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Not a place for respectable people, but the ends of the earth converge there: insights from Wisad Pools into the nature and context of Jordan's Black Desert Neolithic

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New data, recovered by the Eastern Badia Archaeological Project, from substantial structures at Wisad Pools have provided insights into the nature and context of eastern Jordan's Black Desert Neolithic cultural complex, dating to between *c*. 7000 and 5000 cal. BC. Hunter-herder-trapper communities, with economies based partially on ante-mortem exploitation of domestic sheep, were adept at maintaining a balance between local and non-local adaptations in shaping a networked culture that was deeply rooted in its local environment. Evidence for trans-regional connections with the Levant and Mesopotamia raises the possibility that longer-term habitation sites, like Wisad Pools, were instrumental in linking the western and eastern arms of the Fertile Crescent via direct routes across the steppe. At least one structure excavated by the Project displays evidence for sophisticated architectural planning, demonstrating awareness of basic geometric principles. New radiometric assays suggest that adaptive processes were profoundly influenced by episodes of climatic and environmental change, including the longer 8.2 ka event. Emerging data from north-west Saudi Arabia require Wisad Pools to be examined in the context of Arabian Neolithization, considering the possibility that the Black Desert Neolithic was a point of departure for some aspects of that process.

Keywords Arabia, Levant, Mesopotamia, steppe, Neolithic

'The wolf also shall dwell with the lamb,
and the leopard shall lie down with the kid'
(Isaiah 11:6)

Introduction

Recent work on 6th- and 5th-millennium[1] cultural complexes such as the Wadi Rabah, Halaf and Ubaid (Carter 2018; 2020; Nieuwenhuyse 2017; Streit 2020) has raised the possibility that the roots of prehistoric 'globalizing' processes might nudge up against the steppic Early Late Neolithic (ELN[2]) and Late Neolithic (LN), taken here to represent the two millennia between approximately 7000 and 5000 cal. BC. At intervals during this period, in what is today the geographic and intellectual interstice between the

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[1]Dates calibrated BC unless otherwise noted. All radiometric dates from short-lived charcoal samples, calibrated using OxCal Online (v4.4 [Bronk Ramsey 2009]; IntCal20 calibration curve [Reimer *et al*. 2020]). Where discussed in the text, 2σ date ranges are used. The radiometric data presented here supersede all radiometric data presented previously.

[2]Following Baird (1993) and Betts *et al*. (2013: 183), the term ELN rather than PPNC is used for steppic assemblages of the terminal 8th and earlier 7th millennia.

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Levant, Mesopotamia and Arabia, the broken basalt country (*ḥarra*) of eastern Jordan's Black Desert harboured an unexpected mosaic of productive seasonal micro-habitats supporting what has been defined elsewhere as the Black Desert Neolithic (BDN) cultural complex (Wasse *et al*. 2020: 95–96). This appears to have been characterized by the socio-seasonal segmentation of hunter-herder-trapper communities through a site hierarchy of so-called 'burin camps' (also referred to as 'burin sites') which were probably associated with herding, specialized hunting camps which were in part associated with 'desert-kite' traps, and longer-term habitation sites with substantial structures, multi-purpose chipped-stone assemblages and evidence for wide-ranging external contacts (Betts 1992: 112; Betts and Burke 2023; Wasse *et al*. 2020). In a clear example of cultural continuity, there is credible evidence that the BDN had steppic antecedents dating back to at least the 9th millennium (Bartl 2018; Clarke and Wasse 2024a: 36; Fujii 2022; Rokitta-Krumnow 2019). All of the BDN structures for which there is information are curvilinear, with the majority being characterized by a single, prominent, central pillar (Rollefson 2022; see also McMahon *et al*. 2024), regardless of the size of the structure and thus distance to be spanned by any roof. In some instances, the central pillar was surrounded by additional pillars around the internal perimeter of the structure, occasionally aligned on the cardinal points (Rollefson *et al*. 2017: figs 3–4). Exclusively functionalist interpretations of the pillars fail to account for both their alignment and the structured placement of objects around the central pillar in at least one instance (Wasse *et al*. 2022: 262, figs 15b–c, 18. See also below). With regard to Göbekli Tepe, Kinzel and Clare (2020: 34–35) have proposed that the iconic T-pillars had a dual symbolic and structural function, an argument that may well be applicable to the BDN.

As observed by Nieuwenhuyse (2017: 839), the emerging focus on prehistoric 'globalization' encourages researchers to: (1) study spaces like the Black Desert in broader geographical contexts, especially in instances where ancient horizons breach modern culture-historical silos; (2) examine relationships and tensions between the local and non-local, particularly with regard to the receptivity of the former to the latter; (3) consider how 'activities and change processes at … [site] level contributed to processes operating over much larger … areas, and *vice versa*'. This article draws on data from the 2019 and 2022 excavation seasons of the Eastern Badia Archaeological Project (the Project) to touch on these issues and others, including architectural planning, human responses to climate and environmental change, and Arabian Neolithization. Fieldwork took place at Wisad Pools (Fig. 1), on the eastern margin of the Black Desert, for four weeks between 24 May and 21 June 2019, and for three weeks between 9 and 29 September 2022; it focused on completing the excavation of Neolithic structures W-80 and W-400, last investigated in 2018 (Wasse *et al*. 2022). The results have further undermined (cf. Rowan *et al*. 2020: 74–75) dichotomizing notions of the steppe being a divergent hunting-and-herding 'margin' to normative, village-based 'core' zones located on the cultivable side of the 'desert line'.[3] Instead, longer-term habitation sites like Wisad Pools emerge as thriving 'crossroads on the steppe' in their own right. Far from being passive recipients of innovation from elsewhere, BDN actors appear to have exercised considerable agency in shaping their own deeply rooted, locally adapted culture, concurrently integrating and segregating as necessary. This doesn't preclude the possibility of other actors — perhaps genuinely migrant herders on even longer journeys, or recidivist bands of resident hunter-trappers who had rejected the pastoral experiment — moving through or otherwise utilizing the territories of the BDN, leaving a correspondingly lighter footprint on the archaeological record.

Structure W-80

Stratigraphy, phasing and interpretation

Excavations in 2013 (Rollefson *et al*. 2013; 2018), 2014 (Rollefson *et al*. 2018; Rowan *et al*. 2015a) and 2018 (Wasse *et al*. 2022), have already demonstrated the complex history of W-80, which saw repeated episodes of occupation, abandonment, modification and rebuilding over more than 2000 years. On current evidence, the Neolithic sequence associated with this substantial structure has four main phases: (1) a basal, seemingly Late Pre-Pottery Neolithic (PPN) B phase (± later 8th millennium) consisting — it appears — of large pavers [111] beneath the eastern part of the structure and ephemeral low walls [121; 141] beneath the western part; (2) a Transitional ELN–LN (± mid 7th millennium), 'wide-entrance' phase associated with the remnants of a gypsum-rich surface, during which the structure appears to have had a communal function; (3) a heavily invested, LN (± earlier 6th millennium), 'narrow-entrance'

[3]Effectively the 200 mm pa isohyet, beyond which reliable rain-fed agriculture is impracticable (cf. Lewis 1987: 3–24; Wasse and Clarke 2024: 63–64).

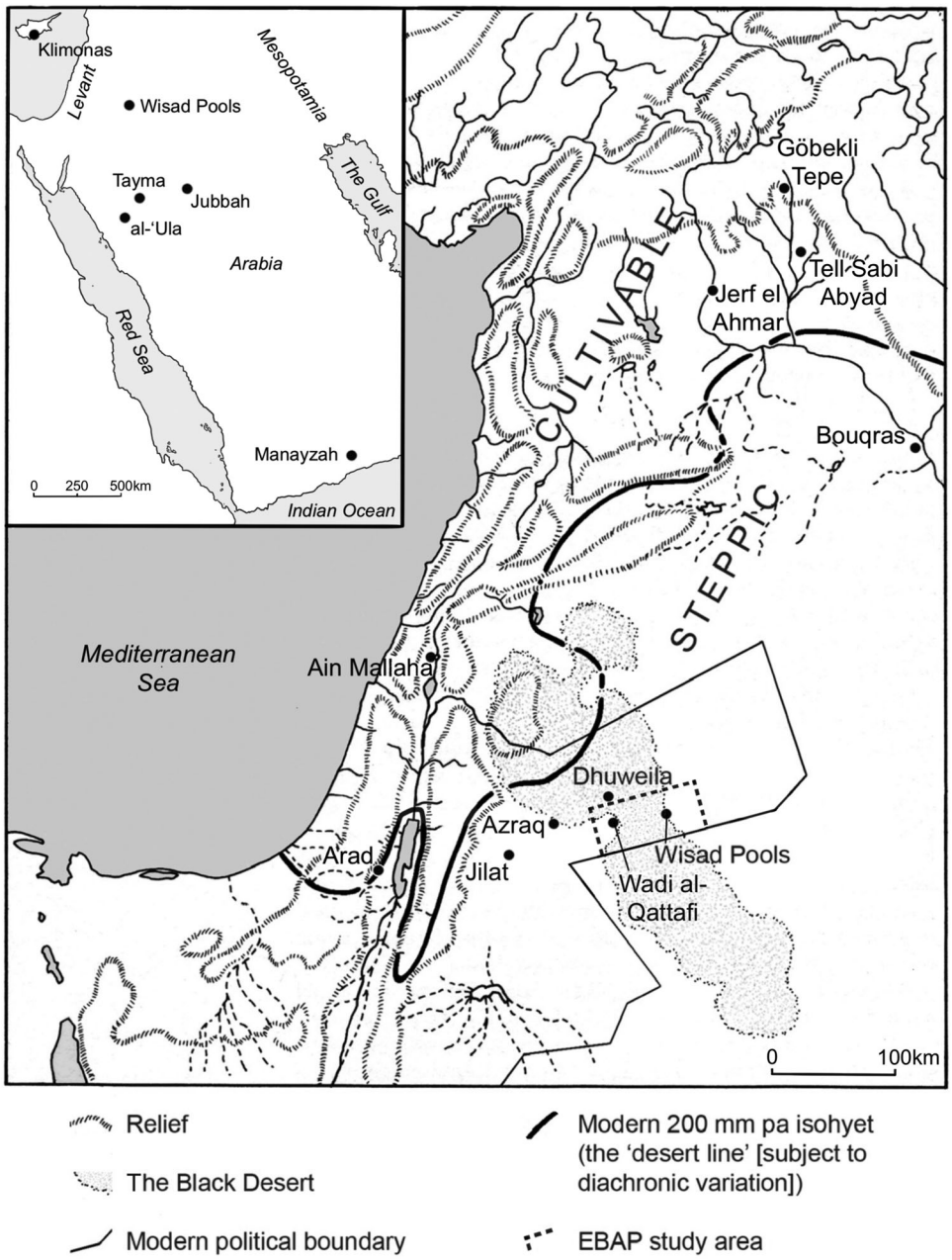

Figure 1 Maps showing the EBAP study area and location of sites mentioned in text (primary base map after Mellaart 1975: fig. 21) (prepared by A. M. R. Wasse).

phase[4] associated with areas of paving and large grinding slabs with central mortars, during which the structure seems to have functioned as a domestic dwelling; (4) a Final LN phase (±later 6th millennium), during which the by now partially collapsed structure functioned as an expedient and likely intermittently utilized shelter (Wasse *et al.* 2022: 254–55 and references therein). Atop the mound of the Neolithic structure was a tomb of probable later Late Bronze Age or Iron Age I date (Rowan *et al.* 2015a: 3, figs 2–4).

[4]Designated Later LN in the preliminary report on the 2018 season, primarily to differentiate it from the ELN. The tautology caused confusion, however, so for simplicity's sake the more widely used LN is employed here for assemblages of the later 7th and earlier 6th millennia.

Late PPNB basal phase

By the end of the 2018 season, it had become apparent that W-80 proper did not represent the earliest utilization of this particular location at Wisad Pools. As reported previously (Wasse *et al.* 2022: 250–51), excavation in the southern half of W-80, beneath the earliest surface associated with the structure's interior walls, exposed a paved surface of olivinitic basalt

slabs [111], some up to 1 m in length. In 2019 and 2022 it was demonstrated that these were associated with ephemeral low walls [121; 141] in the south-west quadrant of the structure. Wall [121] was associated with a possible post hole, approximately 25 cm in diameter, located close to a stone upright of the Transitional ELN–LN phase. The architecture of this succeeding phase seemed to respect the positioning of underlying walls [121] and [141], raising the possibility that W-80 represents a rebuild in the same location of the basal-phase structure, potentially with stone uprights replacing wooden ones. All of these basal-phase architectural features ran under the walls of W-80 proper, and were separated stratigraphically from them by an average of 10 to 15 cm of redeposited reddish natural sediment [107] (cf. Rowan *et al.* 2015a: 7). W-80 appears to have been constructed on top of this sediment at the start of the Transitional ELN–LN phase.

The basal phase clearly predates the main structure, with the preliminary report on the 2018 season observing that its discovery 'in all probability push[es utilization of the location] back into the [E]LN if not earlier' (Wasse *et al.* 2022: 250). Since then, the redeposited reddish sediment [107] separating the basal phase from W-80 proper has been radiometrically dated to 7452–7083 cal. BC (UGAMS 59351), suggesting that the basal phase itself dates to at least the Late PPNB. Such an affiliation would accord with the presence of Late PPNB chipped stone immediately west of Wisad Pool 1 (Wasse and Rollefson 2005: 17. For location see Rowan and Hill 2014: fig. 1). It would also align with the phasing of Dhuweila, located approximately 60 km to the west-north-west, where Late PPNB and LN phases have been documented (Betts *et al.* 1998). Supporting evidence exists in the form of five naviform blades found within W-80 since 2013. Three of these are probably residual (perhaps thrown up by later-phase digging within the structure, or by one of the many rebuilding episodes it witnessed). Of the remaining two naviform blades, one was found in 2018 in the blocking of a LN window, with another being recovered in 2022 from the clean-up of a LN wall that was collapsed by looters between seasons. The working hypothesis is that these last two blades represent LN curation of residual 'heirloom'/'ancestral' material and, probably, its incorporation into the structure of the building for apotropaic purposes (Wasse *et al.* 2022: 261–62; see also Clarke and Wasse 2024a: 36–37). The presence in the 2022 chipped-stone sample of two heavily patinated Byblos points (Fig. 2), in contexts that almost certainly predate the utilization — though perhaps not the construction — of the Transitional ELN–LN structure, is likewise indicative of a PPNB presence within the immediate vicinity of W-80. One of the Byblos points was found in [140], a loose, darkish brown deposit filling a shallow cut to bedrock that accommodated and was thus sealed by Transitional ELN–LN sunken curvilinear feature [136] (see below). As only three chipped-stone artefacts — all heavily patinated — were recovered from [140] (the aforementioned Byblos point, a pyramidal polyhedron [see below] and a utilized blade) it is conceivable that they were placed under [136] as a foundation deposit prior to its construction. The polyhedron is unlikely to be Late PPNB, suggesting that the point was residual or curated. The structure has also yielded five previously reported Byblos points, probably residual (Rowan *et al.* 2015a: table 1). These data from W-80 accord with current regional settlement-pattern data suggesting that, in the Neolithic context, the deep steppe was not intensively utilized until the Late PPNB (Betts 2008: 35). Earlier PPNB occupation appears to have been concentrated along the western steppe margins, with the PPNA seemingly restricted to a small number of well-watered refugia such as Shubayqa (Fujii 2022; Richter 2020: 27–29).

Figure 2 **Heavily patinated Byblos points from W-80, recovered in 2022 from contexts that predate the utilization of the Transitional ELN–LN structure (photograph by G. O. Rollefson).**

The relationship of W-80 with the paved surface [111] and low walls [121; 141] beneath it remains uncertain. These features sat on an extremely compact, sterile deposit [122] surrounding an exposure of higher bedrock, upon which the central pillar of the structure proper was subsequently erected. There is no reason to assume that [122]

Figure 3 Possible paved surface laid around an exposure of higher bedrock, close to structure W-13. Potential schema for the Late PPNB phase at W-80 (photograph by B. E. Heidkamp).

does not represent the geological substrate. The redeposited natural sediment [107] that sealed the basal-phase architectural features was not sterile, but yielded a sparse but consistent presence of cultural material, comprising a few tiny scraps of badly preserved bone and very occasional chipped-stone debitage. Like some of the aforementioned Byblos points, this debitage was typically heavily patinated to a milky-white colour, suggesting long-term exposure to the elements. Of particular interest was the discovery of an area of possible paving on the ground surface *c*. 120 m north-west of W-80, close to structure W-13 (Rollefson 2022: 114, fig. 10a). As in the case of [111], these stones appear to have been placed around an exposure of higher bedrock (Fig. 3) and, significantly, were not directly associated with any stone architecture. This raises the possibility that Transitional ELN–LN W-80 was constructed over an earlier area of paving, *viz*. [111], which was either a focus of open-air activity or — more likely on account of the presence of low walls [121] and [141] — was perhaps associated with some sort of temporary organic superstructure, possibly wood, or bundled or woven reeds. Although it is acknowledged that bedrock may fracture in regular patterns in arid environments, the possible paving close to W-13 contrasts with the convincingly natural exposed basalt slabs in the immediate vicinity. In this context, it should be noted that a 1×1 m sondage, excavated within W-80 in 2014 (Rowan *et al*. 2015a: 7, fig. 13a), demonstrated that at least one of the large [111] pavers lay up to 30 cm above bedrock.

In sum, although it is clear that a basal, pre-LN, probably Late PPNB architectural phase exists beneath W-80 proper, where accessible it is too badly preserved — and is too minimally associated with cultural material — to permit even speculative statements as to its nature and function. It must be noted, however, that the abandonment, deliberate infilling and reconstruction in the same location of structures is well documented in the Neolithic archaeological record of the Near East (Clarke and Wasse 2024a: 33–34; Watkins 2024: 121–22). Although it is reasonably clear that there was a period of abandonment, of unknown duration, between the basal phase and construction of W-80 proper, it remains ambiguous as to whether [107] represents: (1) a natural accumulation of reddish sediment during that abandonment; (2) deliberate 'burial' of the basal-phase architecture at the conclusion of its use, after a thorough cleaning out; (3) the placement of some kind of levelling fill prior to the construction of Transitional ELN–LN W-80. What may be said, however, is that the massive basal pavers [111] appear to be restricted to the area beneath the east side of the structure, with the contemporary low, ephemeral walls (121; 141) being present to the west. This architectural 'weighting' (heavier to east; lighter to west) mirrors the 'weighting' of W-80 as originally constructed in the Transitional ELN–LN

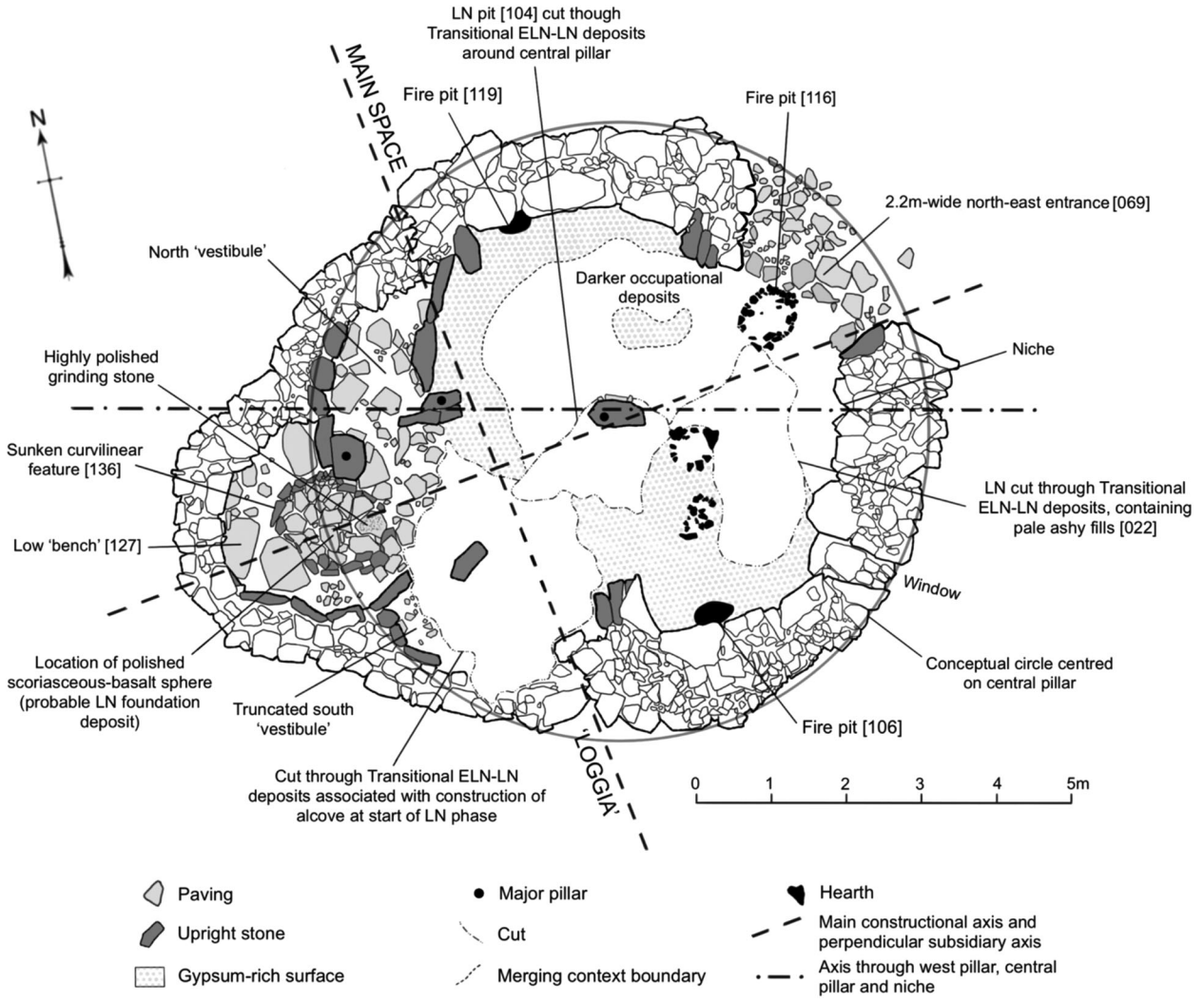

Figure 4 Plan of W-80 during the Transitional ELN–LN, 'wide-entrance' phase (±6645–6432 cal. BC). Bold dashed and dash-dotted lines mark the main architectural axes described in the text; note also the conceptual circle centred on the central pillar (prepared by A. M. R. Wasse).

phase, cautiously hinting that such basal-phase architecture as existed may not have been entirely dissimilar.

Transitional ELN–LN, 'wide-entrance' phase (± mid 7th millennium)

As originally constructed in the Transitional ELN–LN, 'wide-entrance' phase (Figs 4 and 5), W-80 consisted of a circular main structure, bounded by heavily built walls to the north, east and south, with a low, apse-like extension to the west (the so-called 'west porch' [Rollefson *et al.* 2013: 12, figs 6, 9b]). The main interior space incorporated a number of substantial upright slabs around its internal periphery, arranged in an approximate radial pattern around the central pillar. As there is some evidence to suggest that the Late PPNB basal-phase structure was semi-subterranean on its southern side, it is conceivable that the Transitional ELN–LN architecture was built within an earlier structure — as for example at 9th-millennium Göbekli Tepe (Kinzel and Clare 2020: 30–33) — thereby reducing the original internal area. The W-80 main space was entered through an impressive 2.2 m-wide entrance [069] to the north-east, flanked by massive vertical basalt slabs, and was associated with a degraded, much-disturbed gypsum-rich surface. A substantial, partially stone-lined fire pit [116] (Fig. 6), *c.* 60 × 70 cm in size, with a maximum depth of *c.* 18 cm, lay just inside the middle of this entrance, to some extent impeding access. In line with expectations, fire pit [116] yielded a radiometric date of 6645–6481 cal. BC (UGAMS 59353).

In contrast, the 'west-porch' area of the structure consisted of a bi-laterally symmetrical, lightly built 'loggia' centred on a sunken curvilinear feature [136]

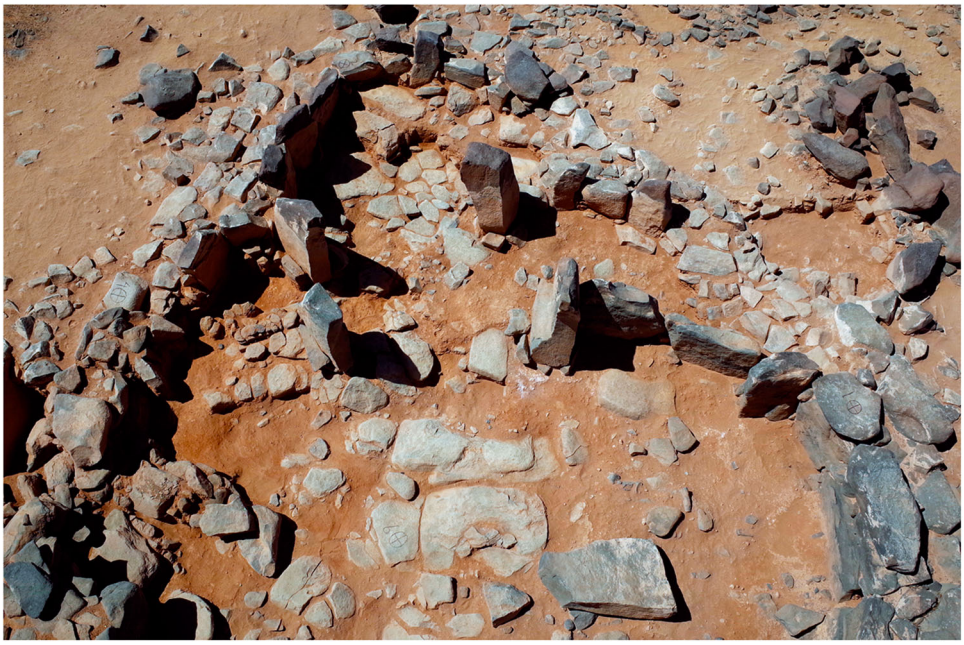

Figure 5 Western part of W-80 as originally constructed in the Transitional ELN–LN, 'wide-entrance' phase (view to west-south-west). Note toppled central pillar at bottom right and bilaterally symmetrical plan (photograph by Y. M. Rowan).

Figure 6 Transitional ELN–LN fire pit [116], located just inside the middle of the eponymous 'wide entrance' on the north-east side of W-80 (photograph by B. E. Heidkamp).

(Fig. 7). Feature [136] was surrounded by a low 'bench' [127], which was in turn surrounded by a low, two-part wall [036/037]. Wall [036/037] consisted of an outer, double row of flat stones [037], retaining an inner line of modest vertical slabs [036] (Rollefson *et al*. 2018: fig. 8a). It seems improbable that wall [037] was ever higher than the slabs of [036], making their combined function one of delineation rather than

Figure 7 Sunken curvilinear feature [136], belonging to the Transitional ELN–LN phase (photograph by T. O. K. Röttger-Morgan).

shelter, although there may of course have been an organic superstructure. Feature [136], *c.* 120 cm in diameter and *c.* 30 cm deep with a dished base, was flanked to the north and south by 'vestibules'. The north 'vestibule' was relatively well preserved and roughly paved; the south 'vestibule' was badly damaged owing to the insertion of a heavily built alcove here in the subsequent LN phase. The 'west-porch' area of W-80 was, therefore, not a later-phase addition to the structure, but rather — as shall be seen later — a focal point in its original configuration, serving to incorporate feature [136] within the structure's bounds. It is conceivable that the bipartite 'weighting' of W-80 during the Transitional ELN–LN phase, *viz*. a heavily built main space to the east, with a central pillar and radial layout of peripheral upright slabs, facing on to a relatively open yet still delineated area in the west, represents the recreation, in basalt, of more ephemeral organic prototypes.

With regard to Early Bronze Age Arad, Finkelstein (1990: 43) wrote: 'The architecture … reflects past traditions … The broadroom with central pillar, and the courtyard surrounded by a wall, resemble the tent with the space in front of it'. At W-80, a plausible past tradition is to be found in the form of Early Natufian shelters, especially Haklay and Gopher's (2015) not-uncontroversial circular reconstruction of the unusually large, semi-subterranean Shelter 131/51 at Ain Mallaha. Here a semi-circular back wall, with a near-central discontinuity, is thought to have faced an open space — likewise semi-circular and possibly defined by low stones — to the front. As at W-80, primary and perpendicular axes are integral to the spatial organization of this reconstruction, with a substantial hearth lying — like feature [136] — directly upon the primary axis in the open space to the front. Building 800 at the early-9th-millennium, PPNA-related site of Klimonas on the island of Cyprus is another credible early comparandum (Vigne *et al*. 2023b).

The sunken curvilinear feature as originally built [136] was beautifully paved with interlocking basalt slabs, the only such paving within W-80 in any phase of its use. Included within the paving was a highly polished, seemingly repurposed grinding stone (Fig. 4). Taken together, these observations suggest that [136] played a significant role within the structure at this time. The function of feature [136] remains unknown; although a few flecks of charcoal and fire-cracked rocks were found in the upper part of its repaved iteration [126], there was no evidence of burning in its base or primary fill. Feature [136] is somewhat reminiscent of — though larger than — the so-called mosaic-lined pits documented at Klimonas. '[C]haracterised by a continuous coverage of the bottom and flanked by cautiously arranged limestone or small polyhedral sandstone blocks' (Vigne *et al*. 2023a: 232), these likewise yielded minimal evidence for burning. Some were located in special places within key structures. The excavators

Figure 8 View from Wisad 1 towards core area of Wisad Pools, approximately 1 km to the north. Neolithic structures clearly visible on middle-distance ridge line; note tiny figures at W-80 at right (photograph by T. O. K. Röttger-Morgan).

have suggested that these pits may have had an important, still undetermined symbolic function.

Intriguingly, the entire west 'loggia' was bi-laterally symmetrical about a west-south-west–east-north-east axis running through the centre of feature [136], W-80's central pillar and the south jamb of the main entrance, with the vestibules being exactly perpendicular to this axis (Fig. 4 [bold dashed lines]). This strongly suggests that W-80 had a central pillar from the start of its Transitional ELN–LN utilization, a supposition supported by the fact that the exterior walls of the structure's main space sit within a conceptual circle centred on the pillar (Fig. 4). Furthermore, the centre of feature [136] and the upright stones marking the outer limits of the north and south vestibules are all positioned on the arc of that same circle. In this context, a second constructional axis, running west-north-west–east-south-east through the west pillar, central pillar and a substantial niche in the structure's main east wall may also be noted (Fig. 4 [bold dash-dotted line]). The presence of not one but two axes within W-80, united by the structure's central pillar, may be taken as evidence for sophisticated architectural planning that is difficult to reconcile with a wholly quotidian function during this phase.

Overall, the volume of cultural material associated with the Transitional ELN–LN phase was much less than in the subsequent LN phase, hinting at less intensive utilization of space. The phase was, however, notable for its large number of hearths and fire pits, located both around the edges and in the central part of the structure's main space. These yielded abundant and seemingly well-preserved charred plant remains; 100% soil samples were taken from all of these features for subsequent flotation. Two small, shallow fire pits were scooped into redeposited natural [107] immediately beneath the internal wall slabs, one approximately north of the central pillar [119] and one approximately south [106], thereby forming a near-perpendicular subsidiary axis. It is improbable that the location of these in relation to the central pillar was fortuitous.

Work undertaken in 2019 and 2022 allows for some preliminary observations regarding the utilization of W-80 as originally constructed. The siting of the structure appears to have been governed by three considerations: (1) access to outcropping basalt-slab building material; (2) proximity to the pools; (3) line-of-sight, frequently sky-line visibility with the structures and flint scatters of Wisad 1 (Wasse and Rollefson 2005: 17) (Fig. 8), located approximately 1 km to the south where the Wisad pools debouche into a small *qa'* (coll. Ar. 'playa'). Of these, the last is suggestive of some sort of territorial statement. The nature of W-80's Transitional ELN–LN configuration, with a main space accessed by a single, expansive entrance placed opposite a bi-laterally symmetrical 'loggia' centred on feature [136], hints at communal rather than household usage. This

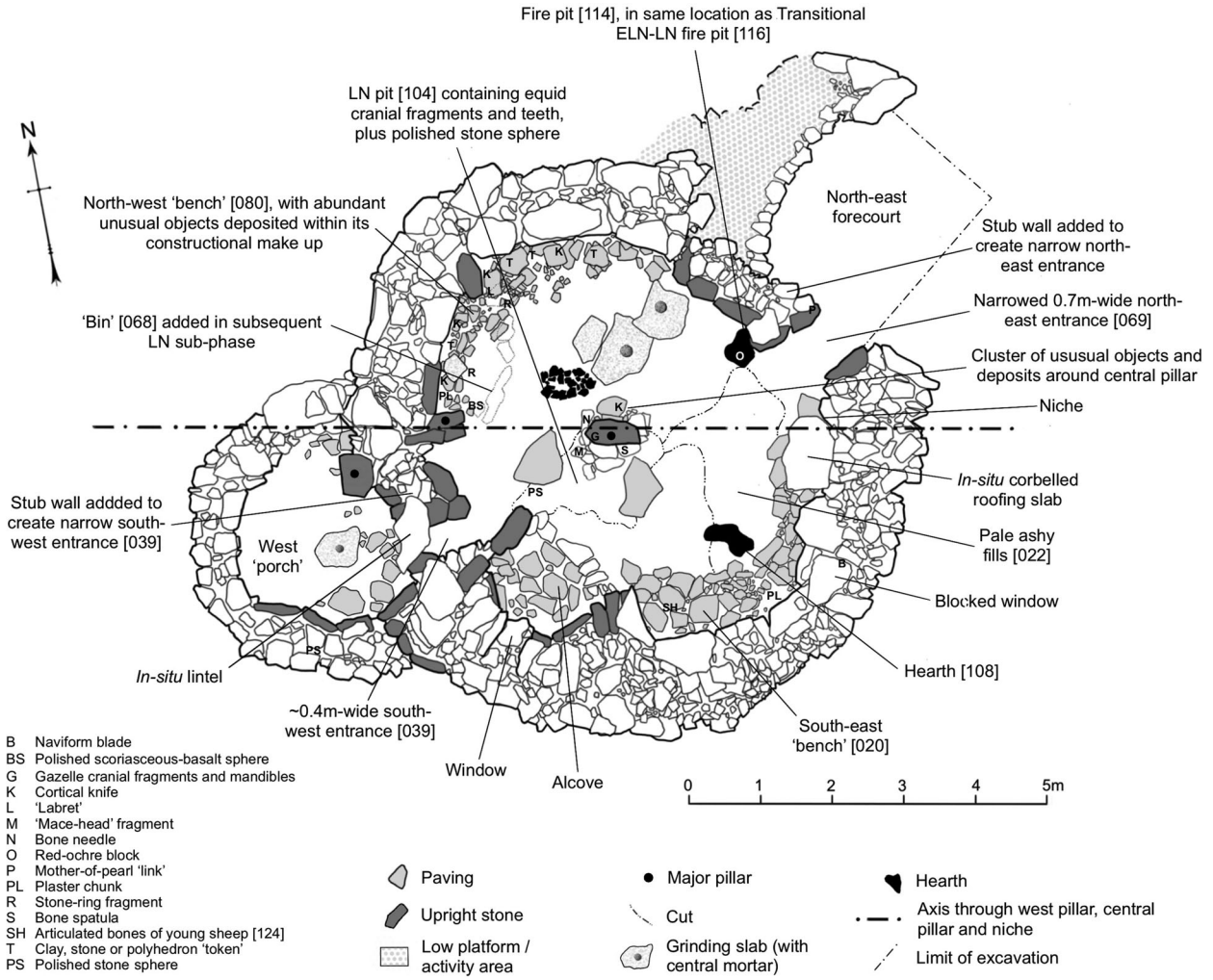

Figure 9 Plan of W-80 during the LN, 'narrow-entrance' phase (±6070–5564 cal. BC); internal installations represent the earliest LN subphase (prepared by A. M. R. Wasse).

interpretation is supported by the presence of multiple hearths and fire pits within the main space of the structure, with the relatively modest volume of cultural material suggesting seasonal utilization. Our working hypothesis is that Transitional ELN–LN W-80 was initially constructed as a focus for extended-family or perhaps clan activity (cf. North American 'frat house'), most likely for use during multi-band, summer aggregation around the pools, when life on the range may have been impracticable (cf. Lancaster and Lancaster 1991: 135). During such periods, normally dispersed communities may have come together to reinforce community identity, strengthen claims to territory, participate in communal hunting activities, engage in trade and exchange, and find marriage partners. It is also worth noting that the apparent abandonment of W-80 in its relatively open, Transitional ELN–LN configuration coincided approximately with the onset of the 8.6–8.0 ka rapid-climate-change (RCC) event. During this event, it has been proposed that the eastern Mediterranean region would have been 'regularly 'bathed' — perhaps for days on end and maybe even for weeks in winter and early spring — with air masses directly from Siberia' (Weninger *et al.* 2009: 17).

LN, 'narrow-entrance' phase (± earlier 6th millennium)

Considerable new information came to light on the LN, 'narrow-entrance' phase during the 2019 and 2022 seasons, which may be added to the picture detailed previously (Wasse *et al.* 2022: 252–54, fig. 4).

Work on the west side of W-80 in 2022 shed further light on the architectural transition from the mid-7th-millennium 'wide-entrance' phase to the subsequent 'narrow-entrance' phase under discussion here. It was already known that the phase began with far-reaching remodelling of the structure (Wasse *et al.*

Figure 10 **W-80 in its LN, 'narrow-entrance'-phase configuration. Structural modifications include narrowing of main north-east entrance (centre right), infilling of north vestibule (top centre), construction of south-west doorway (top left), and construction of alcove in south vestibule (centre left) (view to north-north-west) (photograph by Y. M. Rowan).**

2022: 253), marked by the eponymous narrowing of the main north-east entrance [069] from 2.2 m to just 70 cm (Figs 9 and 10). This was achieved by constructing a short stub wall within the original entrance, which ended in a substantial stone jamb dropped straight into fire pit [116]. However, the earlier tradition of burning in this important location was maintained during the LN phase by hearth [114], set likewise into fire pit [116]. One consequence of the construction of the stub wall was that the narrowed north-east entrance now lay within a markedly linear 'façade'. Concurrently, the lightweight 'loggia' of the 'wide-entrance' phase was substantially 'hardened' with the insertion of massive walls [100; 025] within the north and south 'vestibules'. As noted above, the south-'vestibule' area was remodelled at this time to allow for the insertion of a heavily built alcove with central window. It is possible that the construction of the alcove and, in a later LN subphase, a rectangular 'bin' (Rowan *et al.* 2015a: 6, fig. 10) along the inner face of the new west wall sought to draw the function(s) of the original south and north vestibules into the main interior space (Fig. 9). These developments facilitated the construction of a low, narrow doorway [039] on the south-west side of W-80, directly opposite the main entrance. The new south-west doorway, just *c.* 40 cm wide and *c.* 60 cm high, with an *in-situ* lintel, gave restricted access to the extant 'west-porch' area and thence the 'west-forecourt' enclosure (Rollefson 2022: fig. 5b; Rollefson *et al.* 2013: 12). At around this time, the original Transitional ELN–LN window in the main south-east wall appears to have been blocked (Wasse *et al.* 2022: 261). As a result of these modifications, the circular and bi-laterally symmetrical architectural elements which graced W-80 in its Transitional ELN–LN phase gave way to a markedly more irregular plan.

At some point, sunken curvilinear feature [136] was carefully repaved with two to three layers of flat cobbles [126], lifting its base by 5–7 cm. A thin layer of fine silt lay between the [136] and [126] pavers; it contained several highly weathered, gazelle-/caprine-sized long-bone fragments and a polished scoriasceous-basalt sphere, the latter found in the bottom of the feature, directly upon the [136] pavers (Fig. 4). Although it seems probable that this sphere was — like its scoriasceous-basalt counterpart in 'bench' [080] (see below) — a LN foundation deposit placed at the time of the [126] repaving, the possibility that it represents an *in-situ* artefact belonging to the Transitional ELN–LN phase cannot be entirely discounted. It was found at the intersection

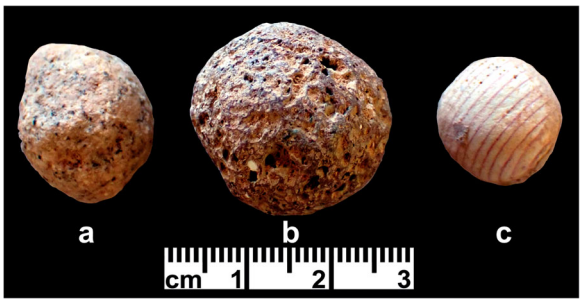

Figure 11 **Stone spheres recovered from W-80 in 2019: (a) possible quartzite blank ('bench' [080]); (b) polished scoriasceous-basalt sphere ('bench' [080]); (c) polished banded-sandstone sphere (wall [037]) (photograph by G. O. Rollefson).**

between W-80's west-south-west–east-north-east constructional axis and the arc of the conceptual circle centred on the central pillar, which is where the lowest paver of [136] was located. Once again, this is unlikely to be fortuitous. The basalt spheres from W-80 may be local copies of the brightly coloured, highly polished stone spheres more normally associated with the Mesopotamian Hassuna and Samarra cultures of the later 7th and earlier 6th millennia (Schmandt-Besserat 1992: 46–47), as well as with the later Ubaid culture (Carter 2018: 54–63). Their function is uncertain but was possibly related to personal identity. One previously reported Mesopotamian-style polished-stone sphere was recovered from a LN pit [104] within W-80 in 2018 (Wasse *et al.* 2022: 262, fig. 15a). In 2019, a second example — this time seemingly of banded sandstone (Fig. 11c) — was found between the stones of 'west-porch' wall [037].

There is some evidence to suggest that feature [126/136] might have continued in use — of whatever nature — following the aforementioned major structural modifications at the start of the LN phase (Fig. 12). Eventually, however, it was sealed with a previously reported grinding slab with central mortar (Rollefson *et al.* 2013: 12, fig. 9a, b), similar to those belonging to this phase in the main space of W-80 (Rowan *et al.* 2015a: 5–6, fig. 9). It may be speculated as to whether grinding activities in the LN phase had a supra-quotidian significance that warranted the deliberate positioning of the 'west-porch' slab directly over the important underlying feature [126/136]. The inclusion of a highly polished grinding stone within the original paving of [136] is once again noted.

The remodelling of W-80 outlined above likely served the twin purposes of: (1) allowing for the roofing of a greater area of the main space with corbelled basalt slabs than previously; (2) restricting access to the interior of the structure from outside. Both would have enhanced privacy and protection from the elements, or at least reduced the requirement to rely on organic structural components to achieve this. The balance of evidence suggests that the relatively open, Transitional ELN–LN W-80 ('wide entrance' to north-east; lightly built 'loggia' to west) was converted into a heavily invested, extremely robust, stone-built domestic dwelling at this time. An association of this 360-degree architectural remodelling with the cold, arid conditions of the longer 8.2 ka climate event (±8250–8090 cal. BP [Flohr *et al.* 2016: 24–26 and sources therein; Roffet-Salque *et al.* 2018]) and/or its immediate aftermath is possible, but has yet to be demonstrated radiometrically. The earliest assays for the LN phase postdate the end of the climate event, but potentially only by a matter of decades. It is conceivable that the climate event reduced the availability of organic construction materials, such as reeds or wood, which would in turn have necessitated greater reliance on stone. In its 'narrow-entrance' phase configuration, W-80 exemplifies the apparently late-7th millennium BDN architectural schema of a curvilinear 'broad-room' marked by a central pillar, with opposing small, central doorways in the long sides giving access to installations and adjoining curvilinear enclosures to the 'rear'. A beautifully preserved example of such a structure was excavated by the Project at Wadi al-Qattafi M4 SS-11 in 2012 (Rowan *et al.* 2015b: 181–82; Wasse *et al.* 2012).

Turning now to the main interior space of W-80 in its LN configuration, excavation in 2019 brought to light a low, paved 'bench' [080] at the north-western end of the space, this being the counterpart of 'bench' [020] at the south-eastern end which was excavated in 2013 (Rollefson *et al.* 2013: fig. 6). The curvilinear 'broad-room' of LN W-80 thus had opposing central doorways in the long sides, and opposing paved 'benches' on the short sides.

Excavation of 'bench' [080] yielded a cornucopia of unusual objects deposited carefully within its constructional make-up (Fig. 9). It must be emphasized that these were found not in use or accidental-discard contexts, but had instead been deliberately incorporated into the structural fabric of the remodelled building (see also Wasse *et al.* 2022: 261–62). The objects included cortical knives placed at regular intervals against the interior face of W-80's perimeter wall (Fig. 13) — perhaps for apotropaic purposes. Comparable behaviour was documented at the transitional PPNA–Early PPNB communal building EA53 at Jerf el Ahmar on the middle Euphrates

Figure 12 Repaved sunked curvilinear feature [126/136] prior to excavation, with LN south-west doorway [039] in background (photograph by B. E. Heidkamp).

Figure 13 Cortical knife placed against the interior face of W-80's perimeter wall, within the constructional make-up of 'bench' [080] (photograph by B. E. Heidkamp).

(Astruc *et al.* 2003: 62), offering further support to the notion that the BDN had 9th-millennium antecedents. A similar cortical knife was found immediately under a paving slab situated somewhat above the base of W-80's central pillar. The constructional make-up of 'bench' [080] also yielded an intact, apparently burned stone 'labret' (Fig. 14), a substantial polished stone-ring fragment and — as in 'bench' [020] — a large chunk of plaster that was unassociated with any floor or installation (Fig. 15). During the Neolithic, plaster had an ideological significance that went far beyond its material properties (Clarke

Figure 14 Stone 'labret' ('bench' [080]) (photograph by G. O. Rollefson).

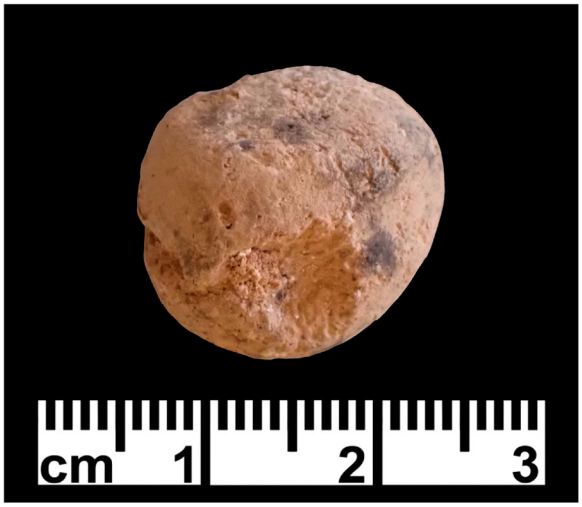

Figure 16 Clay sphere ('bench' [080]) (photograph by G. O. Rollefson).

Figure 15 Plaster chunk deposited within the constructional make-up of 'bench' [080] (photograph by B. E. Heidkamp).

and Wasse 2024b). Also found in the make-up of 'bench' [080] were two clay spheres (Fig. 16) and two stone spheres: one a polished scoriasceous basalt example (Fig. 11b) similar to that found in sunken curvilinear feature [126/136], and the other a possible quartzite blank (Fig. 11a). The same context also yielded a probable quarter-sphere made on a 'gizzard stone',[5] as well as a spherical quartz polyhedron (Fig. 17). Collectively, such objects have frequently been interpreted as 'tokens' and — with the possible exception of the aforementioned Mesopotamian-style polished-stone spheres — are typically associated with counting and/or administration (*inter alia* Bennison-Chapman 2018; 2023). This raises the questions of what might have been counted and/or administered at Wisad Pools, and to what end. Animals and/or the products thereof are but one possibility. It is conceivable that, with intensified regional exploitation of ante-mortem products such as milk or fleece at sites such as Tell Sabi Abyad from the last quarter of the 7th millennium onwards (Akkermans *et al.* 2014: 252–53; Wasse and

[5]Small, rounded pebbles of creamy coloured quartzite (Rollefson *et al.* 2018: 542, fig. 22), at W-80 found — much like the stone and clay spheres — almost exclusively in 6th-millennium contexts.

Figure 17 Spherical quartzite polyhedron ('bench' [080]) (photograph by G. O. Rollefson).

Clarke 2024: 53–54), hitherto under-utilized steppic rangelands — essentially the far-right bank of the Tigris-Euphrates river system — acquired unprecedented 'economic' value. It is apposite to recall that 'in Mesopotamia, there is no doubt that it was the development of sheep farming, in the second half of the Ubaid period, which triggered the [emergence of chiefdoms]' (Breniquet 2014: 73). W-80 has additionally yielded 49 whole 'gizzard stones', frequently in clusters that suggest deliberate curation. For example, 20 came from a *c*. 25 × 50 cm area in a Final LN context [008] within the LN-constructed alcove. As an aside, small spheres of clay, stone and bitumen between *c*. 1 and *c*. 3 cm in diameter were a frequent presence at Late PPNB–ELN Bouqras, located in the dry-steppe of eastern Syria's middle Euphrates valley (Akkermans *et al*. 1983: 356). Similarly, more than 70 clay spheres and cones were recovered from a single production context at Late PPNB es-Sifiya in southern Jordan (Mahasneh and Gebel 1999).

Between 2019 and 2022, the central pillar of W-80 was sadly toppled by visitors to the structure. Cleaning up at the start of the 2022 season exposed the *in-situ* skull of a young gazelle that had been buried directly beneath the pillar prior to its erection (Fig. 18). This skull clearly predates the previously reported LN foundation deposit of gazelle cranial fragments and at least five mandibles placed at the base of the pillar, alongside a number of other special objects (Wasse *et al*. 2022: 262, figs 11b–c, 18). However, stratigraphic discontinuities caused by the digging of pit [104] around the pillar base at the

Figure 18 Gazelle skull placed beneath the central pillar of W-80, exposed when the pillar was toppled by visitors to the site sometime between the 2019 and 2022 seasons (photographer T. O. K. Röttger-Morgan).

Table 1 Radiometric dates from W-80

Lab code	^{14}C age (BP)	Calibrated range (cal. BC [1σ])[1]	Calibrated range (cal. BC [2σ])	δ^{13}C (‰)	Phase	Context	Notes
UGAMS 59351	8240 ± 30	7330–7184	7452–7083	-10.70	LPPNB[2]	[107]	Redeposited reddish natural sediment upon which W-80 proper was constructed; *terminus ante quem* for LPPNB phase
UGAMS 59353	7750 ± 30	6638–6511	6645–6481	-24.75	ELN–LN[3]	[116]	Fire pit located inside main 'wide entrance' on north-east side of W-80
Beta 366676*	7650 ± 40	6565–6439	6589–6432	-23.20	ELN–LN	[034][4]	Close to base of central pillar
Beta 524015	7150 ± 30	6058–5992	6070–5928	-11.00	LN	[108]	Hearth located between two LPPNB basal pavers [111]; evidence for LN digging within main interior space of W-80
UGAMS 59352	7070 ± 30	5992–5910	6018–5887	-24.58	LN	[124]	Associated with possible foundation deposit of young sheep bones under uplifted LPPNB basal paver [111]
Beta 366677*	7030 ± 40	5982–5849	6007–5803	-23.70	LN	[033]	Deposit overlying original LN paving in alcove
Beta 395441*	6940 ± 30	5876–5759	5894–5732	-23.10	LN	[078]	North-west quadrant of main interior space
Beta 395440*	6850 ± 30	5756–5671	5801–5661	-24.70	LN	[075]	Fire pit south-west of central pillar
Beta 366675*	6730 ± 40	5705–5571	5720–5564	-24.90	LN	[011]	South-east quadrant of main interior space; late within LN phase

[1]All dates from short-lived charcoal samples, calibrated using OxCal Online (v4.4 [Bronk Ramsey 2009]; IntCal20 calibration curve [Reimer *et al.* 2020]).
[2]Late PPNB.
[3]Transitional ELN–LN.
[4]Originally attributed to [022] (Rollefson *et al.* 2018: table 2).
* Published previously (Rollefson *et al.* 2018: table 2).

start of the LN phase (Wasse *et al.* 2022: 253) mean the chronological gap between these two rather similar foundation deposits is unknowable in the absence of radiometric evidence. As is so often the case in prehistoric archaeology, it could be a matter of hours or of centuries. Although the plan of W-80 indicates that it almost certainly had *a* central pillar in the Transitional ELN–LN phase, we cannot be certain that the *extant* pillar was not erected or indeed re-erected at the start of the LN. In this context, the presence of articulated bones belonging to a young sheep [124], placed under an uplifted Late PPNB paver [111] at the south end of W-80's main interior space, should also be noted. A radiometric sample found in association with the [124] bones yielded an assay of 6018–5887 cal. BC (UGAMS 59352), suggesting that they were placed in the LN phase, perhaps as another foundation deposit at or around the time of the major structural modifications.

Some final insights relating to the organization of space in W-80, especially during the LN phase, are to be found in Bourdieu's (1973) classic essay, *The Berber House*. First, it is notable that the main entrance of W-80 faces north-east, ensuring that the interior would have benefited from dawn light in summer and that morning egress from the structure would have been towards the rising sun. Second, Bourdieu (1973: 106) describes how the main door of the Berber house stands 'in opposition to [a] low and narrow door, reserved for the women, which opens in the direction of the garden, at the back of the house'. This recalls the positioning of W-80's low and narrow south-west entrance [039], directly opposite the main entrance [069]. Third, Bourdieu (1973: 101–02) describes how special significance is attributed to key structural elements within the Berber house, particularly the central pillar and main roof beam which it supports. Together, these have specific associations with fertility and protection, with containers of seed being piled up around the former and sacrifices being made to the latter. This is to some extent analogous with the structured placement of special objects and gazelle cranial fragments and mandibles around W-80's central pillar. Fourth, Bourdieu (1973: 108–10, fig. 2) sees a diagonal

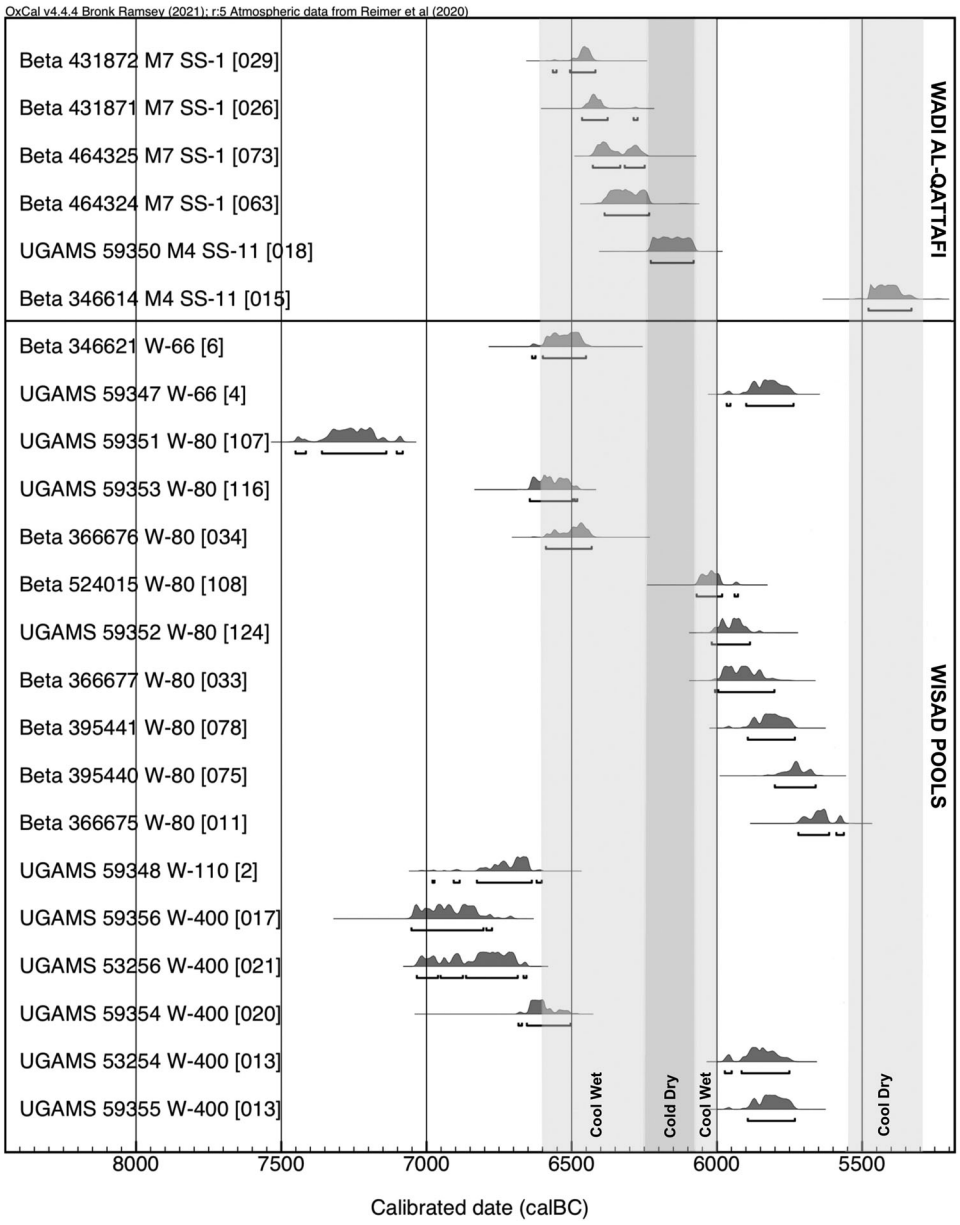

Figure 19 **Calibration plots for all radiometric assays processed by the Project to date, set against rapid-climate-change (RCC) episodes (light-grey bars [Weninger 2022; Weninger *et al.* 2009]) and the longer 8.2 ka climate event (dark-grey bar [Flohr *et al*. 2016]) (prepared by A. M. R. Wasse).**

division of interior space within the east-facing, rectilinear Berber house into south-east and north-west halves, based on the illumination the respective interior walls receive through the main entrance. The south-east part of the interior space is thus associated with darkness, sleep and storage, and the north-west with light and domestic activity. This recalls the arrangement of W-80's LN-phase 'broad-room', with: (1) opposing paved 'benches' on the short, south-east and north-west, sides; (2) large grinding slabs positioned at the north end of the main space, with deep fire pits between them in later LN sub-phases (Rollefson *et al*. 2018: 534, fig. 10); (3) particularly high, substantial main walls to the south and east, with evidence for corbelled, basalt-slab roofing over at least part of the south-eastern quadrant of the structure (Rowan *et al*. 2015a: fig. 5; Wasse *et al*. 2022: 253).

Absolute dating

A total of nine radiometric dates have, thus far, been obtained from W-80 (Table 1; Fig. 19). Five have been published previously (*inter alia* Rollefson *et al*. 2018: table 2; Wasse *et al*. 2022). Four are presented here

Table 2 Tool types from W-80 and W-400, 2019 and 2022

	W-80		W-400	
Tool type	n	%	n	%
Projectile point	75	16.0	6	0.5
Sickle	1	0.2	—	—
Burin	39	8.3	79	6.3
Truncation	13	2.8	19	1.5
Endscraper	10	2.1	5	0.4
Endscraper + burin	1	0.2	—	—
Racloir	21	4.5	16	1.3
Cortical scraper	2	0.4	—	—
Notch	42	9.0	30	2.4
Denticulate	76	16.2	49	3.9
Perforator	8	1.7	—	—
Borer	20	4.3	33	2.6
Drill	12	2.6	814	65.0
Biface	3	0.6	6	0.5
Wedge	82	17.5	146	11.7
Unifacial knife	16	3.4	15	1.2
Bifacial knife	7	1.5	8	0.6
Seam knife	7	1.5	10	0.8
Cortical knife	1	0.2	—	—
Backed element	2	0.4	4	0.3
Tanged blade	2	0.4	—	—
Polyhedron	20	4.3	8	0.6
Pecking stone	1	0.2	—	—
Other	7	1.5	4	0.3
Subtotal	468	100.0	1252	100.0
Retouched pcs	101	(16.7)	195	(13.2)
Unclassifiable	37	(6.1)	28	(1.9)
Total	606		1475	

Figure 20 Microdenticulate from W-80 (photograph by G. O. Rollefson).

for the first time. Although the architectural sequence of the structure is reasonably clear, disturbance to deposits in its main space — whether through deep digging on the part of its prehistoric occupants, or *Polyphylla* sp. beetle-larva and other burrowing-animal activity — has complicated the attribution of contexts to phase.

As noted, the basal Late PPNB phase is dated by the *terminus ante quem* yielded by UGAMS 59351 (7452–7083 cal. BC). On current evidence, the immediate locale then seems to have been abandoned until W-80 proper was constructed some time prior to the mid-7th-millennium dates provided by UGAMS 59353 (6645–6481 cal. BC) and Beta 366676 (6589–6432 cal. BC), both of which are associated with the Transitional ELN–LN utilization of the structure. Until now, it has been unclear whether the succeeding LN phase segued directly out of its precursor, or if there was an intervening break in occupation (Wasse *et al.* 2022: 252–53). Seventeen radiometric dates, derived from four structures, have now been obtained from Wisad Pools (Fig. 19). As none have offered any evidence for occupation of the site between the middle and end of the 7th millennium, the balance of evidence suggests that there was indeed a hiatus — or at least a substantial reduction in site-occupation intensity (cf. Munro 2004: S7) — at W-80 between the Transitional ELN–LN and LN phases. The correlation of this radiometric, if not actual, gap in occupation with the cold, arid conditions of longer 8.2 ka climate event is striking.

The start of the LN phase is currently dated by Beta 524015 (6070–5928 cal. BC) and UGAMS 59352 (6018–5887 cal. BC). As the latter sample seems likely to come early in the phase on stratigraphic grounds, it is possible that the LN renovations of W-80 commenced as early as the last century of the 7th millennium, that is to say within a few decades of the end of the longer 8.2 ka climate event. LN activity clearly continued into the second quarter of the 6th millennium, as evidenced by Beta 366675 (5720–5564 cal. BC), but whether this was continuous or intermittent remains uncertain. Beta 366675 also provides a *terminus post quem* for the Final LN phase, but unfortunately no assays have so far been processed from that phase itself. It seems probable that Final LN activity continued at W-80 into the cool, arid RCC episode at ±7.4 ka (Weninger 2022), but whether this was instrumental in bringing about the abandonment of the structure — or indeed the site — is unknown. Compared to the LN phase,

Table 3 Projectile-point frequency as a percentage of formal tools by season at W-80, showing a decrease in both as the excavation progressed

Season	% Projectile Point	n Formal Tools
2013	29.6	1029
2014	21.1	1394
2018	13.5	856
2019	12.6	326
2022	12.0	283

Table 4 Projectile-point types at W-80 and W-400, 2019 and 2022

	W-80		W-400	
Point type	n	%	n	%
Transverse (stemmed)	27	39.1	—	—
Transverse (untanged)	3	4.3	—	—
Transverse (rectangular/trapezoid)	3	4.3	—	—
Haparsa	22	31.9	1	16.7
Nizzanim	7	10.1	2	33.3
Herzliya	4	5.8	2	33.3
'Byblos'	3	4.3	—	16.7
Other	—	—	1	16.7
Subtotal	69	100.0	6	100.0
Preform	1	(1.3)	—	—
Unclassifiable	5	(6.7)	—	—
Total	75		6	

Table 5 Change in the frequencies of transverse and non-transverse projectile-points by phase at W-80, all seasons (excluding post-Final LN and exterior contexts)

Phase	Type	n	%
Final LN	Transverse	134	92.4
	Non-transverse	11	7.6
	Subtotal	145	
LN	Transverse	414	85.5
	Non-transverse	70	14.5
	Subtotal	484	
Transitional ELN–LN (later)[1]	Transverse	80	68.4
	Non-transverse	37	31.6
	Subtotal	117	
Transitional ELN–LN (earlier)[2]	Transverse	6	26.1
	Non-transverse	17	73.9
	Subtotal	23	
Late PPNB	Transverse	—	—
	Non-transverse	2	100.0
	Subtotal	2	
Total		771	

[1]Utilization of W-80 in its 'wide-entrance' configuration.
[2]Initial construction of W-80 in its 'wide-entrance' configuration.

site-occupation intensity at W-80 was significantly lower during the Final LN phase. A key research question that remains to be resolved is whether Wisad Pools was utilized into the early Ubaid period, that is to say the last quarter of the 6th millennium (Campbell and Fletcher 2010).

Figure 21 Nizzanim, Herzliya and Haparsa arrowheads from W-80; non-transverse types like these predominant in the mid 7th millennium (photograph by G. O. Rollefson).

Chipped stone

Tools

The tool types recovered from W-80 in 2019 and 2022 are listed in Table 2. Projectile points, denticulates and wedges are the most prominent, but there are also strong contributions from notches and burins. The denticulates (Fig. 20) and wedges may have played a major role in: (1) processing *Phragmites* sp. and *Typha* sp. reeds into material suitable for constructing frames for the roofs of structures; (2) splitting reeds to weave them into mats covering roof frames, as well as for ground cover inside and outside the structures (Rollefson 2023: 159–63).

Table 3 reveals that, as the excavation of W-80 progressed through the structure's stratigraphic sequence

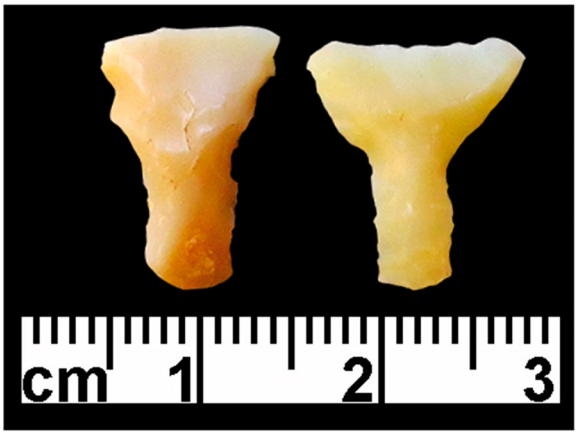

Figure 22 Transverse arrowheads from W-80; absolutely predominant from terminal 7th millennium onwards (photograph by G. O. Rollefson).

Table 6 Burin types from W-80 and W-400, 2019 and 2022

Burin type	W-80		W-400	
	n	%	n	%
Simple	15	38.5	18	22.8
On break	1	2.6	10	12.7
Double on break	1	2.6	4	5.1
Angle	—	—	1	1.3
Double simple	—	—	1	1.3
Opposed simple-simple	1	2.6	3	3.8
Simple transverse	1	2.6	1	1.3
Opposed transverse-transverse	2	5.1	3	3.8
Straight dihedral	1	2.6	9	11.4
Canted dihedral	3	7.7	5	6.3
Straight truncation	2	5.1	1	1.3
Oblique truncation	6	15.4	5	6.3
Concave truncation	2	5.1	5	6.3
Convex Truncation	—	—	3	3.8
Double oblique truncation	1	2.6	4	5.1
Double concave truncation	1	2.6	2	2.5
Opposed oblique-concave truncation	1	2.6	1	1.3
Opposed concave-concave truncation	—	—	2	2.5
Opposed dihedral-concave truncation	—	—	1	1.3
Opposed simple-oblique truncation	1	2.6	—	—
Total	39	100.0	79	100.0

Table 7 Shape of polyhedrons from W-80 and W-400, 2019 and 2022

Shape	W-80		W-400	
	n	%	n	%
Cuboid	4	18.2	4	66.7
Pyramidal	17	77.3	2	33.3
Other	1	4.5	—	—
Total	22	100.0	6	100.0

from generally later to generally earlier contexts, the fraction of projectile points dropped steadily from a high of 29.6% in 2013 to a low of 12.0% in 2022. This decrease was associated with a reduction in the number of formal tools excavated each year. Whilst this might indicate some correlation with sample size, it is also possible that the decrease in sample size reflects lower site-occupation intensity in the Transitional ELN–LN phase, and thus the amount of time the structure was used in that occupational episode compared to the LN.

Projectile point types recovered in 2019 and 2022 are given in Table 4. When these frequencies are combined with the data from previous seasons, and the frequencies of transverse and non-transverse types are arranged by phase (Table 5), a clear diachronic trend can be discerned. This sees the frequency of transverse types increasing throughout the W-80 sequence. The ELN–LN (earlier) category represents

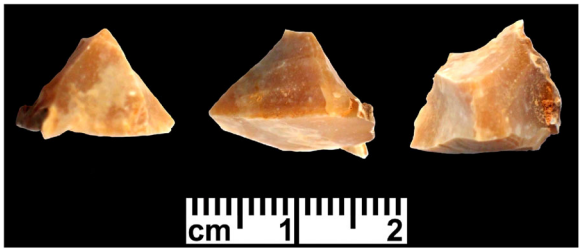

Figure 23 Pyramidal polyhedron from W-80 (photograph by G. O. Rollefson).

Figure 24 Microcores from W-80 (photograph by G. O. Rollefson).

the initial construction of W-80 in its 'wide-entrance' iteration. This period shows a dominance of earlier LN, non-transverse arrowheads (Fig. 21), and it is possible that the few, relatively tiny transverse pieces are intrusive. In the succeeding ELN–LN (later) phase, representing utilization of the 'wide-entrance' structure, the ratio is flipped completely. By the LN, transverse arrowheads (Fig. 22) are almost six times the number of other kinds of projectile points, a ranking that increased in the Final LN to more than 12 times non-transverse arrowheads. The Transitional ELN–LN phase has yielded two radiometric dates in the mid 7th millennium, suggesting that an absolute predominance of transverse arrowheads is — at W-80 at least — very much a terminal 7th- and 6th-millennium phenomenon. The potential significance of the small quantity of PPNB material found within the structure is discussed above.

The burins at W-80 (Table 6) may have been a source of spalls to convert to drills, although the much smaller number of drills indicates that most drills based on burin spalls left the structure, quite the opposite of the situation at W-400. The rest of

Table 8 Core types from W-80 and W-400, 2019 and 2022

Core type	W-80		W-400	
	n	%	n	%
Bladelet core	3	2.0	12	12.1
Opposed platform non-naviform blade core	3	2.0	3	3.0
Microcore	27	17.8	8	8.1
Core on flake	18	11.8	21	21.2
Single face radial core	10	6.6	5	5.1
Radial core	2	1.3	1	1.0
Single platform/single face flake core	12	7.9	1	1.0
Single platform/multiple face flake core	6	3.9	6	6.1
Multiplatform single face flake core	—	—	2	2.0
Multiplatform multiface flake core	21	13.8	16	16.2
Single platform/single face blade core	27	17.8	7	7.1
Single platform multiface blade core	6	3.9	5	5.1
Pyramidal core	5	3.3	2	2.0
Semi-pyramidal core	2	1.3	—	—
90° change-of-orientation core	7	4.6	10	10.1
Other	3	2.0	—	—
Subtotal	152	100.0	99	100.0
Manuport	8	(4.3)	2	(1.0)
'Casual' core, tested piece	7	(3.8)	6	(5.1)
Unclassifiable	20	(10.9)	10	(8.5)
Total	187		117	

Table 9 Types of change-of-orientation core at W-80, 2019 and 2022

90° C-o-O combinations	n	%
Blade: Blade	5	71.4
Blade: Flake	1	14.3
Blade: Bladelet	1	14.3
Total	7	100.0

the W-80 tool inventory appears to reflect common domestic activity with the exception of the 22 polyhedrons (Table 7; Figs 17 and 23). The character of these objects, which occur in spheroid, cuboid and pyramid form, generally with maximum dimensions of less than 20 mm, remains undetermined, but their use as gaming pieces or as part of a simple system of quantification or record keeping is not out of the question (Cropper 2011; Rollefson in press; Wasse *et al.* 2022: 258). The fact that a spherical quartz polyhedron was found in the same context as stone and clay spheres, that is to say within the constructional make-up of 'bench' [080], certainly hints at an association between the two artefact categories. Similarly obscure is the function of the numerous 'microflakes' produced by microcores (Fig. 24) before they were discarded.

Table 10 Drill types from W-80 and W-400, 2019 and 2022

Drill type	W-80		W-400	
	n	%	n	%
Bladelet, symmetrical	—	—	98	12.0
Bladelet, asymmetrical	1	9.1	43	5.3
Burin spall, symmetrical	5	45.5	372	45.7
Burin spall, asymmetrical	3	27.3	156	19.2
Mèche de foret	1	9.1	—	—
Double drill, burin spall	1	9.1	18	2.2
Bit only	—	—	127	15.6
Total	11	100.0	814	100.0

The seven tools in the 'Other' category comprise a notched and denticulated flake with a thinned bulb, three wedges with denticulates on other edges, a biface used as a wedge, a burin used as a wedge, and a serrated knife.

Cores and debitage

At W-80, blade/bladelet cores make up around a quarter of the 2019 and 2022 inventories (Tables 8, 9), much the same as at W-400. In terms of tools, at W-80 blade blanks outnumbered flakes 77% to 23%. The eleven drills at W-80 are almost exclusively on burin spalls (Table 10), rather than on bladelet blanks. The minimal representation of bladelet cores in the 2019 and 2022 assemblages is presumably reflected in the small number of drills.

Special finds

The assemblage of unusual objects found within the constructional make-up of 'bench' [080] has already been noted, as have the stone spheres found there and elsewhere. The balance of special finds from 2019 and 2022 (Table 11) includes the general variety of artefacts commonly found at ELN and LN sites in the *badia*.[6] An interesting body of imported material concerns the five small sandstone 'palettes' and abraders, plus seven fragments of the same material. These build on the previously reported sandstone corpus from W-80 (Rollefson *et al.* 2018: table 9; Wasse *et al.* 2022: table 8). Wright *et al.* (2008: 141, 148–50, fig. 15a–b) have argued, on the basis of ELN data from Wadi Jilat, that such objects are likely to have been used in stone-bead making, for grinding down blanks. This is to some extent supported by the recovery from within W-80 of a number of such blanks, primarily, though not exclusively, on aqua-coloured limestone similar to Daba marble (cf. Wright *et al.* 2008: 155–56). The presence of carnelian

[6]Water-stressed rangelands on the steppic side of the 'desert line'.

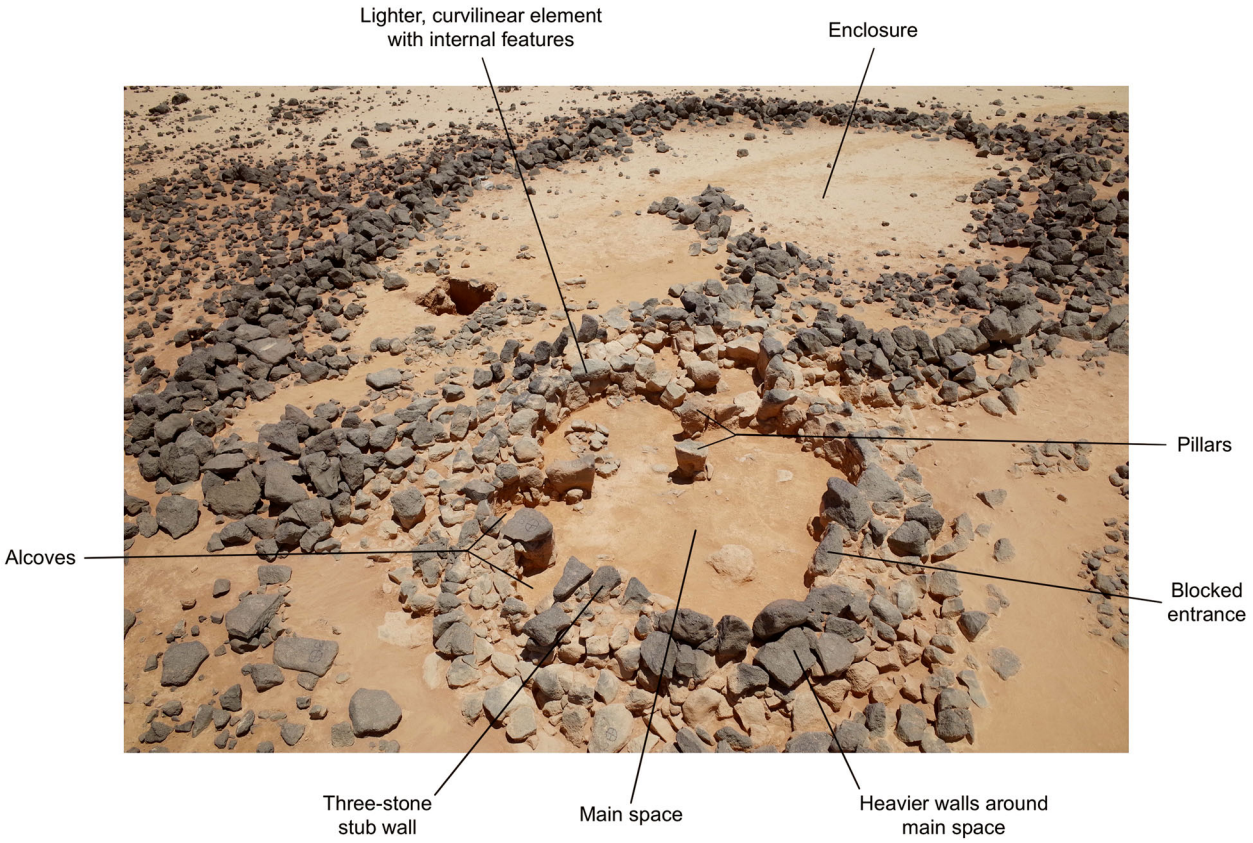

Figure 25 W-400 (view to east), with key structural elements annotated for comparison with W-80 (photograph by Y. M. Rowan).

flakes and chunks is likewise indicative of bead or perhaps pendant making within the structure. Wright *et al.* (2008: 144) were also puzzled by the relatively low frequency of drills (*c.* 3–4% of tools, i.e., broadly comparable to W-80) at the bead 'workshops' they studied and concluded that this might 'sometimes relate to [their] systematic removal or discard … by the artisans'. It has been suggested that, during the ELN, bead making may have been 'embedded in hunting and/or herding activities in remote areas' (Wright *et al.* 2008: 155), with the mobility inherent in such activities perhaps facilitating access to both steppic raw-material outcrops and village-based population centres. The emerging data from Wisad Pools give little reason to dispute this plausible scenario, and its probable continuation into the LN (see below; also Wasse and Clarke 2024: 59–60).

Structure W-400

Summary

Located approximately 615 m north-north-west of W-80, at a distance of more than 350 m from the eponymous pools, W-400 was first investigated in 2018 (Rollefson 2022: 112–13, fig. 7; Wasse *et al.* 2022: 262–63) to test the hypothesis advanced by Betts *et al.* (2013: 189) that Timnian-type (cf. Rosen 2017 ch. 8) hut-and-enclosure compounds appear relatively late in the local LN sequence. Continuing work at W-400 has since resulted in the complete excavation of the structure and detailed investigation of the attached enclosure (Fig. 25). A detailed preliminary report on the stratigraphy, phasing and interpretation of W-400 will be produced in due course. In the meantime, it seems clear that although there were significant differences between W-400 and W-80, there were also a number of important similarities, amongst them a bipartite division between a more heavily walled main space with alcoves, and a lighter, curvilinear element opposite an entrance that had at some point been blocked. W-400 was characterized by the presence of pillars, but these were smaller and less credible functional elements than at W-80. It is possible that they functioned more as 'memory markers' within the structure (cf. Kinzel and Clare 2020: 34, fig. 3.3). Some of the differences between W-400 and W-80 may be attributable to the more fragmented building material available in this part of the site. Separately, the prominent W-400 enclosure appears to be the much larger counterpart — in

Figure 26 Variety of drills from W-400 (scale above bottom-right drill is 1 mm from left white edge to right of black edge) (photograph by G. O. Rollefson).

Figure 27 Bifacial knife from W-400 (photograph by G. O. Rollefson).

spatial if not functional terms — of W-80's 'west forecourt', being located in the same relative position within the structure. It may also be noted that stable-isotope analyses of snail shell have identified some important intra-site differences in the immediate environments of W-400 and W-80 during their periods of utilization, with W-400 being characterized by a more arid, more evaporative regime (Jenkins *et al*. 2023: 262–63). This aligns well with the presence of a *qa'* immediately north of the structure.

Absolute dating

Five radiometric dates have thus far been obtained from W-400 (Fig. 19). These are suggestive of two main periods of utilization within the structure: one in the earlier 7th millennium, that is to say during the ELN, and the other in the earlier 6th millennium, contemporary with the LN phase at W-80. The earlier phase at W-400 appears to predate Transitional ELN–LN W-80 by some margin, potentially challenging the notion that hut-and-enclosure compounds appear later in the local LN. As at W-80, there is no evidence to suggest that W-400 was intensively utilized over the longer 8.2 ka climate event, perhaps to the point of having been virtually abandoned for four centuries, or more, in the later 7th millennium. Given the presence of an enclosure that was presumably used to corral domestic livestock, it is interesting to speculate — assuming the enclosure was indeed contemporary with the earlier phase of the structure — whether W-400 was associated with the well-documented consolidation of herding as a mainstream economic activity in the steppe during the ELN (Betts 2008; Betts *et al*. 2013: 179–91; Garrard *et al*. 1994, 1996; Köhler-Rollefson 1992; Quintero *et al*. 2004; Rollefson and Köhler-Rollefson 1993).[7]

Chipped stone

Tools

W-400 has a genuine 'cottage industry' in view of the dominance of drills (Table 2). The drills also reflect the importance of burins in this cottage industry: 65% of the drills are on burin spalls (Table 10); clearly the burins were not 'tools' in the normal sense, but were cores to service a bead-drill industry (Finlayson and Betts 1990). The drill industry is curious; very few beads were found inside W-400, nor did there appear to be any raw material stored there as might be expected (Wright *et al*. 2008).

With regard to drill types, one factor overlooked when developing the typology used in the analysis

[7] Faunal analyses are ongoing.

Table 11 Special finds from W-80, 2019 and 2022

Description	n	Description	n
Ceramic sherd[1]	7	Stone quarter-sphere	2
Stone bead[2]	45	Clay sphere	2
Shell bead	10	Conical clay object	1
Bone bead	1	Clay fragment[5]	7
Clay bead	1	'Gizzard stone' (quartzite pebble)	1
Sandstone fragment	5	Stone-ring fragment	6
Sandstone 'palette'[3]	3	Mica fragment	4
Sandstone abrader[4]	2	Red-ochre piece	2
Basalt rubber	2	Yellow-ochre piece	1
'Labret'	1	Carnelian flake or chunk	4
Polished banded-sandstone sphere	1	Bone spatula[6]	2
Polished scoriasceous-basalt sphere	2	Bone awl	1
Possible quartzite sphere blank	1	Bone needle	1

[1]One handle; one incised.
[2]Including aqua, red, white and black stone.
[3]One stained with red ochre.
[4]One grooved and stained with red ochre; one incised.
[5]Some shaped.
[6]More bone tools will be identified during faunal analysis.

was drill-tip morphology. Bead drills commonly have relatively blunt and rounded tips as a consequence of the abrasion caused by the rotary movement in unyielding materials such as shell, bone and stone. Only in the later stages of analysis did it become clear that a new type of tool exists at W-400, one tapering to a point measuring 1–2 mm in diameter (Fig. 26). These, therefore, resemble needles. It is unlikely that such 'needle drills' could be used against rigid materials, in view of the fragile nature of the design, but they may have been used with more yielding material. It is possible that W-400 was a structure that also housed a tattoo industry.

There is not much evidence of 'normal' domestic activity at W-400. Knives are almost negligible, as are scrapers and notches/denticulates. Having said that, one large, bifacial knife (Fig. 27) recovered from W-400 is remarkably similar to a cache of four bifacial tools recovered from the cell of a 'desert-kite' hunting trap near Qa'a Mejalla (Betts and Burke 2023: 193, fig. 6.7). The extremely low percentage of arrowheads at W-400 contrasts with W-80, and suggests much less of a focus on hunting, a supposition supported by the presence at W-400 of a substantial enclosure. Notably, only non-transverse arrowheads were found at the compound (Table 4; see also Wasse *et al.* 2022: 262). If the trend in transverse-arrowhead popularity documented at W-80 is anything to go by (Table 5), hunting at W-400 is likely to have been practiced primarily in the first half of the 7th millennium, a conclusion supported by the earlier radiocarbon dates from the structure. This may be indicative of a shift towards herding following the longer 8.2 ky climate event, perhaps associated with intensified exploitation of ante-mortem products as at Tell Sabi Abyad (Akkermans *et al.* 2014: 252–53).

Wedges, that is to say flake/blade fragments with heavy bifacial battering on both polar edges or on opposed lateral edges, or on all four edges, are about equal at W-80 and W-400 in percentage terms (Table 2). This suggests that whatever activity used heavily battered blade/flake fragments was about the same at both venues. The splintering damage to wedges indicates that they could have been used as chisels to split reeds or small bones, the first activity used in conjunction with denticulates for processing *Phragmites* sp. and *Typha* sp. reeds into roofing and matting material, and the second possibly to extract bone marrow.

Cores and debitage

At W-400, all blade/bladelet cores make up around a quarter of the 2019 and 2022 inventories, much the same as at W-80 (Table 8). In terms of tools, at W-400, 78% of the non-drills were on blades/bladelets, with 19% on flakes and 3% on cores. With regard to drills 17% were on bladelet blanks, which clearly explains the presence of bladelet cores at the structure (Table 8; Fig. 28). The astounding number of burin spalls at W-400 matches nicely the scale of the number of drills (Table 10), but the number of burins (Table 2) is plainly too low to have produced that many spalls, even allowing for the removal of multiple spalls from each burin. The 79 burins recovered from W-400 in 2019 and 2022 displayed a total of 150 facets, an average of 1.9 facets per burin. This suggests that many spall drills were made elsewhere, most probably on 'burin sites' where '[t]here are large numbers of burins … but far too few corresponding spalls, suggesting that the spalls themselves were removed' (Betts *et al.* 2013: 182) — perhaps to locations such as W-400.

'Burin sites' are typically open camps located out on the range, without access to long-term water supplies (Betts *et al.* 2013: 184–85). Chipped-stone assemblages tend to be heavily dominated by truncation burins, and there is usually little to no associated cultural deposit. There is credible evidence to suggest that 'burin sites' were associated with mobile sheep herding and winter utilization (Lancaster and Lancaster 1991: 135; Wasse *et al.* 2020: 84–85). Combining the data from W-400 and the 'burin sites' hints that small groups of mobile herders may have specialized in drill production whilst dispersed

Figure 28 Change-of-orientation bladelet core from W-400 (photograph by G. O. Rollefson).

with their flocks during the winter, for use or exchange during periods of aggregation at longer-term habitation sites close to near-perennial water sources in the summer. As an exchange commodity, spall drills (and indeed beads) would have possessed the singular advantage of being highly portable. It is possible that this potentially networked drill industry represents a LN precursor to the subsequent Chalcolithic/Early Bronze Age cortical-scraper industry in the steppe (Finlayson and Flohr 2023: 28; Müller-Neuhof 2013).

Faunal analyses

Zooarchaeological study of the animal-bone remains recovered by the Project has so far focused on sampling three structures: Wadi al-Qattafi M7 SS-1 (Rollefson *et al.* 2016; 2017), and Wisad Pools W-66 (Rollefson *et al.* 2011; 2014) and W-80 (see above). Typical of Jordanian steppic and desert sites, the bone material is highly fragmented which affects identification and tends to produce relatively low sample sizes (e.g., M7 SS-1: 139 NISP; W-66: 461 NISP; W-80 has a higher 1757 NISP thus far). With regard to W-80, the majority of bone is attributable to the LN phase.

Trends for all three structures show a similar pattern of gazelle dominance (45–55%), a near absence of cattle — a single *Bos* sp. premolar was recovered from W-80 — and low percentages of small equids which are likely onager (*Equus hemionus*) (5–7%). Sheep and goats make up 20–30% of the larger assemblages and can safely be assumed to be predominantly domestic imports; wild goats are not known from the Neolithic in the *badia,* whilst wild sheep are scarce (Yeomans *et al.* 2017). It is notable that herded caprines are secondary in importance to gazelle. Unusually for southern Levantine Neolithic assemblages, sheep outnumber goats in the extreme, strongly hinting at management for ante-mortem products (see also Burqu' 27000 [Betts *et al.* 2013: table 3.44] which shows a similar pattern). Hare make up 10–25% of assemblages, showing trapping of these small fur/meat animals to have been a regular practice. Foxes are less common, but disarticulated canid bones are relatively common at W-80 and M7 SS-1 (whether wolf [*C. lupus*], domestic dog [*C. familiaris*] or a combination has yet to be determined). Other carnivores include several medium-sized felid phalanges (possibly from desert lynx [*Caracal caracal*]), all from a single LN context at W-80. This suggests that they may have been introduced to the structure with a pelt. As previously reported (Wasse *et al.* 2022: 261), a distal phalanx of lion (*Panthera leo*) — which in the *badia* may only have become extinct in the 19th century (cf. Musil 1927: 337) — was recovered from beneath a LN-phase paving slab in the south-eastern quadrant of W-80's interior. It is possible that it was placed there deliberately, perhaps for apotropaic purposes. Also notable from LN-phase W-80 is a fragment of oryx horncore (*Oryx leucoryx*), which are scarce in the *badia* faunal record. A single fragment of *Sus* sp. — almost certainly wild boar — from M7 SS-1 attests to a wetter environment in the vicinity of that structure during the third quarter of the 7th millennium (cf. Wasse *et al.* 2022: 264–65 and references therein).

The bird and small-mammal assemblages recovered by the Project await study, but will provide palaeoecological information to augment the palaeoenvironmental picture that has emerged from the Project's geoarchaeological (Jones *et al.* 2022), palaeobotanical and molluscan (Jenkins *et al.* 2023) research.

Discussion

Retreat to environmental refugia during the longer 8.2 ka climate event?

If calibration plots for the radiometric assays thus far processed by the Project for Wadi al-Qattafi are compared with those for Wisad Pools (Fig. 19), an interesting trend is discernible. The previously noted radiometric gap at Wisad Pools between the middle and end of the 7th millennium appears to have been precisely when utilization of Wadi al-Qattafi was at its most intensive (noting that only two LN structures have thus far been sampled at the latter site). Taken as a whole, the Wadi al-Qattafi and Wisad Pools assays raise the possibility that the latter site was more sensitive to climate fluctuations — reduced temperatures and especially heightened aridity — than the former, located approximately 50 km to the west, which may have served as a refugium during such interludes.

Figure 29 Wadi al-Qattafi M7 SS-1 (view to south-west) (photograph by Y. M. Rowan).

Indeed, Wadi al-Qattafi is located within 60 km of the Azraq basin, which would presumably have been amongst the first rank of potential environmental refugia in eastern Jordan. It may be noted that the longer 8.2 ka climate event is typically interpreted as a sharp, cold, dry interlude superimposed upon a cool, wet 8.6–8.0 ka RCC episode, with the ±7.4 RCC episode reported as cool and dry (Jenkins *et al.* 2023 and sources therein; Weninger 2022; Weninger *et al.* 2009). Given the documented existence of a falling north-west–south-east rainfall gradient today and, probably, during the Neolithic (Betts *et al.* 1998: fig. 1.7; Jenkins *et al.* 2023), a retreat up the gradient during periods of aridity seems logical. The situation is complicated, however, by emerging data from north-west Saudi Arabia which suggest that locales such as Tayma and Jubbah remained moist over the longer 8.2 ka climate event, in the context of generally wet conditions during the period 8.55–7.9 ka (Neugebauer *et al.* 2022; Petraglia *et al.* 2020). Other data point to the formation of lacustrine and marsh environments in the Great Nefud desert between *c.* 10.0 and 6.0 ka (Breeze *et al.* 2017). With a choice of potentially wetter refugia to the north-west and south, therefore, Wisad Pools may not have been an optimal location in which to sit out the longer 8.2 ka climate event. Warmer temperatures in north-west Arabia may have been an additional pull-factor. It is notable how both structures excavated by the Project in Wadi al-Qattafi, M4 SS-11 and M7 SS-1, display evidence for intensive burning within and immediately adjacent to the structures (Fig. 29. See also Rollefson *et al.* 2017: 21; Wasse *et al.* 2012: 21, fig. 8). Fire cracking of vertical interior wall slabs raises the possibility that these were deliberately heated to function as 'radiators'. Such evidence has thus far not been identified at Wisad Pools, corroborating the radiometric evidence that the excavated structures there were not intensively utilized during the coldest interludes. In a similar vein, the tiny entrances and small internal volume of M4 SS-11, to date the only structure excavated by the Project with evidence for utilization at the height of the longer 8.2 ky climate event (Fig. 19), may have been fuel-saving adaptations to cope with low temperatures (cf. Rowan *et al.* 2015b: 181).

Potential role of the Black Desert in Arabian Neolithization

The subsequent processing of 11 additional radiometric assays has reinforced the observation made in Wasse *et al.* (2022: 266) that dates from Wisad Pools (Fig. 19) align closely with Drechsler's (2009: 161–63, fig. 1) schema for the Neolithization of Arabia. This posits peaks of 'extensification' (*sensu* Shennan 2018) between 6700 and 6400 BC and after 6000 BC, separated — at least in some locations

— by climate-influenced retreats to environmental refugia during the later 7th millennium. It is tempting, therefore, to position Wisad Pools within an Arabian orbit and Wadi al-Qattafi within a Levantine one, although there is clearly much work still to be done in refining local palaeoclimatic and settlement-pattern sequences in order to project these against regional ones. The situation was clearly complex, with a diversity of processes at work at a multiplicity of scales. It seems increasingly clear, however, that the history of Neolithic settlement at Wisad Pools cannot be fully understood without reference to Arabian Neolithization.

The discovery in recent years of many hundreds of LN stone structures in north-west Saudi Arabia has echoes of the discovery of BDN 'megasites' like Wadi al-Qattafi and Wisad Pools (Rollefson 2021; Rollefson *et al.* 2014). It certainly has important implications for the potential role of eastern Jordan's BDN as a point of departure for Arabian Neolithization. In the Near East and Europe, the later 7th and 6th millennia were characterized by an expansive 'globalization' that saw the dispersal to the west and north-west of migrant farmers and herders as far as the Atlantic seaboard and — almost — the English Channel by 5000 BC (Fregel *et al.* 2018; Shennan 2018: 129). Emergent data from the Arabian Peninsula suggest that relative aridity was no barrier to Neolithic dispersals to the south and east during this same period. Instead, crop cultivation was simply dropped from the normative Neolithic 'package' at the 'desert line' (cf. Quintero *et al.* 2004; Rollefson and Köhler-Rollefson 1993; Rollefson *et al.* 2014), leaving mobile herders free to continue their *Drang nach Osten* without it, unencumbered by the physiological limitations of cultivars. This process was in all probability fuelled by grass- and possibly even park-woodland expansion across much of northern Arabia between 6700 and 6000 BC (Dinies *et al.* 2015; Neugebauer *et al.* 2022; Petraglia *et al.* 2020; Wasse *et al.* 2022: 264–65 and references therein), to say nothing of the concomitant milking of flocks which may have had a profound demographic impact (cf. above. See also Wasse 2019). The site of Manayzah in Yemen's southern Jawl mountains is of critical importance in this regard, suggesting as it does that imported caprine domesticates — most likely of Levantine origin — had been marched to within metaphorical sight of the Indian Ocean by 6000 BC (Martin *et al.* 2009). It is against this expansive, 'globalizing', technologically innovative backdrop that the recent discoveries in north-west Saudi Arabia must be evaluated.

Relevant LN structures in north-west Saudi Arabia fall into two broad categories, with excavated examples of both having been radiometrically dated to the 6th millennium. This raises the possibility that the apparent increase in site-occupation intensity at Wisad Pools following the longer 8.2 ka climate event, that is to say during W-80's LN phase, was part of a more general expansion out of refugia at that time. It may be posited, therefore, that the BDN response to ameliorating climatic conditions at the end of the 7th millennium included intensification within the Black Desert, and 'extensification' into the Arabian Peninsula.

'Standing stone circles'

'Standing stone circles', as reported from al-'Ula, are domestic dwellings containing the 'remains of hearth fires, discarded animal bones, household tools and even jewelry' (Heggie 2023). Often found in clusters, they typically have a circular outer wall consisting of two concentric rows of upright stone slabs and — as the name suggests — a central pillar. Their initial construction is believed to date primarily to the last three quarters of the 6th millennium (cf. McMahon *et al.* 2024: fig. 7). 'Standing stone circles' share many characteristics with the structures of eastern Jordan's BDN, most obviously Wadi al-Qattafi M7 SS-1 (Fig. 29). Critically, the first Jordanian examples appear — at least on current evidence — to predate their earliest Saudi-Arabian counterparts by more than six centuries. This hints at the existence of a north–south chronological gradient, allowing us to speculate about the direction and rate of Neolithic dispersals — whether cultural or demographic — into the Arabian Peninsula. Specifically, it raises the possibility that the BDN was a point of departure for key aspects of Arabian Neolithization, which in turn encourages us to think about the potential push-/pull-factors involved in that process. A non-exclusive list might include: (1) issues of autochthonous demographic growth vs in-migration; (2) technological developments such as milking and water management; (3) climate and ecological change, including the availability or otherwise of pasture and environmental refugia; (4) the socio-cultural impacts of demographic 'packing' within refugia during periods of aridity; (5) territorial competition on the range or absences thereof.

Mustatil*s /'gates'*

*Mustatil*s (Ar. 'rectangle' [plural anglicized]), also known as 'gates', are, as the name suggests, rectangular to sub-rectangular monumental structures up to 600 m in length (Kennedy *et al.* 2023: 2/50).

Concentrated in north-west Saudi Arabia, they typically consist of parallel platforms/chambers linked by low, perpendicular walls. Although their exact function remains elusive, *mustatil*s are thought to have been the settings for complex ritual activity lying at the 'intersection of belief and economic lifeways' (Kennedy *et al.* 2023: 42/50). These activities certainly involved the placement of votive offerings, and perhaps even pilgrimage. Although *mustatil*s have not, thus far, been documented in eastern Jordan, behaviours and architectural features documented at an excavated example in al-'Ula display some parallels with those observed at W-80.

Dating to the later 6th and earlier 5th millennia, *mustatil* IDIHA-F-0011081 includes a chamber at its 'head' containing — amongst other features — a central pillar and a peripheral pillar in the centre of its east wall. To judge from published photographs and plans (Kennedy *et al.* 2023: figs 7–8), the alignment of these two pillars is approximately west–east, and at odds with alignment of the *mustatil* as a whole. This echoes the two primary axes already noted at Transitional ELN–LN W-80 (Fig. 4). At IDIHA-F-0011081, cranial fragments and horns of goat and cattle were carefully deposited at the base of and around the aforementioned pillars (Kennedy *et al.* 2023: figs 10–12). Near-identical behaviour involving the structured placement of gazelle cranial fragments and mandibles was observed around the base of the central pillar at W-80.

Notwithstanding the disparate morphologies of W-80 and IDIHA-F-0011081, focusing on human behaviours and the arrangement of the pillars allows a conceptual link to be drawn between them. It may not be stretching the bounds of credibility too far to suggest that ritual behaviours practiced alongside quotidian activity at LN-phase W-80 were excised from the 'house' and dropped into a specifically ritual architectural setting in the later-6th-millennium Arabian context. One might speculate on the extent to which this may have been related to the onset of increasingly arid conditions in north-west Arabia by around 5800 BC (Neugebauer *et al.* 2022), which may have forced communities to adopt less invested, more mobile ways of life. As in the case of 'standing stone circles', a north–south chronological gradient can be discerned between W-80 and IDIHA-F-0011081. This once again hints that the BDN may have played an antecedent role in aspects of Arabian Neolithization.

Conclusions

Recent data from Wisad Pools have yielded considerable new insights relating to the nature and context of BDN utilization of the site. With regard to W-80, the layout of the mid-7th-millennium, Transitional ELN–LN structure has been clarified, providing evidence for sophisticated architectural planning that was prejudicially unanticipated in a location too easy to write off as 'marginal' ('the bigotry of low expectations' [Shermer cited in Banning 2023: 21]). It involved the unification of two primary architectural axes about a central point, marked by a stone pillar, and the marking out of a circle within which the main architecture appears to have been constructed. Significant architectural features were positioned on these primary axes, on their perpendicular subsidiaries and on the arc of the aforementioned circle. It seems increasingly probable that the Transitional ELN–LN structure represents a rebuild in stone of an earlier, Late PPNB structure, one perhaps utilizing a higher proportion of organic components within a broadly comparable organization of space.

Following a radiometric, if not actual, hiatus at Wisad Pools over the course of the longer 8.2 ka climate event, W-80 was, at the end of the 7th millennium, seemingly reconfigured as a robust, heavily invested domestic dwelling. This involved substantial structural modifications, including the narrowing of entrances to the maximum practical extent, and the installation of paving and substantial grinding slabs with central mortars. This LN-phase structure was also characterized by the careful deposition of unusual objects in key locations, echoing 9th-millennium regional practice. Some of these objects are indicative of contact with Mesopotamia, as well as with the Levant, underpinning characterization of the site as a 'crossroads on the steppe' — one that perhaps linked the western and eastern arms of the Fertile Crescent (cf. Betts *et al.* 2013: 189), and the greater Syrian desert with northern Arabia. The results of faunal analyses suggest that during the LN phase, subsistence was based primarily on hunting of gazelle and the exploitation of sheep for their secondary products.

With regard to W-400, although further work remains to be done on the phasing of the structure, it is already clear that its utilization differs from that of W-80 in several important aspects. Key amongst these is a paucity of projectile points in the chipped-stone assemblage, hinting at an association with herding already attested to by the presence of a substantial, attached enclosure. W-400 also provides some indication of where the burin spalls that are long known to have been missing from 'burin sites' may have ended up, offering the potential to examine site hierarchies within the steppe and possible

associations between mobile herding and aspects of the stone-bead industry (cf. Wright *et al.* 2008: 157), specifically spall-drill manufacturing and perhaps exchange. The tentative identification of chipped-stone tattoo 'needles' at W-400 is of particular interest, for tattooing and stone beads both relate to personal ornamentation. This recalls the intriguing suggestion made by Wright *et al.* (2008: 155) that 'hunter-herder corporate groups … [may have] engaged in special activities, in remote areas, involving art, personal ornaments and ritual … this [being] one example of diverse strategies of social networking linking lineages, households and communities'.

It is clear that some aspects of steppic material-culture and socio-economic change — for example, subsistence trends within the domestic economy, or the uptake of 'tokens' of various kinds — were tracking contemporary trends on the cultivable side of the 'desert line'. However, in other aspects the BDN as evidenced at Wisad Pools displays a quite remarkable cultural conservatism. Some of the behaviours documented at W-80 evoke those of the 9th-millennium PPNA and Early PPNB, whilst others find credible comparanda in the late Epipalaeolithic Natufian. This combination of 'go-fast, go-slow' is echoed in Neolithic Cyprus (cf. Clarke and Wasse 2019), suggesting that marginality — whether onshore or offshore — to the so-called Neolithic 'core zone' may have elicited similar responses as local communities sought to negotiate their receptivity to outside influences and innovations. If evolutionary rather than agency-driven perspectives are privileged, the relative absence of regional-level demographic pressure in the *badia* comes to the fore as a potentially important contributory factor (cf. Wasse 2007). At the same time, the site-level discovery of many hundreds of LN structures in north-west Saudi Arabia forces us to consider the potential role of the BDN in Arabian Neolithization and the additional possibility that key aspects of that process were aligned with episodes of climate change.

It is anticipated that a deeper understanding of the morphologies, functions and stratigraphic sequences of W-80 and W-400 will be refined as post-excavation analyses of the substantial corpus of cultural, geoarchaeological and palaeoenvironmental material recovered from Wisad Pools continue. These will shed further light on the nature of human activity, community organization and transregional contacts in the eastern *badia* during the Neolithic, as well as helping to reconstruct episodes of climatic and environmental change. In September 2023, the Project embarked on a three-season programme of survey, aimed at contextualizing the results of the excavations at Wadi al-Qattafi and Wisad Pools, broadening the chronological focus of research to include the Chalcolithic/Early Bronze Age and Roman-Byzantine/Islamic periods, and piloting palaeoclimatic and palaeoenvironmental investigations within the Project study area.

Author contributions

Alexander Wasse: conceptualization, methodology, investigation, resources, data curation, writing (original draft), writing (review and editing), visualization, supervision, project administration, funding acquisition; Gary Rollefson: methodology, investigation, resources, data curation, writing (original draft), writing (review and editing), visualization, funding acquisition; Yorke Rowan: methodology, investigation, resources, data curation, writing (review and editing), visualization, supervision, project administration, funding acquisition; Blair Heidkamp: investigation, data curation, visualization; Louise Martin: methodology, investigation, resources, data curation, writing (original draft), supervision, funding acquisition; Tom Röttger-Morgan: investigation, data curation, visualization; Özlem Sarıtaş: investigation, data curation, writing (original draft).

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No potential conflict of interest was reported by the author(s).

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