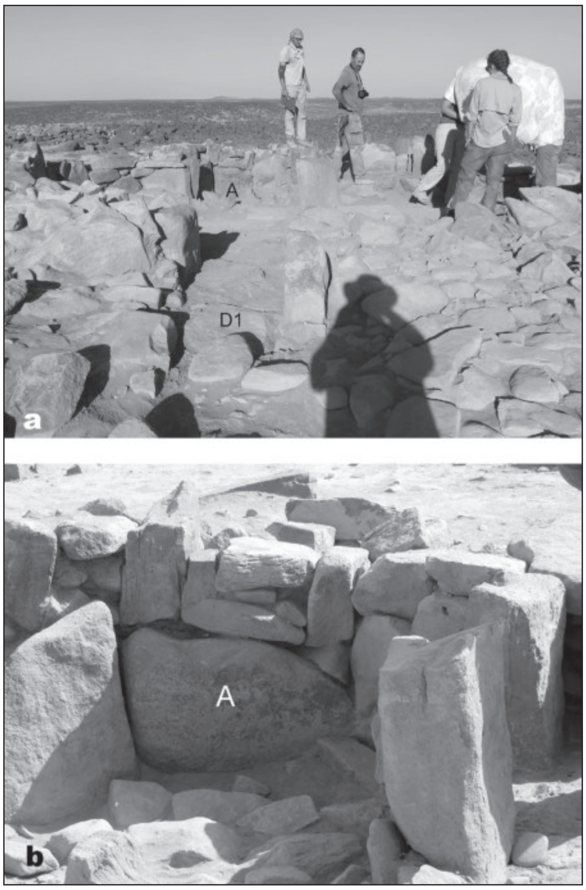
Outside of the main structure to the west is a forecourt (WF in **Figs. 5, 8a**), fenced with basalt slabs set on edge. Why this area was set apart is not clear, since there was no concentration of artifacts or animal bone, although there was a small, shallow fireplace near the center. In the middle of the fence was a small U-shaped feature made by two "arms" of basalt slabs oriented to the west; the northern arm was 55 cm long and the southern one 96 cm long. The feature was 75 cm wide, and in the center of the eastern margin there was a small standing stone, 32 cm high and 25 cm wide (Locus 031 in **Fig. 8a**). Farther north along the wall of the western forecourt, there was a larger U-shaped feature (Locus 079 in **Fig. 8a,b**) that used the wall as its back. The two arms of the feature were 125 cm long, and they were separated by 162 cm at the back wall. In the rear of the feature was a standing stone, 80 cm high, that had toppled towards the SW (**Fig. 8b**).



7. Large grinding stone with a cuphole in the center in the external work area P in Fig. 5. Low doorway D2 leads into the main structure. North arrow is 25 cm long. (Photo: G. Rollefson).



8. a: The location of the Western Forecourt (WF) in relationship to the "porch" (P) and the interior of W-80. Between the "porch" (P) and the alcove (A) is a short vestibule (V). North is towards the bottom of the image. (Photo: Y. Rowan). b: view towards the SE of Feature 079, showing its relationship to the WF wall (Locus 032). (Photo: G. Rollefson).



9. a: The photographer's shadow on June 26, 2014, parallels the axis from the NE doorway (D1) towards a niche in the Alcove. b: Detail of the alcove niche, which appears to have once been a window that was later blocked up. (Photos: G. Rollefson).

There is some indication of attention paid to the summer solstice. The shadow in a photo taken on June 26, five days after the 2014 solstice, aligns almost perfectly along an axis that passes through the middle of the NE doorway (D1) to intersect the middle of a niche in the alcove (**Fig. 9a, b**). The current rainy season generally ends in April, although occasionally rain can occur in late May, as was discovered during the 2011 season at Wisad (Rollefson, Rowan and Perry 2012). Modern "pasturage" in the area today is not abundant, and dries up soon after the end of the rainy season, so a solstice marker seems unnecessary, unless past climate provided for a more verdant and longer-lasting vegetation cover. Notably, architectural orientation around a summer solstice marker was also noted at Late Neolithic structures in the Negev Desert (Rosen and Rosen 2003; Rosen *et al.* 2007).

The grinding area (GA in **Fig. 5**) was dominated by large grinding slabs, four of which had central cupholes that ranged in diameter from 7-11 cm and depths up to 10 cm. The largest grinding slab was calculated to weigh 140 kg, while the smallest weighed 50 kg. Notably, most of the hearths were in close proximity to the grinding slabs (**Fig. 10**). A cache of three large pestles and a handstone were found in a niche under a corbeling slab at the eastern wall, just to the south of door D1 (**Fig. 11**); the storage of several pestles recalls the cache of 11 pestles found in structure W-66 in 2011 (Rollefson, Rowan, Perry and Abu-Azizeh. 2012).

At the western edge of the grinding area, and perhaps associated with milling activity, is a rectangular "bin", set off with low basalt slabs set on edge near the central pillar against the western wall (CP1) (**Fig. 12**). On the eastern side of central pillar 2 (CP2) is a small cache (Locus 072) of gazelle/caprine astragali (**Fig. 13b**), and another cache of astragali (Locus 064)

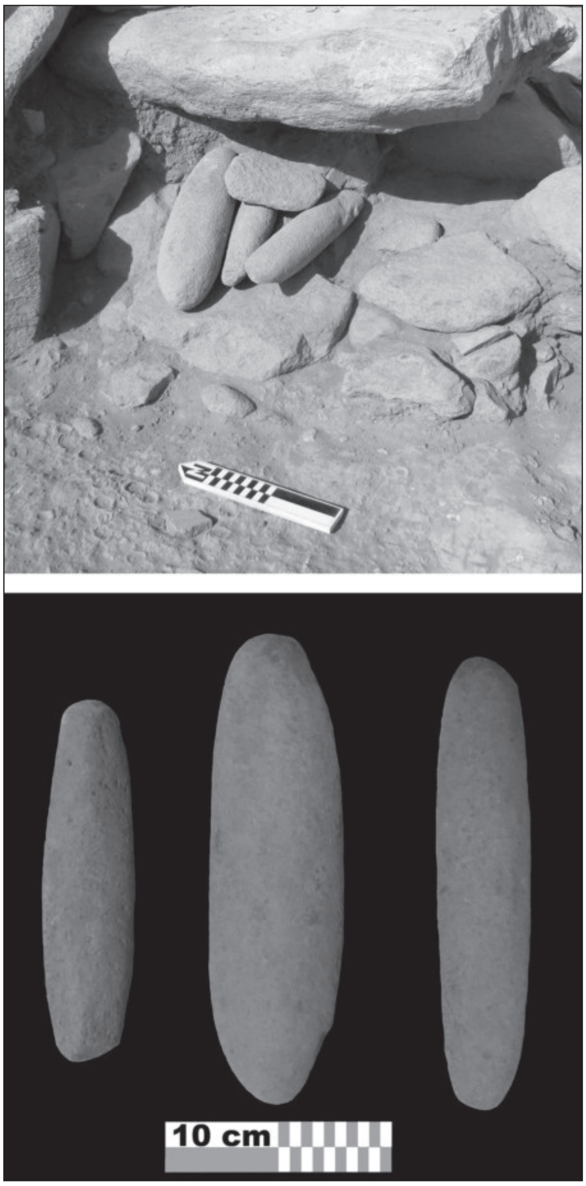
10. *Six grinding slabs, four of which have central cuphole mortars, near central pillar C2. Loci 055, 058, and 061 are deep hearths. (Photo: Y. Rowan).*

is near the northern edge of the main doorway D1 (**Fig. 13a**).

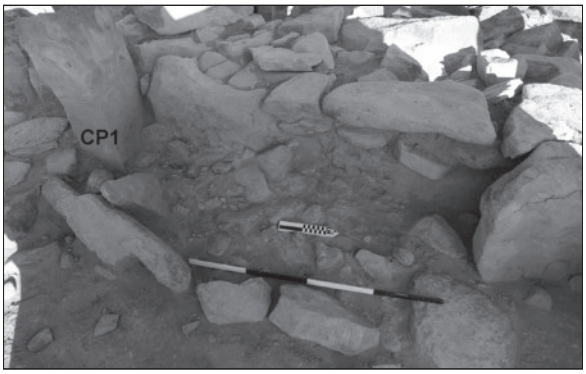
A 1 x 1m probe was sunk beneath the floor of W-80 near the center of the eastern wall ("pr" in **Fig. 5**). The excavation revealed a layer of gritty, porous red sediment up to 37 cm thick, that had clearly been protected from wind and water erosion by the construction of W-80 (**Fig. 14a**). A similar situation was found under the original floor of W-66 in 2011 (**Fig. 14b**). The importance of this layer is that winter rains would not have washed off the land surface as they do today. Instead, much of the precipitation would have been absorbed into the soil, where it would have remained as a reservoir for a much more luxuriant vegetation cover than occurs today; the vegetation cover would also have lasted for a longer period of time.

Charcoal Analysis

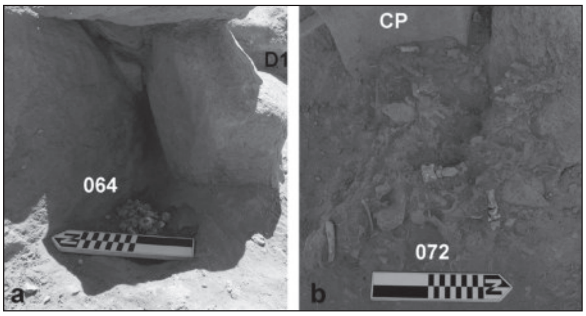
The hearths in the grinding area (GA) were rich in charcoal. Probably at least partly related to the soil found under W-80, the presence of *Tamarisk* sp. and *Quercus ithaburensis* type (**Fig. 15a, b**) should not be surprising, since they are constituents of forest-steppe vegetation (Willcox 1999). Even so, their presence is



11. *The cache of three pestles and a handstone from Locus 007, against the east wall of W-80. The largest pestle weighs 8.2 kg, the smallest 2.7 kg. (Photos: G. Rollefson).*



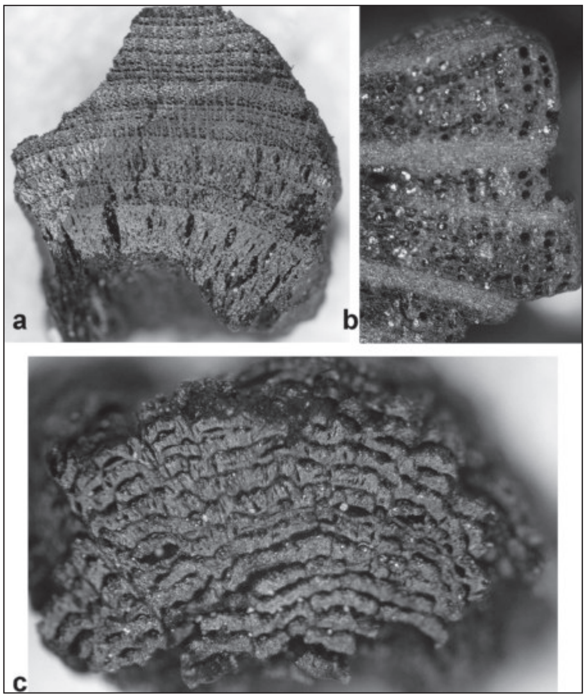
12. *A low-walled rectangular bin at the western wall of W-80, adjacent to central pillar CP1. (Photo: Y. Rowan).*



13. a: a small cluster of gazelle/caprine astragali, just inside and to the north of the main entrance D1. b: A second cluster of gazelle/caprine astragali, adjacent to the eastern face of central pillar CP2. The north arrow is 25 cm long. (Photos: Y. Rowan).

14. a: The darker sediment at the base of the probe is an absorbent reddish soil. b: Matt Jones takes an OSL sample from a similar reddish soil from beneath the floor of W-066, excavated in 2011. (Photos: G. Rollefson).

somewhat startling, considering the hyperarid status that characterizes the area today; it is probable that the region enjoyed a higher level of precipitation during the Late Neolithic, at least (Rollefson 2017). Although it is commonly held that Tabor oak (*Q. ithaburensis*) needs c. 350 mm annual rainfall, local topography and hydrological conditions under lower rainfall amounts may have resulted in isolated oak



15. Charcoal samples from W-80. a: Tamarix sp. 12x; b: Quercus ithaburensis type, 12x; c: Anabasis sp. 25x. (Microphotos by B. Lorentzen).

stands in wadis and along playas. *Anabasis* brush (**Fig. 15c**) is currently the most abundant fuel in the region today, and it was also plentiful in the past.

The presence of oak raises important possibilities for the inhabitants of Wisad. *Q. ithaburensis* is one of the most productive acorn producers for the genus, and this resource may have made the diet of the herder-hunters of Wisad much more nutritious. The cuphole grinding stones in the grinding area (GA) fit in well with the possibility that they were used for crushing the meat of acorns before leeching out the tannins, a combination of equipment and processing known among Native American populations of southern California, and postulated for Late Epipaleolithic populations in the Mediterranean zone (e.g. McCorriston 1994; Olszewski 1993).

Archaeobotanical Analysis of Flotation Samples

Three soil samples were collected from different loci of a hearth feature in square W80 and processed by water flotation to recover macro-botanical remains. A total of 326 specimens were identified that represent 13 plant taxa and 24 were indeterminate (**Table 1**).

Table 1: Identified archaeobotanical remains from hearth features at Wisad Pools

Sample # (lab)	**1**	**2**	**3**
Square	W80	W80	W80
Locus	55	61	75
Sample # (field)	56	65	76
Species			
Aizoon sp.	22		
Arnebia sp.	206	51	9
Astragulus sp.	1		
Carex sp.			1
Asteraceae		17	
Cypruss sp./Juniper sp.	2*		
Erodium sp.	1		
Lithospernum sp.	5		
Malva sp.	3		
Medicago sp.	1		
Onobrychis sp.	6		1
Phalaris sp.			1
Spergularia sp.	1		
Indet.	17	7	0
Total	**263**	**75**	**12**

* Possible contamination from flotation site.

All species were wild or weedy in nature and no domesticated seeds were identified. Arnebia nutlets were the most common specimens recovered. Arnebia (most commonly the root) is known to have many medicinal properties such as treating skin disorders and burns (Zargari 1990; Ghasemi Pirbalouti *et al.* 2009) and as an antibacterial and an anti-inflammatory (Kim *et al*. 2001; Ghorbani 2005). They have also been noted to contain red dye in their roots. The fact there is a significant number of Arnebia identified in the samples compared to other species could potentially be the result of the intentional collection of the plant for medicinal purposes. There were too few of the other species recovered to discuss potential uses or reasons for their inclusion in the assemblage as they may have been simply accidentally collected and burned.

This brief study of the archaeobotanical assemblage recovered from Wisad provides evidence of a local desert environment, as many of the species identified are generally found in desert settings. However, there are indications of seasonal precipitation as species in genera like Aizoon, Carex and Spergularia were identified and can be found in damp soils, dry stream beds, oases and muddy soils. All species identified flower between January and June and point to an occupation of the site in the spring (Zohary 1966: 74-75 and 123-125; Feinbrun-Dothan 1986: 369-375). Although only three samples were collected, it is clear that the plant remains provide support for both the environment of the region in antiquity as well as the season of site occupation.

Radiocarbon Dating

Charcoal from several hearths provided the means of acquiring C14 dates from several loci in the stratigraphic sequence at W-80. (The results are presented in **Table 2**.) All of the samples were small stems or twiglets of local brush and trees, so "old wood" problems are not in effect.

The sequence of dates is stratigraphically sound, with the earliest occupation perhaps beginning at the end of the PPNC, but later uses of the building certainly continued almost to the middle of the 6th millennium. At the moment there are gaps in the dates that suggest periodically prolonged absence, but there are radiocarbon samples from the intervening occupation layers that have not yet been assayed. The earliest date at W-80 is very close to the founding of W-66, and we might suggest that many of the corbeled structures were originally constructed at around 6,500 calBC[2].

Table 2: Radiocarbon dates from W-80.

Sample	**Locus**	**calBC (2σ)**	**13C/12C ratio**	**Comments**
Beta 395440	073	5765 to 5670	-24.7 0/00	Late in sequence
Beta 366675	011	5710 to 5610/5590 to 5570	-24.9 0/00	Middle of sequence
Beta 395441	078	5890 to 5740	-23.1 0/00	Middle of sequence
Beta 366677	033	6000 to 5840	-23.7 0/00	Halfway up fill of alcove
Beta 366676	022	6590 to 6580/6570 to 6440	-23.2 0/00	Near floor

2. Two C-14 dates from early layers in Late Neolithic structure SS-1 at the foot of Mesa 7 in the Wadi al-Qattafi are also near the PPNC/Late Neolithic "boundary": 6455 to 6390 calBC and 6490 to 6430 calBC (unpublished data).

Faunal Remains

Animal bones were richly preserved throughout the interior of W-80. Faunal analysis is still underway, but samples from three loci from the 2013 season indicate a dominance of gazelle, followed by hare at c. 25% and caprines making up c. 10% of the mammals. Fox is present, as are small and large felids, including possible cheetahs, and there is a sizeable quantity of bird and microfaunal bones as well.

Chipped Stone Tools

Stone tool manufacture and use is richly represented in **Tables 3-8**. The strong character of the hunting aspect of the subsistence economy is clearly shown by the importance of projectile points in **Table 3**, where points make up almost a third of the classifiable formed tools. Scrapers account for almost 11% of the inventory, with knives of various sorts making up an additional 7%. The production of holes in beads, bone, and perhaps wood was strong, with perforators, borers and drills representing 14% of the shaped tools. Notches and denticulates were also well represented, at almost a fifth of the tool kit. At the fringe of chipped stone tools are two pecking stones – one made on a flake core and the other on a quartzite pebble – used to shape grinding stones (**Fig. 16**).

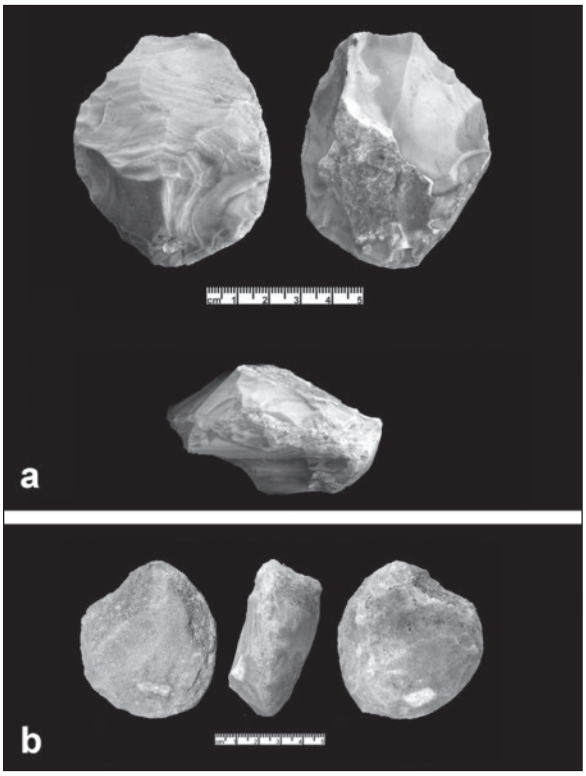
The production of stone tools was heavily dependent on blade manufacture (**Table 4**), although flakes were also important blanks for a wide variety of tools. Other forms of blanks are weakly represented; notably, the Levallois blanks indicate a parsimonious use of flint, since double patina on all six Middle Paleolithic pieces shows they were retouched into new tools used by the Late Neolithic inhabitants.

Hunters clearly preferred transverse arrowheads (**Table 5**), with other types registering only 15% presence (**Fig.17**). Although the number of cores (see below) and the enormous quantity of unretouched blades, flakes, and other debitage indicate that arrowheads were probably manufactured inside W-80, the large quantities of animal bones might also indicate that many of the arrowheads fell out of the animal carcasses as they were butchered. Support for this interpretation is indicated by damage to the bits, tangs, and corners of the projectile points (**Fig 16a**).

Table 3: Tool types from structure W-80, Wisad Pools, 2013-2014.

Tool type	n	%	%'
Projectile point	638	27.2	32.0
Sickle	2	.1	.1
Burin	58	2.5	2.9
Truncation	89	3.8	4.5
Endscraper	34	1.4	1.7
Sidescraper	136	5.8	6.8
Tabular/fan scraper	37	1.6	1.9
Core scraper	2	.1	.1
Circular scraper on thermal spall	2	.1	.1
Unifacial knife	105	4.5	5.3
Bifacial knife	17	.7	.9
Tuwailan knife	1	.0	.1
Seam knife	18	.8	.9
Backed element	15	.6	.8
Tanged blade	6	.3	.3
Notch	153	6.5	7.7
End-notched blade	34	1.4	1.7
End-notched flake	2	.1	.1
Denticulate	200	8.5	10.0
Perforator	29	1.2	1.5
Borer	142	6.1	7.1
Drill	102	4.3	5.1
Biface	10	.4	.5
Pick	2	.1	.1
Chisel	3	.1	.2
Chopper	2	.1	.1
Wedge	96	4.1	4.8
Other	49	2.1	2.5
Lunate, abrupt	1	.0	.1
Bladelet, exterior retouch	9	.4	.5
Bladelet, interior retouch	1	.0	.1
Bladelet backed & retouched	1	.0	.1
Subtotal	1996		100.0
Retouched flake	85	3.6	
Retouched blade	51	2.2	
Utilized piece	59	2.5	
Unclassifiable	155	6.6	
Total	2346	100.0	

In addition, there were 10 bone awls and one bone needle. More bone tools will be identified as faunal analysis continues.



16. a: Flake core converted to pecking stone (note battering at the bottom). b: Quartzite pebble used as a pecking stone. (Photos: G. Rollefson).

Table 4: Debitage blanks for W-80 tools, 2013-2014 seasons at Wisad Pools.

Debitage type	n	%	%’
Ordinary blade	922	39.3	50.4
Naviform blade	4	0.2	0.2
Unknown blade type	1	0.0	0.1
Bladelet	79	3.4	4.3
Flake	735	31.3	40.2
CTE	18	0.8	1.0
Burin spall	27	1.2	1.5
Microflake	2	0.1	0.1
Debris	1	0.0	0.1
Core, nodular	12	0.5	0.7
Core, tabular	17	0.7	0.9
Chunk/thermal spall	4	0.2	0.2
Levallois blade	3	0.1	0.2
Levallois point	2	0.1	0.1
Levallois flake	1	0.0	0.1
Subtotal	1828		
Unclassifiable	518	22.1	
Total	2346	100.0	100.0

Tools on microflakes were an unidentifiable tool fragment and a retouched flake fragment. The debris example was a small seam knife fragment.

Table 5: Projectile point types from W-80, 2013-2014 seasons at Wisad Pools.

Point type	n	%	%’
Transverse, stemmed	210	32.9	34.2
Transverse, not tanged	151	23.7	24.6
Transverse, trapezoid	156	24.5	25.4
Trapeze, unknown	19	3.0	3.1
Haparsa	34	5.3	5.5
Nizzanim	13	2.0	2.1
Herzliya	19	3.0	3.1
Byblos	4	0.6	0.7
Other	8	1.3	1.3
Subtotal	614		100.0
Tang only	12	1.9	
Preform	3	0.5	
Unclassifiable	9	1.4	
Total	638	100.0	

Table 6: Burin types from W-80, 2013 and 2014 seasons at Wisad Pools.

Type	n	%	%’
Simple	6	16.7	18.2
On break	7	19.4	21.2
Angle	1	2.8	3.0
Simple transverse	1	2.8	3.0
Transverse from lateral retouch	1	2.8	3.0
Straight dihedral	1	2.8	3.0
Canted dihedral	3	8.3	9.1
Oblique truncation	4	11.1	12.1
Concave truncation	4	11.1	12.1
Convex truncation	2	5.6	6.1
Double concave truncation	1	2.8	3.0
Atypical/other	2	5.6	6.1
Indeterminate	3	8.3	
Total	36	100.0	100.0

Table 7: Drill types from W-80, 2013 and 2014 seasons at Wisad Pools.

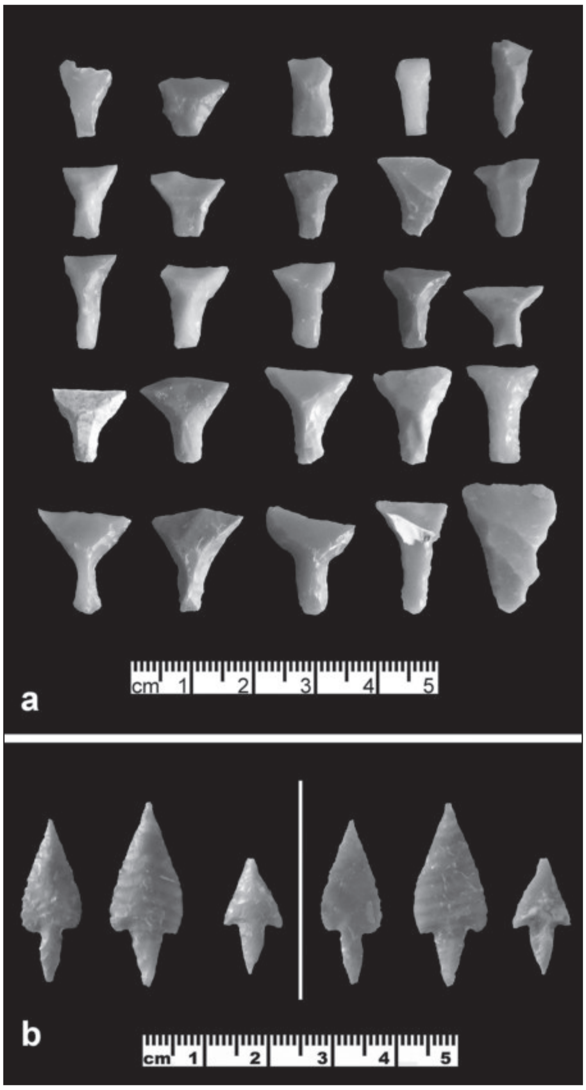
Type	n	%	%’
Bladelet, symmetrical	14	25.9	28.0
Bladelet, asymmetrical	8	14.8	16.0
Burin spall, symmetrical	7	13.0	14.0
Burin spall, asymmetrical	5	9.3	10.0
Mèche de forêt	15	27.8	30.0
Double drill, burin spall	1	1.9	2.0
Bit only	1	1.9	
Indeterminate	3	5.6	
Total	54	100.0	100.0

Table 8: Core types from W-80, 2013 and 2014 seasons at Wisad Pools.

Type	n	%	%'
Single face radial flake core	19	1.8	2.3
Biface radial flake core	23	2.2	2.8
Single platform, single face flake core	125	11.8	15.3
Single platform, multiface flake core	68	6.4	8.3
Single face, multiplatform flake core	44	4.1	5.4
Multiface, multiplatform flake core	131	12.3	16.1
Core on a flake	75	7.1	9.2
Other flake core	1	0.1	0.1
Microflake core	132	12.4	16.2
Bladelet core	21	2.0	2.6
Blade + bladelet core	1	0.1	0.1
Opposed platform non-naviform blade core	2	0.2	0.2
Single platform, single face blade core	74	7.0	9.1
Other blade core	15	1.4	1.8
Pyramidal core	3	0.3	0.4
Semi-pyramidal core	15	1.4	1.8
90° change-of-orientation core	59	5.6	7.2
Other	8	0.8	1.0
Subtotal	816		100.0
Manuport	6	0.6	
Tested piece	32	3.0	
Unclassifiable	208	19.6	
Total	1062	100.0	

Although burins were very important during the Late Neolithic, especially at burin sites, W-80 produced only a minor amount, with individual burin classes(Rollefson 1959: Table 1) represented by many simple types (42.4%), far fewer transverse varieties (6.0%), moderate numbers of dihedral types (12.1%), and relatively strong truncation burins (33.3%). However, the total of 36 burins pales beside the huge numbers at burin sites, and even at other kinds of Late Neolithic settlements such as at Mesa 7 structure SS-1 (644 burins from a total of 1331 shaped tools, 48.4%; unpublished analysis) or at Kharaneh A-15, where in a sample of a calculated population of more than 80,000 artifacts, 87% of the tools were burins (Muheisen and Rollefson 1985:142-144).

Only 74 drilled beads and pendants of any kind were recovered from inside W-80 (**Table 8**), but 102 bead drills came from the same sediments (**Table 3**). It is likely that either many of the beads that were made were taken away, perhaps for trade, or that bead drills were used for more than bead manufacture. In a study of eastern badia burins, the absence of use-wear on many of the truncation types led Finlayson and Betts (1990) to suggest that it may have been the burin spalls that were the objective of much of the burin production during the Late Neolithic, possibly as blanks for drill bits, an interpretation supported by frequent correlations of unretouched burin spalls and drill beads as was noted in Yarmoukian layers at 'Ayn Ghazal (unpublished research). Another possibility was the use of burin spalls as teeth,



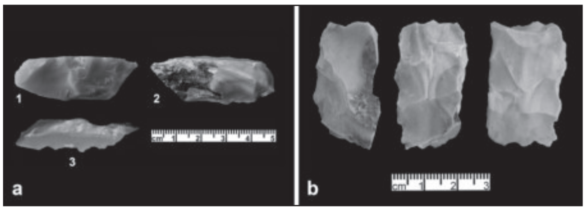
17. a: Transverse arrowheads; note damage to bits and bit corners. b: Three Haparsa points. (Photos: G. Rollefson).

mounted in wooden or bone handles for use as carding boards to harvest wool from Late Neolithic sheep (Quintero *et al*. 2002:209). The status of blanks used for making drills at W-80 is equivocal in terms of what burin spalls were used for. **Table 7** shows that 44% of drills were made on bladelets, not burin spalls (which were still strong at 24%).

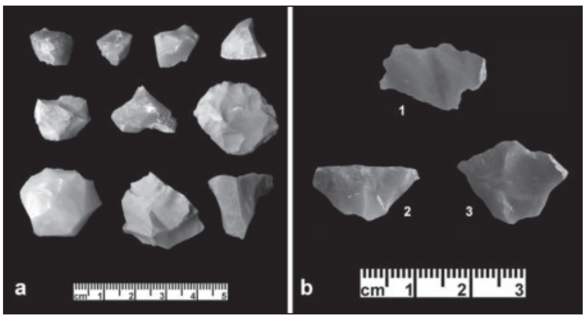
Cores were remarkably frequent in the W-80 sediments, underscoring the intensity of tool production inside the building. Flake cores of various kinds were most numerous, with single platform single face cores (**Fig 18a**) and multiple platform multiface cores most popular (**Table 8**). Blade cores were also numerous, though less so than the importance of blade blanks for tool production (**Table 4**). Microflake cores are intriguing, since many of them have active faces that would have produced flakes only around a centimeter in maximum dimension (**Fig. 19a, b**).

Special Finds

Among the material recovered from below the tomb, stone "bracelet" fragments were the most numerous items, except for beads and pendants (**Table 9**). Dabba marble outcrops can be found in the vicinity of Wisad Pools, so beads of this stone do not represent any long-distance networking. Shells, on the other hand, probably represent extensive contacts with both the Mediterranean and Red Seas. In addition to several tray or platter fragments made of (local?) sandstone, a reddish quartzite tray fragment was decorated by small depressions ("dimples") on one surface (**Fig. 20a**), as well as a burned and broken limestone (?) palette, with eight longitudinal channels engraved on one surface (**Fig. 20b**). Thirteen potsherds (many of them minute fragments) included four typical Yarmoukian examples (**Fig. 21**); two other Yarmoukian potsherds came from structure W-66 in 2011(Rollefson, Rowan, Perry and



18. a: Single face single platform core. 1=active face, 2= inactive face, 3= platform. b: Three-face prismatic flake core. (Photos: G. Rollefson).



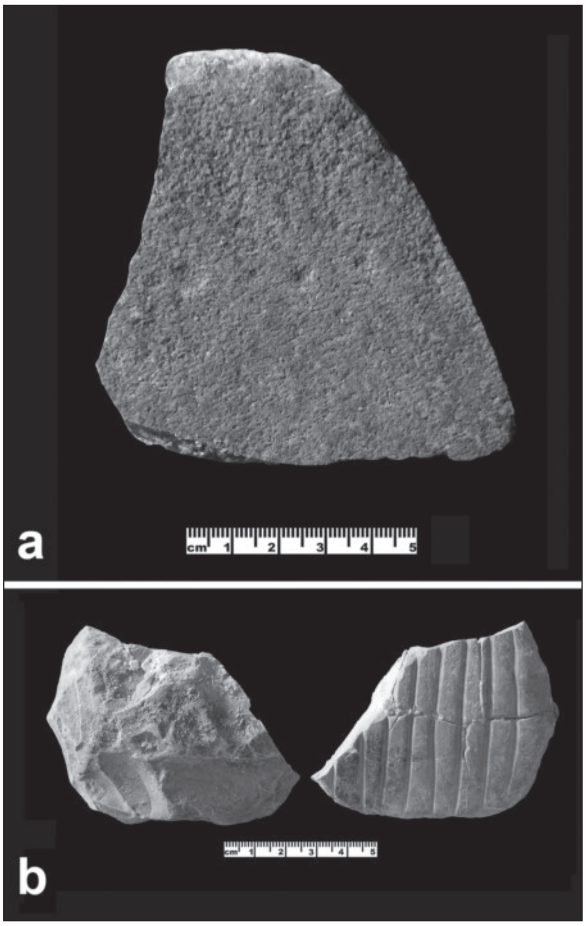
19. a: Microflake cores. b: Semi-pyramidal microflake core; 1=platform, 2 and 3 are active faces. (Photos: G. Rollefson).

Table 9: Special finds from W-80, 2013-2014 seasons at Wisad Pools.

Material	n	Material	n
*Bronze arrowhead	2	Shell beads	12
*Copper finger ring	1	Shells	3
*Silver ear ring	1	Mother-of-pearl pendant	1
*Carnelian biconical beads	12	Stone micro-vessel	1
*Carnelian disc beads	2	Stone vessel fragment	1
*Carnelian tubular bead	1	Quartzite tray fragment	1
*Frit/glass beads	2	Sandstone tray fragment	4
*Cowrie shell beads	2	Other stone tray fragment	1
*Dabba melon "melon" bead	2	Gypsum palette	1
*Copper bead	1	Sandstone disc	1
Carnelian chunks	4	Potsherds[3]	13
Mace head fragments	8	Acheulian bifacial cleaver	1
Stone bracelet fragments	22	Basalt shaft straighteners	3
Stone finger rings	4	Grooved stone	1
Bone beads	5	Red ocher fragments	5
Quartz beads	2	Green crystal fragment	1
Dabba marble disc beads	18	Quartz crystal	1
Dabba marble pendants	8	Incised crystal	1
Redstone beads	11	Incised stone fragment	1
Blackstone beads	2	Polished/ worked stone	8
Other stone beads	15	Gizzard stones[4]	47
Stone bead blanks	11	Iron/steel pin	1

3. At least four of the potsherds are Yarmoukian.

4. Of these, 27 are from one locus.

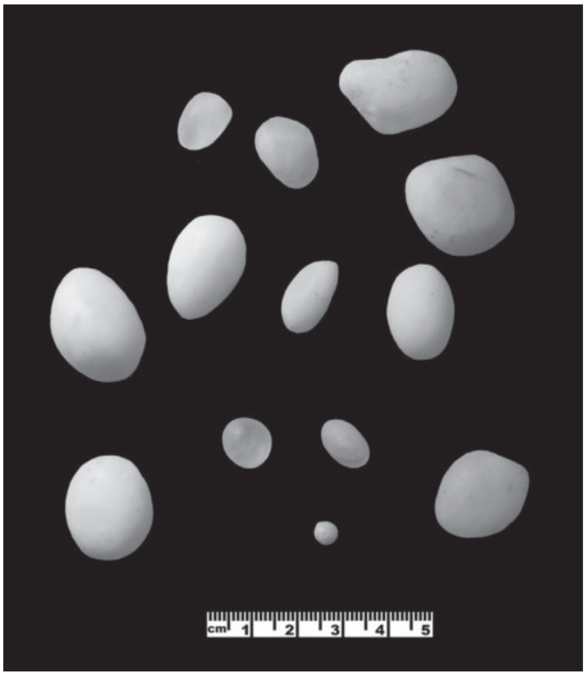


20. a: Red quartzite tray fragment; note the dimples on the surface. b: grooved limestone palette. (Photo: G. Rollefson).

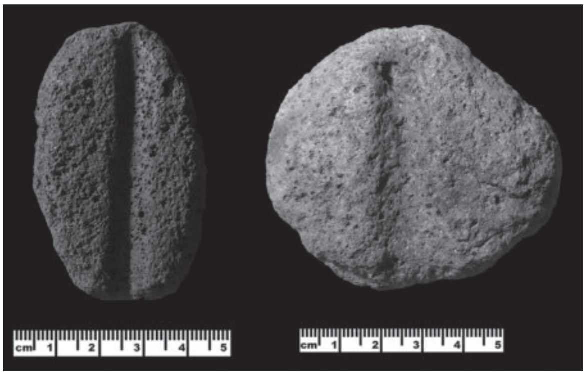
21. One of four Yarmoukian potsherds. (Photo: G. Rollefson).

Abu-Azizeh 2012: 40; Rollefson *et al*. 2013: **Fig. 19c**). A total of 47 gizzard stones, all of a creamy colored quartzite, were recovered from the sequence inside W-80, although 27 were from a restricted area within a single layer (**Fig. 22**). Some researchers have suggested they were used as sling stones, and while that may be true for some of them, the tiny size of many of them raises doubt to their use as projectiles.

Finally, three basalt shaft straighteners (**Fig. 23**) might be taken to reflect a much moister period of occupation of W-80. Arrow shafts have not been found in Levantine Neolithic sites, but it is widely held that many hunters used reeds (*Phragmites* sp.) that grew abundantly near marshy conditions for their arrows. Shaft



22. Selection of quartzite gizzard stones showing the variability in sizes. (Photo: G. Rollefson).



23. Two of the three basalt shaft straighteners recovered from W-80. (Photos: G. Rollefson).

straighteners would have been used to remove the nodes for a smooth surface. It is not clear if shaft straighteners were used for other purposes, or if there were resources other than *Phragmites* in the Black Desert. The presence of oak charcoal argues for a wetter environment at Wisad Pools, and the shaft straighteners lend support to that observation.

Concluding Remarks

Three residential structures have been excavated at Wisad Pools since 2011, and all three have proven to be Late Neolithic in age. There are hundreds of structures in the core area of Wisad, and it now appears that perhaps a majority (at least) of the structures could be 7th and 6th millennia buildings. The concentration of permanent (albeit likely seasonally inhabited) residences challenges earlier views that the badia was an inhospitable territory, that demanded frequent shifts from one camp to another during the Late Prehistoric period. Instead, more and more evidence of a landscape with lusher vegetation and effective water harvesting during the rainy season made it possible for relatively large herder-hunter groups to remain throughout the rainy season, and even for some time into the post-rainy season.

The bleakness of the current landscape is probably a relatively late phenomenon; the hyperarid desert may have developed only in the past three to four millennia (Rollefson n.d.; Rollefson, Rowan and Wasse 2014) and until that time, people may have enjoyed a comfortable life style. Research will continue at Wisad in the future, with particular attention paid to different types and styles of construction, in part searching for the time when structures were founded on bedrock or silt, not the red absorbent soil that had been deflated due to intense aridity and strong winds.

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Bibliography

Feinbrun-Dothan, N.
1986 *Flora Palaestina: Part IV*. Jerusalem: Israel Academy of Science and Humanities.

Finlayson, B. and Betts, A.
1990 Functional Analysis of Chipped Stone Artefacts from the Late Neolithic Site of Ǧabal Na‘ja, Eastern Jordan. *Paléorient* 16/2: 13-20.

Ghasemi Pirbalouti, A.
2009 Iranian medicinal and Aromatic Plants. Islamic Azad University Publishers, Shahrekord, Iran, 2nd edition.

Ghorbani, A.
2005 Studies on Pharmaceutical Ethnobotany in the Region of Turkman Sahra, North of Iran. *Journal of Ethnopharmacology* 102: 58-68.

Kim, S. H, Kang, I. C and Yoon, T. J.
2001 Antitumor activities of a newly synthesized shikonin derivative, 2-hyim-DMNQS-33. *Cancer Letter* 172: 171-175.

McCorriston, J.
1994 Acorn-eating and Agricultural Origins: California Ethnographies and Analogical Inference in the ancient Near East. *Antiquity* 68: 97-119.

Muheisen, M. and Rollefson, G.
1985 Chipped Stone Artifacts from a Specialized Neolithic Camp near Kharaneh Castle, Eastern Jordan. *ADAJ* 29: 141-150.

Olszewski, D.
1993 Subsistence Ecology in the Mediterranean Forest: Implications for the Origins of Cultivation in the Epipaleolithic Southern Levant. *American Anthropologist* 95: 420-435.

Paz, S.
2014 Chapter 11. The Beads. Pp. 227-235 in Y. Gadot, D. Ilan, Y.Tepper and E.Yannai (eds.), *The Bronze Age Cemetery at ʻAra*. Salvage Archaeology Reports No. 8. Tel Aviv: Tel Aviv University Publications in Archaeology.

Quintero, L. Rollefson, G. and Wilke, P.
2004 Highland Towns and Desert Settlements: Origins of Nomadic Pastoralism in the Jordanian Neolithic. Pp 201-213 in H. Bienert, H. Gebel and R. Neef (eds.), *Central Settlements in Neolithic Jordan.* Berlin: ex oriente.

Rollefson, G.
1995 Burin Variability at Neolithic ʻAyn Ghazal, Jordan. *SHAJ 5*: 515-518.
2017 Greener Pastures: 7th and 6th Millennia Grasslands in Jordan's Eastern Badia. In K. Bartl M. Reindel and F. Lüth (eds.), *The Development of Early Settlement in Arid Regions*. Berlin: Deutsches Archäologisches Institut (in press).

Rollefson, G., Rowan,Y. and Perry,M.
2012 A Permanent Late Neolithic Residential Structure in the Eastern Desert of Jordan. Pp 211-221 in P. Bienkowski *et al*. (eds.), *Proceedings of the 8th ICAANE, Vol. 3*. Wiesbaden: Harrassowitz Verlag.

Rollefson, G. Rowan, Y., Perry, M. and Abu-Azizeh,W.
2012 The 2011 Season at Wisad Pools, Black Desert: Preliminary Report. *ADAJ* 56: 29-44.

Rollefson,G. Rowan, Y. and Wasse, A.
2013 Neolithic Settlement at Wisad Pools, Black Desert. *Neo-lithics* 1/13: 11-23.
2014 The Late Neolithic Colonization of the Eastern Badia of Jordan. *Levant* 46 (2): 285-301.

Rollefson, G., Rowan, Y., Wasse, A., Hill, A.C., Kersel, M., Lorentzen, B., al-Bashaireh, K. and Ramsay, J.
2016 Investigations of a Late Neolithic Structure at Mesa 7, Wadi al-Qattafi, Black Desert, 2015. *Neo-Lithics* 1/16: 3-12.

Rollefson,G. Wasse, A. and Rowan, Y.
2014 In Loving Memory: A Preliminary Assessment of the Architecture at the Late Prehistoric Necropolis at Wisad Pools, Eastern Badia, Jordan. Pp 285-295 in G. Rollefson and B. Finlayson (eds.), *Jordan's Prehistory: Past and Future Research*: Amman: Department of Antiquities of Jordan.

Willcox, G.
1999 Charcoal Analysis and Holocene Vegetation History in Southern Syria. *Quaternary Science Reviews* 18: 711-716.

Yahalom-Mack, N.
2014 Chapter 10. The Metal Objects. Pp 213-226 in Y. Gadot, D. Ilan, Y. Tepper and E. Yannai (eds.) *The Bronze Age Cemetery at ʻAra*. Salvage Archaeology Reports No. 8: Tel Aviv: Tel Aviv University Publications in Archaeology.

Zargari, A.
1990 *Medicinal Plants*. Tehran University Publishers, Tehran, Iran. 4th edition.

Zohary, M.
1966 *Flora Palaestina*: Part I. Jerusalem: Israel Academy of Science and Humanities.