Chapter 13
The "Upper Paleolithic" of South Arabia

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Keywords Demography • Dhofar • Paleoclimate • South Arabia

Introduction

The practice of assigning names to archaeological periods in Arabia is inherently problematic. Just as the Arabian subcontinent is the geographic bridge between Africa and Eurasia; similarly, it is wedged between the bifurcation of Eurasian and African taxonomic schema. This distinction represents separate evolutionary trajectories as expressed in the development of regional lithic technologies. For instance, if we refer to the Arabian "Middle Paleolithic" (MP), we are using a Eurasian name and insinuating closer affinities to this part of the world between 250 and 40 ka, whereas the Arabian "Middle Stone Age" (MSA) presumes a connection to sub-Saharan Africa during a similar interval. This distinction is critical for evaluating the origin and expansion of early modern humans, which predicts linked stone tool technologies on either side of the Red Sea during the Middle and/or Late Stone Age (LSA).

Hence, our use of the term Upper Paleolithic (UP) in reference to South Arabia is no accident. It is a deliberate attempt to highlight closer archaeological affinities with lithic industries found in North Africa and Southwest Asia, rather than sub-Saharan Africa. Indeed, a similar connection has already been made based upon Middle and Upper Paleolithic discoveries in Yemen (Delagnes et al., 2008; Crassard, 2009) and the United Arab Emirates (Marks, 2009). For the purposes of this chapter, "Upper Paleolithic" should be considered an archaeological phase, however, since there is so little evidence from this period in Arabia, we cannot presume a temporal range. The apparently wide range of blade technologies in South Arabia (Amirkhanov, 1994, 2006; Delagnes et al., 2008; Crassard, 2009; Marks, 2009) suggests a long-term tradition of linked laminar[1] technologies that spans at least MIS 4 through early MIS 1 (~75–8 ka).

The new data presented in this chapter comes from archaeological fieldwork conducted by the Central Oman Pleistocene Research (COPR) from 2002 to 2008. We include al-Hatab Rockshelter, an Arabian UP site with AMS and OSL ages placing it within the Terminal Pleistocene and Early Holocene, Ras Aïn Noor, an Arabian UP site buried in aeolian sands at the edge of an ancient spring, as well as a surface scatter sampled from Dhanaqr, situated on a rock outcrop overlooking the confluence of two drainage systems in the eastern Nejd Plateau (Rose, 2006).

Using observations from lithic assemblages collected at these three sites, as well as other reported occurrences from southern Arabia with similar technological features (e.g., Amirkhanov, 1994, 2006; Delagnes et al., 2008) we begin to define and articulate relevant features of the South Arabian UP. Broad technological trends are examined within the framework of the genetic and paleoenvironmental records. It is concluded that the current body of evidence does *not* support an 'Out of Africa' scenario via the Bab al Mandab Strait from MIS 4 onward.

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[1] For the purposes of this paper, we define "laminar" as a simple, unidirectional mode of core reduction utilizing one or more working surfaces, with unidirectional-convergent or unidirectional-parallel flakes often removed from an elongated longitudinal axis of the core. This is not necessarily a true prismatic blade technology in the sense of volumetric cores, crested blade production, core maintenance, rejuvenation, etc.

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The Arabian Paleoclimate During the Latter Half of the Upper Pleistocene

There are meager climatic data from MIS 4 and early MIS 3 in southern Arabia. Indirect evidence can be gleaned from composite signals expressed in a summed probability curve (Parker and Rose, 2008) as well as the index of Indian Ocean Monsoon activity (Fleitmann et al., 2007), which suggest this period was characterized by increasingly hyperarid conditions throughout the interior culminating around 70 ka, followed by a return to a more humid regime by 50 ka (Fig. 1). Evidence for MIS 4 aridification is also inferred from geological profiles in the Rub' al Khali, which attest to a stage of aeolian deposition immediately below the MIS 3 lake marls. While most of central and southern Arabia was probably uninhabitable, bathymetric and hydrographical data suggest certain areas along the emerged coastal plain were ameliorated around this time (Bailey et al., 2007; Parker and Rose, 2008).

Geologists working in the Rub' al Khali sand sea have uncovered evidence of a landscape that was once marked by a network of rivers and small lakes (Fig. 2) spread across the interior (McClure, 1984). Radiocarbon measurements on freshwater mollusk shells and marls indicate the lakes reached their highest levels sometime prior to 37 ka (McClure, 1976, 1978). These playas ranged from ephemeral puddles to pools up to ten meters deep, and numbered well over a thousand. They are primarily distributed along an east–west axis across the centre of the Rub' al Khali basin, covering a distance of some 1,200 km (McClure, 1984). Similar lake basins have been reported in the an-Nafud in northern Arabia (Garrard and Harvey, 1981; Schultz and Whitney, 1986).

In addition to interior paleolakes, other signals of the MIS 3 wet-phase include depositional terraces in the Wadi Dhaid, UAE; their stratigraphic position suggests an age between 35 and 22 ka (Sanlaville, 1992). Interdunal lake deposits (called *shuquq* in Arabic) recorded in the Liwa region of the UAE produced 31 OSL and C14 dates that cluster between 46.5 and 21.5 ka (Wood and Imes, 1995; Juyal et al., 1998; Glennie and Singhvi, 2002). Paleosols were recorded in the ad-Dahna desert, which are interstratified between MIS 4 and MIS 2 aeolian deposits (Anton, 1984). Clark and Fontes (1990) dated calcite formations from ancient hyperalkaline springs in northern Oman, producing radiocarbon ages between approximately 33 and 19 ka. Two soil horizons clustering around 26 and 19 ka were discovered around the central plateau of the Yemeni highlands, characterized as molissols – soils that form on landscapes covered by savannah vegetation (Brinkmann and Ghaleb, 1997).

The MIS 2 hyperarid phase was more extreme than the peninsula had experienced since the Penultimate Glaciation, if not earlier (Anton, 1984). Ages obtained from dune formations in the Rub' al Khali (McClure, 1984; Goudie et al., 2000; Parker and Goudie, 2007), an-Nafud (Anton, 1984), and the Wahiba Sands (Gardner, 1988; Glennie and Singhvi, 2002) all signal a major phase of aeolian accumulation between 17 and 9 ka. Calcite fractures in northern Oman corroborate the evidence for increasing aridity, indicating there was considerably less moisture in the environment starting around 19 ka (Clark and Fontes, 1990). Sometime around 13,500 years ago this period of environmental desiccation

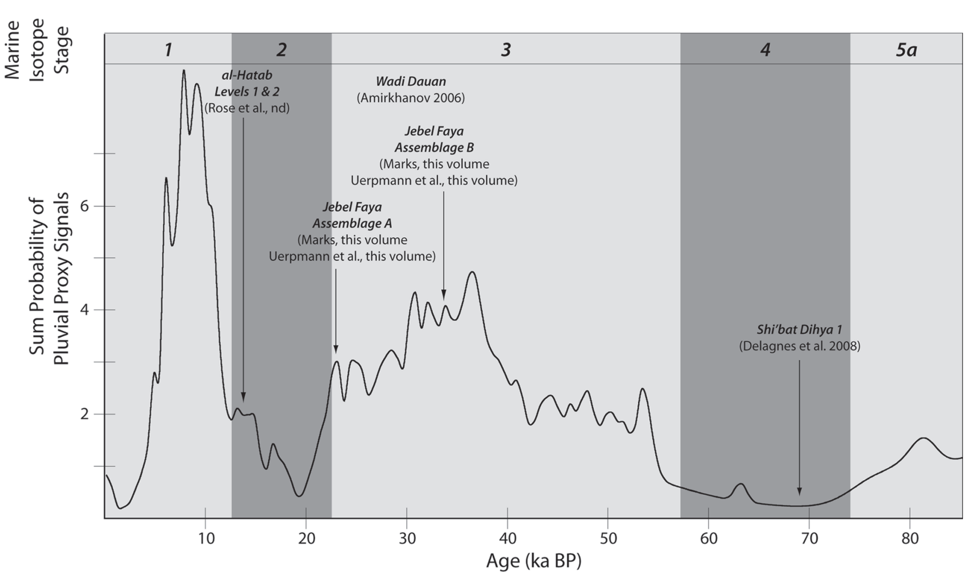
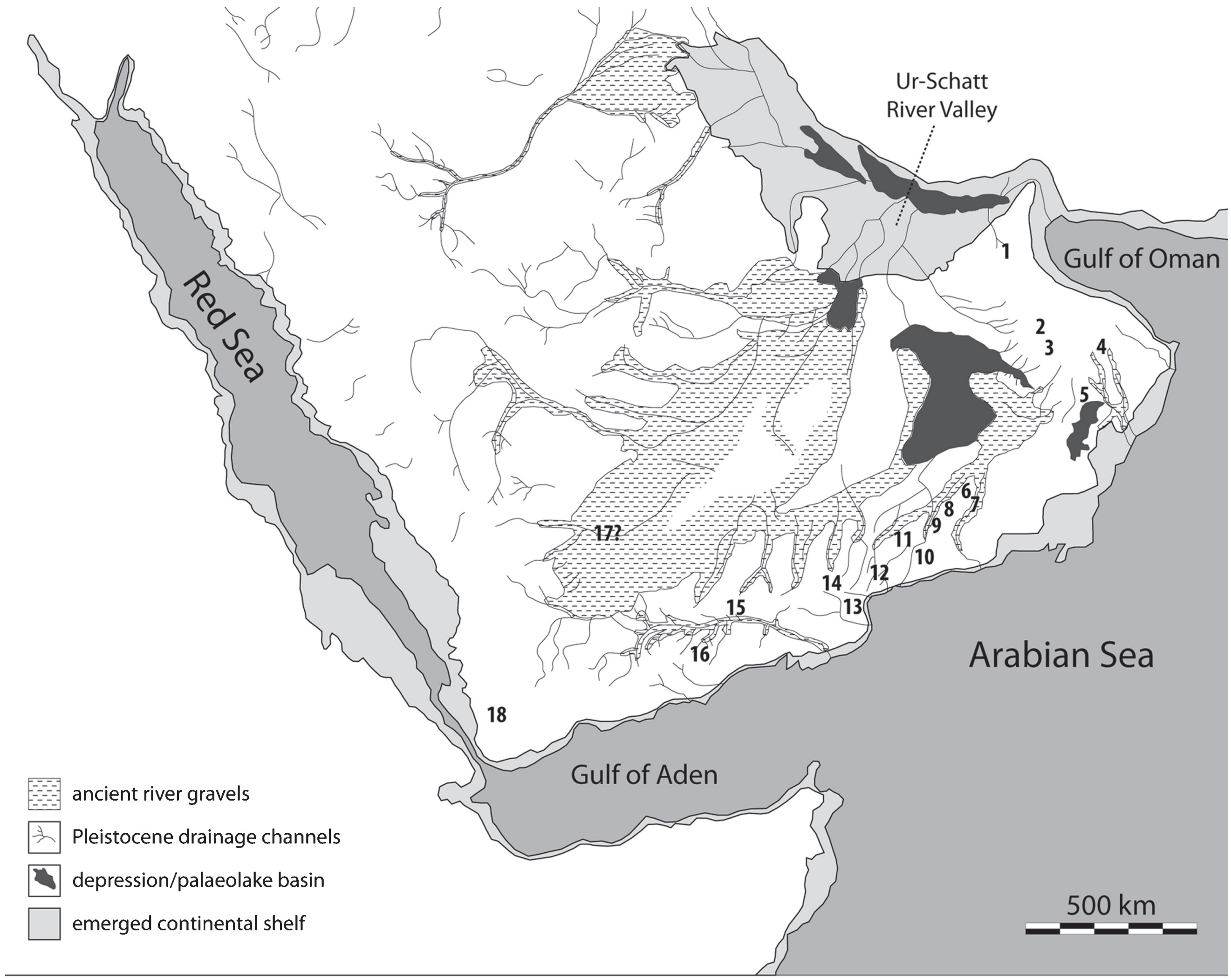


Fig. 1 Arabian paleoenvironmental curve adapted from Parker and Rose (2008, Fig. 4, pp. 31) displaying summed probability curve of pluvial proxy signals from MIS 5a–MIS 1. Dated Upper Pleistocene archaeological sites are also depicted to show their general chronological position in relation to paleoclimatic conditions



1 - Jebel Faya (Uerpmann et al., this volume)
2 - Hamra ad-Duru (Rose et al., unpublished)
3 - Maradi (Rose 2007a)
4 - Tawi Silaim (Rose et al., unpublished)
5 - Haushi-Huqf (Biagi 1994; Rose 2006; Jagher nd.)
6 - Bir Khasfa (Pullar 1974)
7 - Ras Aïn Noor (Rose 2006)
8 - Wadi Mahwis (Rose 2006)
9 - Dhanaqr (Rose 2006)
10 - al-Hatab (Rose 2006)
11 - Shisr/Wadi Ghadun (Pullar 1974; Zarins 2001)
12 - Habarut (Payne & Hawkins 1963; Amirkhanov 2006)
13 - Mahra (Amirkhanov 1994; Rose 2002)
14 - Wadi Jiza (Zarins, pers. communication)
15 - Wadi Wa’shah (Crassard 2008)
16 - Wadi Dauan (Amirkhanov 1994, 2006)
17 - Faw Well Site (Edens 2001)
18 - Shi’bat Dihya 1 (Delagnes et al. 2008)

Fig. 2 Map of ancient drainage channels, alluvial deposits, and paleolake basins throughout the Arabian peninsula. The boundaries of the continental shelf indicate the extent of Arabia during periods of reduced sea levels (roughly between 75 and 8 ka). Sites mentioned in this chapter are also shown

came to an end, as the Indian Ocean Monsoon again picked up in strength and again deposited rainfall across southern Arabia (Overpeck et al., 1996; Ivanochko et al., 2005).

The transformation of the South Arabian landscape throughout the latter half of the Upper Pleistocene had a profound effect upon the submerged continental shelf. Taking into account the shallow bathymetry of the Persian Gulf (Lambeck, 1996) and Red Sea basins (Bailey et al., 2007), nearly half a million square kilometers of contiguous land were repeatedly submerged and exposed by glacio-eustatic cycles of marine transgression and regression. The emergence of the continental shelf around Arabia probably had direct implications for prehistoric occupation, since the exposed landmass provided abundant sources of freshwater juxtaposed to a severely desiccated landscape.

Faure et al. (2002) describe the formation of littoral freshwater upwelling they refer to as “coastal oases,” highlighting the importance of such habitats for early humans groups. Depressed sea levels cause an increase of hydrostatic pressure on submarine rivers; consequently, greater amounts of freshwater flow through these aquifers. Eventually, this process leads to the creation of springs in favorable loci on the emerged shelf with lithology and topography conducive to upwelling. One extreme example of this phenomenon is the submerged seeps at the bottom of the Persian Gulf. The area around modern Qatar is the terminus of several submarine rivers that flow eastward beneath Arabia, creating a mass of upwelling in plumes scattered throughout the eroded karstic sea bed lining the Gulf basin (Church, 1996).

Throughout most of the Upper Pleistocene and Early Holocene, a considerable amount of runoff in southwest Asia was funneled into the Gulf basin via submarine aquifers flowing beneath Arabia, the Karun drainage network originating in the Zagros Mountains, and the Tigris and Euphrates Rivers flowing from the Anatolian Plateau. All of these systems converged in the centre of the Gulf basin, forming the Ur-Schatt River (Fig. 2), which ran through a deeply incised canyon that is still evident in the extant bathymetry (Seibold and Vollbrecht, 1969; Sarnthein, 1972). The most recent phase of Ur-Schatt River downcutting culminated during the Last Glacial Maximum, when global sea levels were reduced by 120 m and the basin was exposed in its entirety (Bernier et al., 1995; Lambeck, 1996; Williams and Walkden, 2002). Prior to the Early Holocene incursion into the Gulf basin, the floodplain was exposed to varying degrees for at least 75,000 years, when eustatic sea levels were more than 40 m lower (Siddall et al., 2002). Therefore, any discussion of human occupation in Arabia during this phase of prehistory must consider the demographic impact of this episodically exposed, large and favorable environmental niche.

Results of the Central Oman Pleistocene Research Program

The identification of mtDNA haplogroup M1 among living populations in East Africa (Quintana-Murci et al., 1999) provided the first glimmer of evidence for early human movement across the Arabian Corridor. Prompted by this discovery, the COPR project was initiated in 2002 to search for direct evidence of a modern human migration out of Africa. From 2002 to 2008, COPR conducted six seasons of archaeological survey and excavation in ad-Dakhliyah and Dhofar regions of Oman.

Ad-Dakhliyah is situated in north-central Oman and comprises the western Hajar Mountain range, accompanying foothills, and a sprawling alluvial plain that begins at the mountain piedmont and extends southward for two hundred kilometers. This plain is interlaced by a dense network of seasonally active widian weakly dipping into the Haushi-Huqf Depression. The bajada landscape displays little relief, declining from 230 m in the north to approximately 100 m in the south (Rogers et al., 1992). During the COPR campaign, archaeological sites were discovered on low terraces throughout the alluvial plain, associated with the low-energy widian (plural of wadi) that drain into the Haushi-Huqf Depression, and within the eroded limestone foothills situated between the Hajar Mountains and ad-Dakhliyah plain.

Following the geomorphic divisions proposed by Zarins (2001), the Dhofar governorate is divided into four zones: coastal plain, Dhofar Escarpment, Nejd Plateau, and Rub' al Khali Desert. The coastal plain of Dhofar stretches for about 50 km aligned southwest-northeast, and reaches a maximum of 15 km in width; it slopes gradually and steadily upward, some 200 m asl at the base of the escarpment. The plain is made up of early Quaternary travertine, ancient terraces, and alluvial fans overlying Tertiary limestone strata (Platel et al., 1992). These coastal deposits are cut by several drainage systems that are active during the summer monsoon season. Salalah, the second largest city in Oman, is situated along the shore in the centre of this plain. The city is surrounded by fields of date and coconut palms, banana trees, mangroves, as well as sorghum, millet, indigo, and cotton. Littoral South Arabia falls within the Sudano-Zambezian phytogeographic zone, which spans sub-tropical Africa into the western portion of the Indian subcontinent (Takhtajan, 1986). Paleobotanical investigations indicate the vegetation was considerably denser along the coastal plains and south-facing mountain slopes in antiquity (Radcliffe-Smith, 1980; Sale, 1980).

The Nejd Plateau is a dissected tableland stretching north from the Dhofar Escarpment. Widian draining across the Nejd into the Rub' al Khali Basin were active throughout the Pleistocene, with at least three distinct terrace systems spanning the last two million years (Zarins, 2001). The southern edge of the Nejd is marked by jagged hills and inselbergs derived from early Tertiary marine strata. The Rus Formation, particularly well developed in this region, is an Eocene bed with very high quality brown tabular chert found at the base and small, gray nodular cherts throughout the unit. As one travels north across the Nejd the vertical relief is reduced to a flat, undulating plain carpeted by Quaternary gravels overlying Late Tertiary limestone beds. The landscape is marked by occasional inselbergs and Rus Formation cherts still occur as lag deposits and in small outcrops exposed on the surface (Fig. 3). The Nejd gradually descends into a vast basin that houses the largest sand sea in the world – the Rub' al Khali.

Al-Hatab Rockshelter (OM.JA.TH.29)

Al-Hatab Rockshelter is a partially-collapsed rock overhang found at the southern end of the Nejd Plateau, just a few kilometers north of the present-day watershed divide along the Dhofar Escarpment. The rockshelter is situated inside a small tributary in the upper courses of Wadi Dawkhah, behind a wide terrace that is about 15m above the active channel (Fig. 4). Not only would this small tributary have provided an ample source of fresh, running water when it was active in the Terminal Pleistocene, there are also abundant fine-grained nodular and tabular chert deposits outcropping throughout the immediate landscape.

The tributary is roughly 15 m long and 10 m wide. There is a small limestone overhang perched approximately 5 m above the gully and oriented parallel to the drainage system. Most sediment inside the overhang has been scoured clean by erosion; however, scree slopes flank both sides of the gully and are comprised of slope waste, wind-borne sands, and eboulis from the collapsed portion of the limestone overhang. A shallow channel incised these sediments, which is how the site was initially recognized.

Nine square meters were excavated from an interstratified sequence of colluvial and aeolian deposits, yielding nearly 2,000 chipped stone artifacts. There are five sedimentary units labeled A to E (Fig. 5). Lithic artifacts were excavated from units A, B, and the upper portion of C. The assemblage was divided into archaeological Level 1 (unit A) and Level 2

Fig. 3 Chert hills comprising the lowest terrace at Ras Aïn Noor

Fig. 4 Al-Hatab collapsed rockshelter with excavation unit in foreground

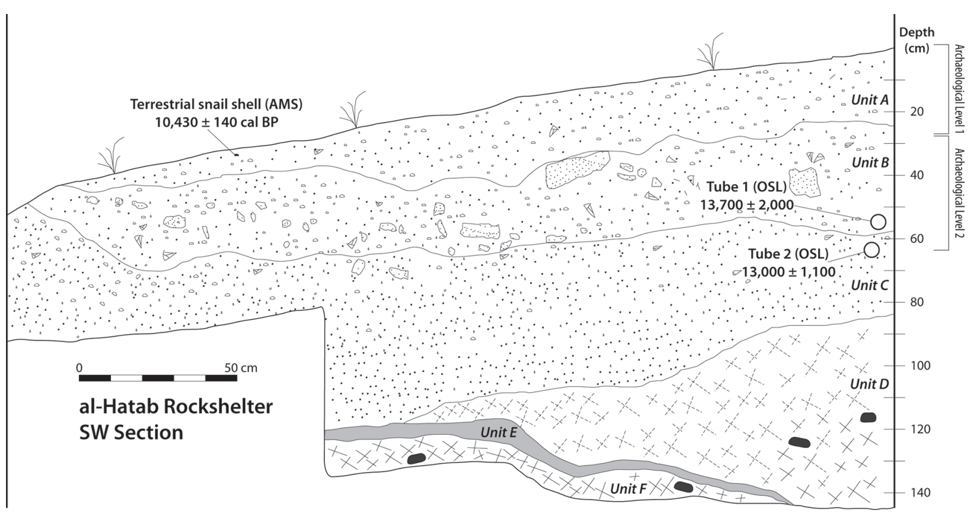


Fig. 5 Al-Hatab stratigraphic sketch depicting the five recognized geological units and locations from which radiometric measurements were obtained

(units B and the top of C). While this deposit is not a living surface, the frequency of chips and the artifacts' pristine state of preservation indicate they probably came from no more than a few meters up the low-gradient slope. Two OSL ages were obtained from the section: one from the top of unit C (13,000 ± 1,100) and the other from unit B (13,700 ± 2,000), producing a bracket date for the level 2 horizon between 14,100 and 11,700 BP (Rose et al., nd). A *terminus ante quem* for the archaeological material in unit A is determined by an AMS date of 10,430 ± 140 cal. BP (Beta-237899) on a terrestrial snail shell excavated from the top of this unit. The snail, *Euryptyxis latireflexa*, is non-borrowing species indicative of dense grass cover (Cremaschi and Negrino, 2005). As such, its presence in Level 1 is attributed to Early Holocene sedimentation, rather than post-depositional site formation processes. This relatively early age for the level 1 Fasad facies predates a similar tool assemblage excavated at KR213 Rockshelter some 30 km to the southeast (Cremaschi and Negrino, 2005), possibly explained by the 14C reservoir effect on shell, which has not been adjusted for on the al-Hatab measurement.

Contiguous one centimeter sediment samples were excavated from the southwest section of al-Hatab to a depth of 73 cm, from units A through C. To obtain a preliminary sketch of paleoenvironmental conditions at the time of deposition, organic and carbonate content was measured using the loss on ignition (LOI) technique (Rose et al., nd).

Unit A is comprised of fine unconsolidated silt that is relatively poor in carbonates and organics. There is a significant increase in both categories at the interface between units A and B, which steadily increases with depth through unit B. This is accompanied by the presence of large angular clasts in the unit B matrix, suggesting a period of alluvial deposition due to increased runoff through the local gully. The transition to unit C is marked by a spike in carbonate deposition and the disappearance of large angular clasts. Both of these trends indicate an abrupt shift from arid (unit C) to pluvial (unit B) conditions. The carbonates probably derive from dry wadi channels nearby; the reactivation of these channels would have significantly reduced the amount of carbonate material available for aeolian transport during the unit B depositional phase.

The characteristics and dates of the al-Hatab stratigraphic section fit comfortably with the regional paleoclimate record. There is ample evidence for a sharp spike in Indian Ocean Monsoon activity during the Terminal Pleistocene (Overpeck et al., 1996; Ivanochko et al., 2005). Dates of 13,500–13,000 for this pluvial event correlate with OSL measurements at the al-Hatab unit B/unit C interface. Hence, overlying units A and B were deposited during the Terminal Pleistocene and Early Holocene wet-phase(s). The decrease in frequency of large clasts from units B to A may indicate a gradual reduction in runoff over the course of this period. Given the very fine, compacted sediments in unit C, the high carbonate content, and the absence of archaeological material, this stratum probably formed during the hyperarid phase associated with the LGM.

While lithic techno-typological features are fairly similar between Levels 1 and 2, some differences have been noted in the variety of raw material found between these two groups. In both cases, the tool manufacturers selected locally available fine-grained chert nodules derived from the Rus Formation, however, the Level 1 material is chocolate brown or yellow in color, while Level 2 cherts are more often shades of gray with banding. Tables 1 through 5 summarize technological features of the al-Hatab assemblage including (respectively) artifact classes, blank types, platform types, dorsal scar patterns, and tool types. The two predominant reduction strategies are simple unidirectional blades struck from volumetric/partial-volumetric cores (Fig. 6a–d) and the façonnage production of small bifacial foliates. This is followed, to a lesser degree, by the manufacture of twisted bladelets from unidirectional volumetric cores, a few carinated pieces, and a low percentage of Kombewa cores and flakes were also identified. On blade-proportionate debitage, the bulbs of percussion are prominent and lipped platforms are rare, implying the use of hard hammer percussion for blade production.

The al-Hatab toolkit is predominantly comprised of burins, endscrapers, notches (Fig. 7h), perforators, carinated pieces, and bifacial foliates. Many of the burins demonstrate multiple spalls struck from a truncated edge (Fig. 7e). Most sidescrapers were made on thick cortical flakes, suggesting that such blanks were deliberately chosen for this purpose. The manufacture of bifacial foliates is also significant since façonnage reduction is notably absent in the Near East during the Middle, Upper and Epi-Paleolithic periods. Given this fact, al-Hatab is probably *not* related to potentially coeval

Table 1 Artifact classes reported from Dhofar UP sites

Artifact class *n* (%)	Ras Aïn Noor, Level 1	Ras Aïn Noor, Level 2[a]	Al-Hatab, Level 1	Al-Hatab, Level 2	Dhanaqr
Debitage	76 (56.3)	11	569 (45.4)	348 (52.5)	239 (55.6)
Cores	2 (1.5)	2	62 (5.0)	35 (5.3)	24 (5.9)
Tools	7 (5.2)	1	178 (14.2)	80 (12.1)	26 (6.0)
Chips	39 (28.9)	3	299 (23.9)	148 (22.4)	33 (7.7)
Chunks/unident.	11 (8.1)	2	144 (11.5)	52 (7.9)	108 (25.1)
Total	135	19	1252	663	430

[a] Percentages not listed for sample sizes under 50.

Table 2 Blank types reported from Dhofar UP sites

Blank type *n* (%)	Ras Aïn Noor, Level 1	Ras Aïn Noor, Level 2[a]	Al-Hatab, Level 1	Al-Hatab, Level 2	Dhanaqr
Flakes	**41 (49.4)**	**7**	**438 (60.2)**	**254 (61.0)**	**179 (66.8)**
Flakes	35 (42.2)	5	348 (47.8)	217 (52.1)	161 (60.1)
Cortical flakes	6 (7.2)	2	90 (12.4)	37 (8.9)	14 (5.2)
Levallois flakes	–	–	–	–	4 (1.5)
Blades	**34 (41.0)**	**5**	**190 (26.1)**	**130 (31.3)**	**71 (26.5)**
Blades	19 (22.9)	2	107 (14.7)	86 (20.7)	39 (14.6)
Cortical blades	–	–	18 (2.5)	5 (1.2)	4 (1.5)
Debordant blades	3 (3.6)	2	25 (3.4)	13 (3.1)	25 (9.3)
Bladelets	12 (14.5)	1	40 (5.5)	26 (6.3)	3 (1.1)
Other	**8 (9.6)**	–	**100 (13.7)**	**32 (7.6)**	**18 (6.8)**
Kombewa flakes	–	–	5 (0.7)	1 (0.2)	1 (0.4)
Biface thinning flakes	4 (4.8)	–	74 (10.2)	20 (4.8)	12 (4.5)
Core trimming elements	4 (4.8)	1/N	10 (1.4)	5 (1.2)	2 (0.8)
Burin spalls	–	–	11 (1.5)	6 (1.4)	3 (1.1)
Total	83	12	728	416	268

[a]Percentages not listed for sample sizes under 50

Table 3 Platform types reported from Dhofar UP sites

Platform type *n* (%)	Ras Aïn Noor, Level 1[a]	Ras Aïn Noor, Level 2[a]	Al-Hatab, Level 1	Al-Hatab, Level 2	Dhanaqr
Unmodified	**44**	**8**	**477 (94.1)**	**293 (95.1)**	**205 (92.8)**
Straight	36	5	327 (64.5)	193 (62.7)	148 (67.0)
Cortical straight	7	3	107 (21.1)	70 (22.7)	39 (17.6)
Cortical curved	1	–	20 (3.9)	11 (3.6)	4 (1.8)
Dihedral	–	–	15 (3.0)	11 (3.6)	9 (4.1)
Dihedral ½ cortex	–	–	8 (1.6)	8 (2.6)	5 (2.3)
Modified	–	–	**30 (5.9)**	**15 (4.9)**	**16 (7.2)**
Faceted straight	–	–	19 (3.7)	10 (3.2)	10 (4.5)
Faceted curved	–	–	7 (1.4)	3 (1.0)	6 (2.7)
Faceted transverse	–	–	4 (0.8)	2 (0.6)	–
Total	44	8	507	308	221

[a]Percentages not listed for sample sizes under 50.

Table 4 Dorsal scar patterns reported from Dhofar UP sites

Scar pattern *n* (%)	Ras Aïn Noor, Level 1	Ras Aïn Noor, Level 2[a]	Al-Hatab, Level 1	Al-Hatab, Level 2	Dhanaqr
Unidirectional	24 (30.4)	4	269 (42.4)	154 (41.5)	88 (35.3)
Unidirectional-crossed	22 (27.8)	1	171 (27.0)	91 (24.5)	45 (18.1)
Unidirectional-parallel	13 (16.5)	3	81 (12.8)	69 (18.6)	48 (19.3)
Convergent	15 (19.0)	2	53 (8.4)	29 (7.8)	28 (11.2)
Bidirectional	1 (1.3)	–	11 (1.7)	4 (1.1)	13 (5.2)
Radial	1 (1.3)	1	25 (3.9)	16 (4.3)	13 (5.2)
Transverse	–	–	8 (1.3)	4 (1.1)	4 (1.6)
Crested	3 (3.8)	–	16 (2.5)	4 (1.1)	10 (4.0)
Total	79	11	634	371	249

[a]Percentages not listed for sample sizes under 50.

Near Eastern industries. Nor can the assemblage be said to resemble contemporary finds in East Africa, where the Late Stone Age exhibits markedly different features such as backed blades and bladelets, geometric microliths, discoids, and concave-base points. Thus, we suggest the Terminal Pleistocene lithic assemblage from al-Hatab represents a local, autochthonous population in South Arabia. The implications of this are discussed at the end of the chapter.

Ras Aïn Noor (OM.JA.SJ.32)

Ras Aïn Noor was discovered by COPR in 2004 and underwent formal investigation during fieldwork activities carried out in 2007. The relict spring, Aïn Noor, derives its name from the al-Noor oil camp approximately 20 km to the north. This findspot belongs to a large complex of lithic scatters situated on an outcrop of high-quality Rus Formation chert

Table 5 Tool types reported from Dhofar UP sites

Tool types *n* (%)	Ras Aïn Noor, Level 1[a]	Ras Aïn Noor, Level 2[a]	Al-Hatab, Level 1	Al-Hatab, Level 2	Dhanaqr[a]
Sidescrapers	–	–	32 (18.0)	18 (22.5)	3
Endscrapers	1	–	16 (5.6)	4 (5.0)	–
Burins	–	–	25 (14.1)	11 (13.8)	4
Notches	–	–	17 (9.6)	9 (11.3)	4
Denticulates	–	–	8 (4.5)	–	1
Perforators	–	–	8 (4.5)	3 (3.8)	–
Truncations	–	–	5 (2.8)	1 (1.3)	1
Carinated pieces	–	–	3 (1.7)	3 (3.8)	–
Retouched pieces	5	–	42 (23.6)	18 (22.5)	9
Levallois points	–	–	–	–	3
Bifacial foliates	–	–	1 (0.6)	2 (2.5)	–
Partially-retouched points	1	–	5 (2.8)	3 (3.8)	–
Fasad points	–	1	1 (0.6)	–	1
Misc bifacial elements	–	–	3 (1.7)	2 (2.5)	–
Heavy duty tools[b]	–	–	18 (10.1)	7 (8.8)	–
Total	7	1	178	80	26

[a]Percentages not listed for sample sizes under 50.
[b]Category includes naturally-backed knives, tranchets, and miscellaneous large chopping tools.

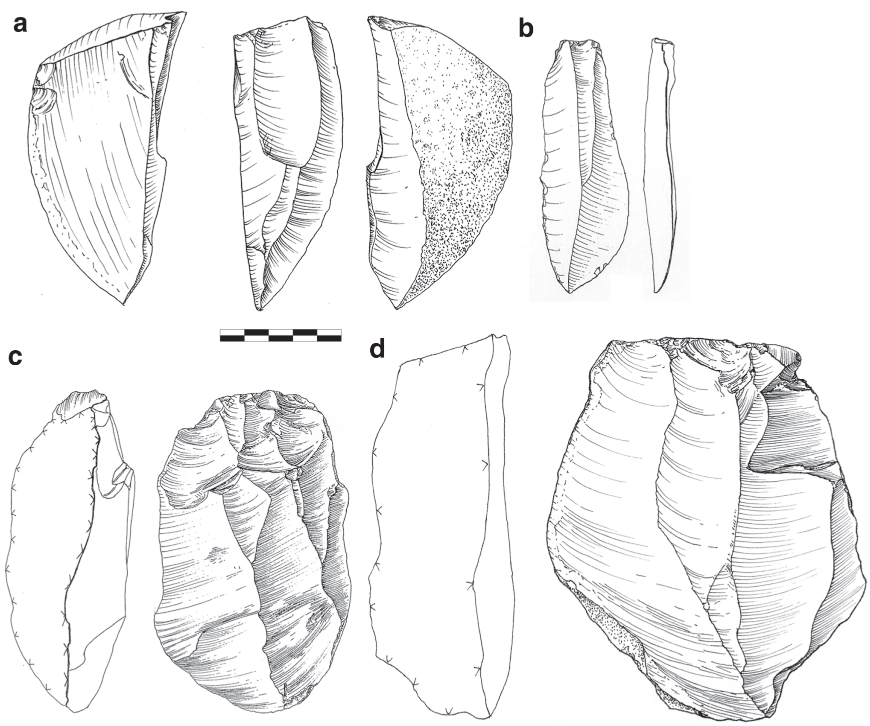


Fig. 6 Blade cores from al-Hatab with unidirectional-parallel and unidirectional-convergent scar patterns (**a**,**c**,**d**) as well an elongated, pointed blade (**b**)

at the edge of an ancient spring. The area investigated is located at the southeastern end of the spring, on the lowest of three terraces rising approximately 5, 10, and 15 m above the low-energy lacustrine basin. The crescent-shaped basin has a diameter of some ten kilometers and abuts a series of low Tertiary limestone hills into which the terraces have been eroded.

Three 1 × 1 m test-pits were excavated at Ras Aïn Noor, two of them located inside the basin (Fig. 3) and one on the 5 m terrace. Pit 1 was sterile, while a moderate density

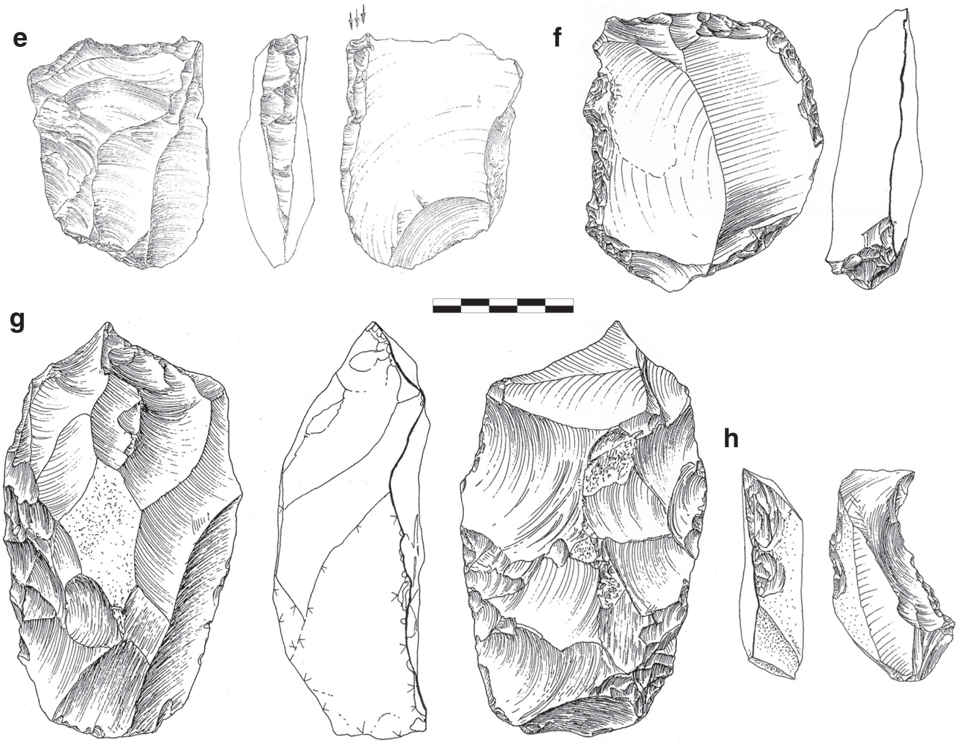


Fig. 7 Tools from al-Hatab including a burin on truncation (**e**), an atypical endscraper (**f**), a miscellaneous bifacial element (**g**), and a notch (**h**)

Fig. 8 Test pit 2 at Ras Aïn Noor. The surface of archaeological level 1 is shown, with flat-lying lithic artifacts immediately above tufa spring deposits

of lithic artifacts was collected from Pit 2 to a depth of 140 cm (Fig. 8). There was also chipped stone material recovered from the surface of Pit 3, although the subsurface strata were sterile. Given that the material from the top of Pit 3 was surface scatter and potentially mixed, we have not included it in this analysis.

Two archaeological levels were recorded in Pit 2. Artifacts from the more recent phase of occupation were excavated between 0 and 50 cm below the surface, while older material was recovered from depths ranging between 100 and 110 cm (Fig. 9). These two archaeological levels are separated by a thick layer of travertine spring deposits interstratified with lacustrine sediments. Level 1 material was excavated in a matrix of aeolian sands with some low-energy fluvial and colluvial input. Artifacts from Level 2 occur in the upper portion of a brecciated calcite layer bearing a coarse sandy matrix. Attempts to obtain OSL ages from geological unit 9 (depicted in Fig. 9) proved inconclusive, although technological parallels with the al-Hatab assemblage (specifically the presence of Wa'shah method core reduction *sensu* Crassard, 2008, as well as evidence for foliate production in the form of biface thinning flakes) suggest a Terminal Pleistocene/Early Holocene temporal attribution.

Level 1 yielded 135 chipped stone artifacts and 19 pieces were collected from Level 2; unfortunately, the low sample sizes preclude a detailed technological analysis. The artifacts were all manufactured from local, high-quality Rus chert. The technological features presented suggest both phases of archaeological occupation employed a similar mode of reduction, which was characterized almost entirely by the simple, unidirectional removal of blades and bladelets from volumetric cores. Even though no bifacial tools were recovered, it is noteworthy that four biface thinning flakes were found in

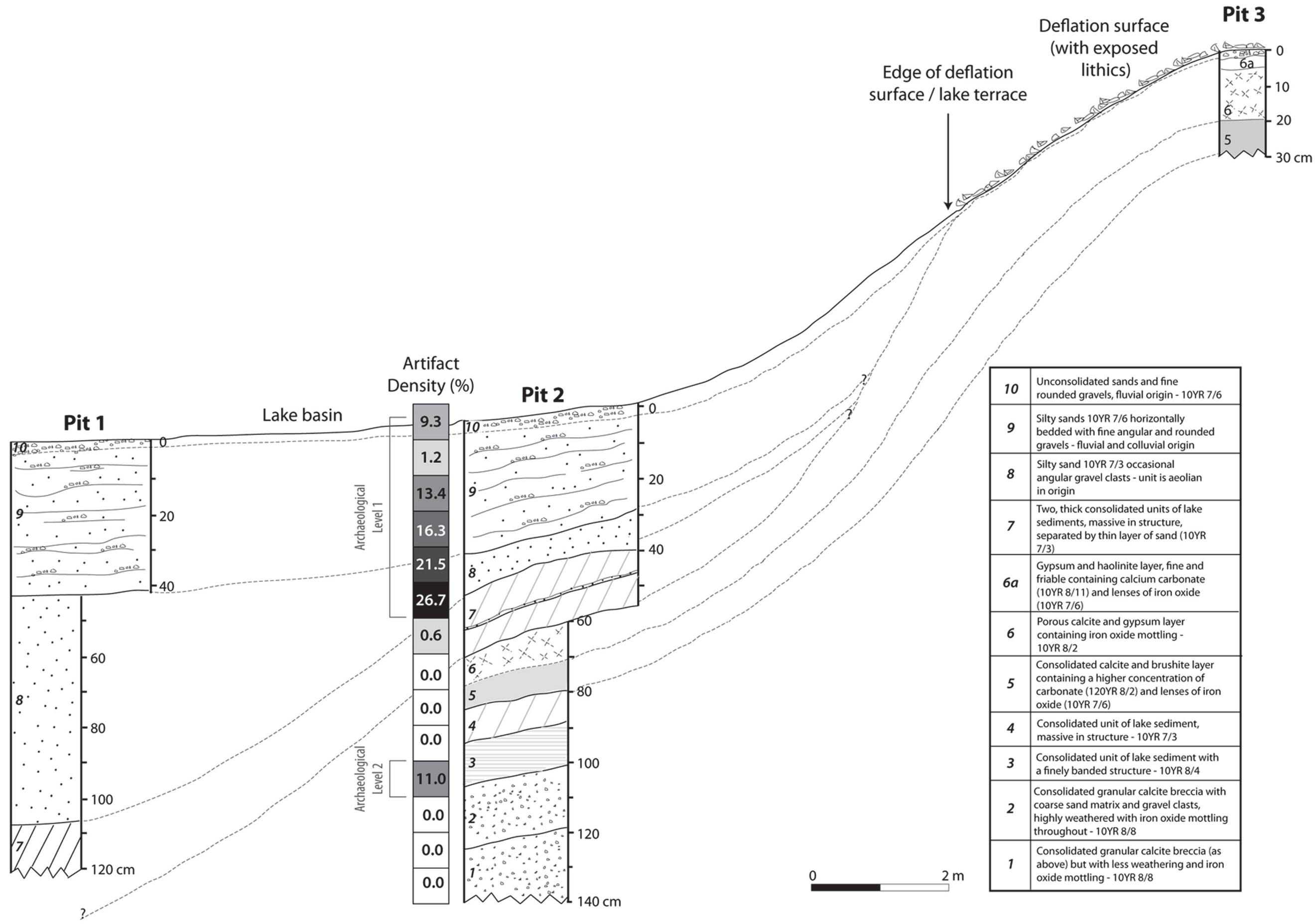


Fig. 9 Stratigraphic profiles of test pits 1, 2, and 3 at Ras Aïn Noor. Artifact distribution between 10-cm excavated spits is also included

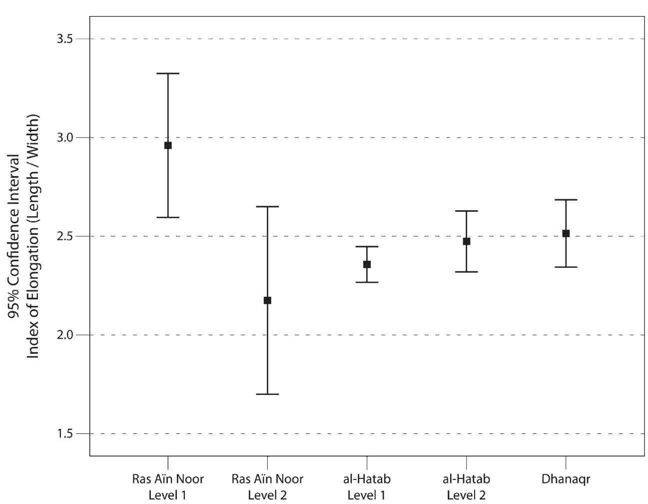


Fig. 10 Error bars comparing indices of elongation (length divided by width) between the Dhofar UP sites

Level 1. With over 40% blade-proportionate blanks, the material from Ras Aïn Noor is considerably more elongated than all other leptolithic assemblage considered in this chapter (Fig. 10). In every case, striking platforms are unmodified. There is also scant evidence for edge preparation, only 13% of the artifacts exhibit grinding along the proximal-dorsal edge. Unidirectional-parallel and unidirectional-convergent scar patterns occur in the highest frequencies at Ras Aïn Noor, in conjunction with volumetric/partially-volumetric blade cores.

Dhanaqr (OM.JA.TH.21)

Dhanaqr was dubbed as such due to its proximity to a local well bearing the same name. The findspot is located at the confluence of Wadi Ribkhut and Wadi Dhahabun in the northern Nejd, in a location where the widian broaden out and drain across the plain on their way toward the Rub' al Khali Basin. The landscape is capped by Quaternary sediments composed of reworked fluvial sands, alluvial fans, depositional terraces, calcareous paleosols, and travertines. There is considerably less vertical relief than in the southern Nejd, though occasional hills and inselbergs rise up from the vast plain.

Dhanaqr is situated on a Tertiary rock outcrop belonging to the Andhur Member, a geological bed of yellowish orange shale with thin-bedded whitish bioclastic limestones and green marls (Platel et al., 1992). The rocky exposure measures roughly 5 km from east to west, 2 km from north to south, and rises about 30 m above the wadi channel. Though there is no chert naturally occurring in this geological unit, immediately to the south there is a deflated gravel plain with Rus Formation chert nodules and slabs outcropping in low density on the surface.

The lithic scatter at Dhanaqr was found on the interior flank of a small cluster of outcropping limestone hills; on a slope that dips gently toward the centre of the outcrop (Fig. 11). The location overlooks both widian, and would have presented a tactical hunting advantage by providing both seclusion and elevation over the alluvial plain.

Fig. 11 Dhanaqr surface scatter within a Tertiary outcrop at the confluence of Wadi Ribkhut and Wadi Dhahabun

Chipped stone debris was collected both on the surface of the hill slope and in a subsurface layer of loose, unconsolidated sandy gypsum that carpets the hill that ranged in thickness from zero to ten centimeters. A recent nearby oil rig camp caused minor trampling and disturbance of the site's surface, although the high percentage of complete artifacts (70%) suggests this activity had minimal affect on the condition of the lithic assemblage. 27 m^2 were systematically sampled in 1 × 1 m units. Where present, the sandy-gypsum surface mantle was scraped clean and screened for artifacts.

The 325 lithic artifacts collected at Dhanaqr are derived from Rus cherts that range from extremely fine-grained and high-quality (15%), to poor, riddled with fracture planes and showing a high degree of shatter (24%), and everything between (60%). There are also traces of artifacts struck from limestone (0.5%). The higher quality material is glossy, orangish-yellow, while the more brittle chert tends more toward a dull brown. For the most part, techno-typological features are fairly homogenous and suggest a single phase of occupation, although given that this site is primarily a surface scatter we cannot rule out the possibility of some intrusive elements.

A few distinct technologies were noted at Dhanaqr. By far the most frequent was the production of blades struck from the narrow working surface of volumetric cores (Fig. 12),

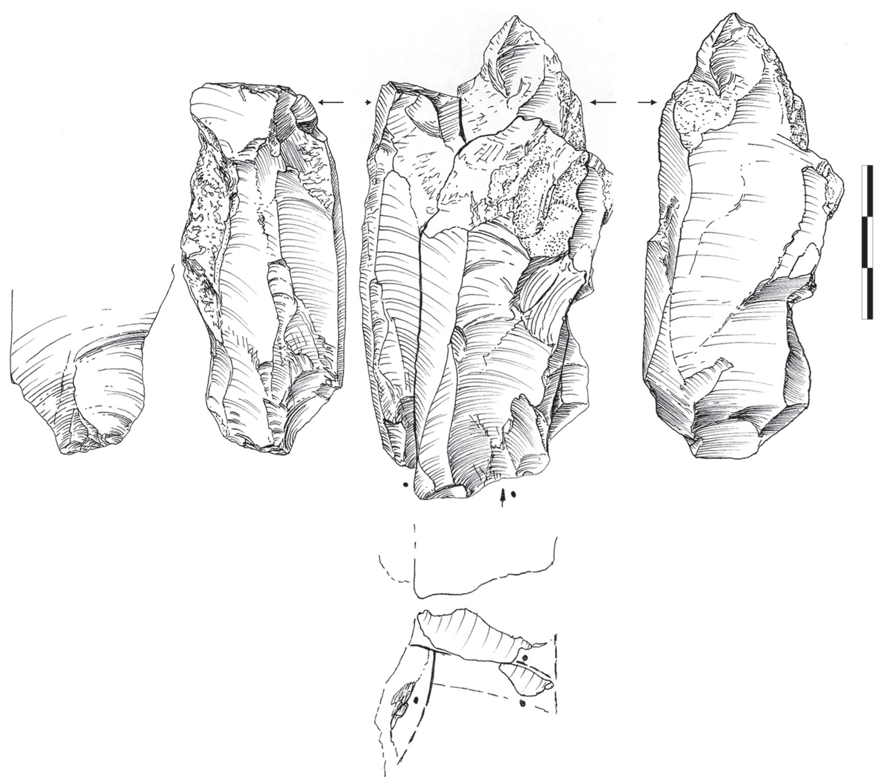


Fig. 12 Blade refits from Dhanaqr showing simple, unidirectional-parallel blade removals. A debordant blade was removed adjacent to the working surface as a means of re-establishing convexity across the working surface

with blade-proportionate pieces representing 27% of the total debitage. In contrast to the predominant use of a simple unidirectional method at al-Hatab, Dhanaqr exhibits a somewhat higher percentage of pieces with bidirectional reduction: 29% of cores are opposed platform and 5% of the debitage have bidirectional scar patterns. In most cases, the distal platforms are supplementary (i.e., short, non-invasive distal removals are used for establishing convexity, rather than to obtain substantial blanks for tools). The bidirectional cores belong to a continuum that, in a few cases, exhibit characteristics of the Levallois technique: there are three flat, prepared cores with evidence of both platform faceting and distal convexity maintenance across the working surface.

While not nearly as prominent as blade production, there is evidence for the façonnage manufacture of bifacial pieces. Biface thinning flakes are present (5%), and one miscellaneous bifacial preform was collected (Fig. 13). All of the façonnage pieces were made from high-quality Rus chert, suggesting the preferential treatment of raw material for specific modes of reduction. There is evidence that the higher quality material was more intensively exploited. One Kombewa flake-core was found, which was made on a thick biface thinning flake that had been longitudinally split during reduction. The lateral-steep edge was used as a striking platform for subsequent blanks (Fig. 14).

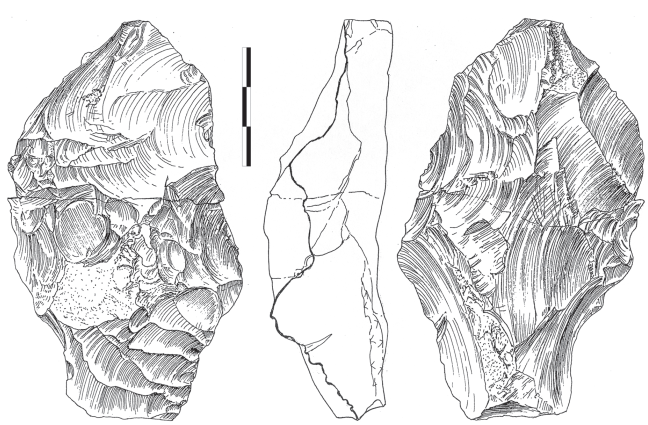


Fig. 13 Miscellaneous bifacial preform from Dhanaqr. The two halves were refit together from different parts of the site, suggesting the preform was discarded during manufacture as a result of the breakage

There are just 26 tools in this assemblage, none of which are particularly diagnostic of any industry, region, or time period. The most frequent types are irregularly retouched pieces (made on an array of blank types), followed by burins, notches, denticulates, sidescrapers, and a bifacial preform.

Discussion

The South Arabian UP

Given the paucity of sites and dearth of absolute sites, it is not yet possible to construct a reliable or comprehensive synthesis of Upper Paleolithic archaeology in southern Arabia. Al-Hatab Rockshelter described in this chapter, Shi'bat Dihya 1 near the Red Sea coast in Yemen (Delagnes et al., 2008) both provide evidence for human occupation in southern Arabia in proximity to coastal environments during MIS 4 and MIS 2, respectively. The site of Jebel Faya 1, with assemblages dated to MIS 5 and MIS 3 (Marks, 2009; Uerpmann et al., 2009) and Upper Paleolithic sites recorded in the Wadi Hadramaut (Amirkhanov, 2006) are examples of Arabian UP findspots found in more marginal environments, with periods of occupation corresponding to paleoclimatic wet phases.

Two distinct modes of reduction are present in South Arabia during the latter half of the Upper Pleistocene: the façonnage creation of bifacial leaf-shaped points and the simple, unidirectional manufacture of blade-proportionate blanks struck from single platform, volumetric cores. Described as diminutive, thin, biconvex tools formed by soft hammer percussion, specimens have been reported at Bir Khasfa (Pullar, 1974;

Fig. 14 Refit Kombewa flake made from a biface thinning flake

Rose, 2004a, 2006), Fahud (Pullar, 1974), and at scattered surface findspots published by Smith (1977) and Villiers-Petocz (1989) from museum collections stored in Muscat. Leaf-shaped points made via this former technology have been designated ‘Type 5′ of the Rub’ al Khali Neolithic (Edens, 1982, 1988). Other scholars include pieces categorized as bifacial foliates with the Middle Holocene Saruq facies (Uerpmann, 1992); there are even foliates from earlier deposits dated to MIS 5 or older (Marks, 2009). Clearly, the presence of bifacially shaped tools is not a useful chronological marker to differentiate South Arabian Pleistocene and Holocene lithic assemblages. On the other hand, some regional geographic patterning may be emerging. The presence of bifacially-manufactured tools is significantly greater from sites around the Gulf basin refugium and adjacent areas of southeastern Arabia (Jagher, 2009; Marks, 2009; Scott-Jackson et al., 2009; Wahida et al., 2009), as opposed to the predominant laminar technologies discussed in this chapter found throughout southern and southwestern Arabia.

Some researchers have pointed out similarities between South Arabian foliates and similar specimens found in Magosian, Doian, and Aterian assemblages from Africa (Caton-Thompson, 1939, 1954, 1957; Van Beek et al., 1963; Gramly, 1971; Pullar, 1974; and Villiers-Petocz, 1989; Rose, 2004a). In East Africa, however, bifacial foliates are found in association with backed blades, microliths, outils écaillés, Levallois cores, microlithic cores, discoids, and thumbnail scrapers (Clark, 1954; Graziosi, 1954; Gresham, 1984; Merrick, 1975; Anthony, 1978; Clark et al., 1984; Brandt, 1986; Ambrose, 1998; Rose, 2004b; Pleurdeau, 2005). Conversely, the Khasfian foliates are most often found in association with single platform, volumetric blade cores, Kombewa cores, burins, nosed endscrapers, perforators, carinated pieces, and naturally-backed knives. While the tools are morphologically similar, they appear to belong to separate techno-typological traditions (contra Rose, 2004a). More likely, the presence of Khasfian foliates in South Arabia is associated with an Upper Pleistocene and Holocene tradition of bifacial tool production reported throughout the eastern portions of Arabia as early as MIS 5 (Marks, 2009), and as late as the Middle Holocene (Charpentier, 2008).

Throughout this paper, we have emphasized a very general definition of the South Arabian “Upper Paleolithic” that carries no temporal connotation. This is because a possible continuum of laminar technologies are known throughout the region between approximately 75 (Delagnes et al., 2008) and 8 ka (e.g., Charpentier, 2008). Al-Hatab provides two points on the timeline between roughly 13 and 10 ka. Based on a TL date from the base of a Late Pleistocene sandy loam in Wadi Hadramaut, the Yemeni-Soviet Expedition bracketed a stratified UP assemblage found there between approximately 30 and 18 ka (Amirkhanov, 1994, 2006). Undated lithic occurrences bearing a suite of potentially-related technological characteristics were also documented in the ‘Asir Highlands (Zarins et al., 1980), Habarut (Amirkhanov, 1994), Wadi Ghadun (Zarins, 2001), the Faw Well Site (Edens, 2001) and Wadi Jiza (Rose, 2002).

Given this wide temporal range and the ambiguity of techno-typological features, we recognize the UP in the most general sense by the ubiquitous presence of simple, hard and soft hammer laminar technologies. There is a considerable degree of variability within this leptolithic complex: (1) flat, unidirectional and bidirectional core reduction (e.g., the Dhanaqr and Wadi Dauan assemblages [Amirkhanov, 1994, 2006]), (2) prismatic blades and bladelets, crest-preparation, double-backed bladelets, endscrapers, and burins (e.g., the Faw Well assemblage [Edens, 2001]), (3) Wa’shah elongated point production (sensu Crassard, 2008) (e.g., al-Hatab, Wadi Wa’shah, and Ras Aïn Noor), and (4) Fasad facies found all throughout southern Arabia (sensu Charpentier, 2008). It is significant that there are no reported instances of microlithic assemblages, lunates, backed blades, bipolar core reduction, or other such features of the East African LSA, nor geometric microliths such as those found in the Levant during MIS 2. This suggests that the South Arabian laminar tradition developed independently in Arabia, with minimal external influence from MIS 3 onward.

The material from Jebel Faya Assemblages A and B, with OSL dates placing them roughly coeval in MIS 3, exhibit a markedly different array of characteristics (Marks, 2009; Uerpmann et al., 2009) and may potentially represent a separate and concurrent stone tool tradition around the Gulf basin refugium. The Jebel Faya material comprises multiple platform cores with flat converging and flat 90-degree flaking surfaces, sometimes from a faceted circumference. To a lesser extent, there is blade production from unidirectional-parallel cores. While technologically quite different, the tool assemblages bear an array of types similar to the UP findings in Dhofar and Hadramaut: burins, endscrapers, denticulates, and sidescrapers.

Given the propensity for laminar reduction in southern Arabia over the course of the Upper Pleistocene, we question why blade manufacture was so frequent. Are these blanks the product of a specialized reduction strategy designed to remove specifically-proportioned blanks or the unintentional byproduct of a simple unidirectional reduction strategy? We argue the latter is the case in Dhofar. The assemblages analyzed from Dhofar most often contain single platform, volumetric cores with unidirectional-parallel, unidirectional-convergent, and bidirectional scar patterns across the working surface. This core reduction technique is organized by recurrent unidirectional blanks struck from the long axis of the core. We do not consider this South Arabian UP laminar reduction strategy to be formal blade technology in the sense of those found in the Levantine UP (e.g., volumetric cores, prismatic blades, crest preparation etc.), rather, they belong to a possibly related, albeit separate techno-typological family.

So, we are able to make a few general observations regarding the Upper Paleolithic found in the southern portions of the peninsula: (1) there are multiple phases of human occupation in South Arabia throughout the latter half of the Upper Pleistocene, (2) there are elements loosely related to the Levantine sequence, however, the South Arabian Upper Paleolithic probably belongs to a unique and locally-derived lithic tradition, (3) there do not appear to be any links with East Africa (with the exception of the Hargeisan) from MIS 4-onward, and (4) assemblages from southern and southwestern Arabia are dominated by different laminar-based technologies between 75 and 8 ka.

Demographic Implications

Merging these archaeological and paleoclimatic data with recent evidence from the burgeoning field of genetics, we address the role of southern Arabia in the emergence of modern humans, in light of the observation that there appears to be minimal exchange with East Africa between MIS 4 and MIS 2.

Analyses of mitochondrial DNA (mtDNA) (Kivisild et al., 2004; Metspalu et al., 2004), Y-Chromosome DNA (yDNA) (Ke et al., 2001; Cadenas et al., 2008), and X-Chromosome DNA (xDNA) (Garrigan et al., 2005; Yotova et al., 2007) suggest *Homo sapiens* initially developed in sub-Saharan Africa between 300 and 50 ka, the timing of this coalescence showing a wide range of variability depending upon the specific marker one examines. During this process of expansion out of Africa, some geneticists argue that early humans did not always replace local archaic groups encountered in their travels; there may have been varying degrees of admixture (e.g., Eswaran et al., 2005; Garrigan et al., 2005; Plagnol and Wall, 2006). Upper Pleistocene demographic pulses through the ‘Arabian Corridor’ probably resulted from early human groups tracking the growth of ecosystems to which they were already adapted (Lahr and Foley, 1998), whether it be colonization along the exposed continental shelf during MIS 4 (Stringer, 2000; Field et al., 2007), the range expansion of big-game hunters into the ameliorated interior (Rose, 2007), or a more complex combination of different dynamics.

Some scholars speculate the modern human demographic expansion, represented by the branching of L3 into M and N lineages, began in East Africa (e.g., Lahr and Foley, 1994, 1998; Ambrose, 1998; Kivisild et al., 2004). Coalescence dates from the earliest detectable mtDNA bottleneck release are 70,600 ± 21,000 BP, represented by the M2 subclade in India (Metspalu et al., 2004), while the M1 subclade in Ethiopia coalesces at 48,000 ± 15,000 BP (Quintana-Murci et al., 1999). Considering this temporal overlap of M coalescence between the two regions, there is no reason to assume that the founder M population originated in East Africa rather than South Asia (or any number of locations within this broadly defined area). These modern geographic designations were not relevant to the early humans under discussion; the Red Sea flanking the western side of Arabia was vastly constricted, while the Persian Gulf basin was more or less dry land between 75 and 8 ka. Thus, it is not surprising that a number of genetic studies point to early human migration *into* Africa (e.g., Altheide and Hammer, 1997; Hammer et al., 1998; Cruciani et al., 2002; Coia et al., 2005; Olivieri et al., 2006). González et al. (2007) report that the most ancient M1 lineages are concentrated in Northwest Africa and the Near East.

From an archaeological perspective, Straus and Bar-Yosef (2001: 2) entertain the same possibility: “there is, however, no reason a priori to exclude the possibility that intercontinental contacts occurred on a two-way street, especially at Suez, via Sinai, or across the shallow Bab al Mandab, so close to that corridor to sub-Saharan Africa, the Nile.” Marks (2005) and Otte et al. (2007) envisage similar scenarios during the MP/UP transitions in the Near East and Zagros regions. Both scholars argue that the archaeological evidence from Eastern Europe and Western Asia indicate the expansion of European UP technologies radiated from these areas, rather than Africa, during early MIS 3. Echoing this proposition from a biological perspective, Schillaci (2008) proposes the spread of Levantine-derived peoples into Australasia between 60 and 40 ka based on fossil evidence and phylogenetic relationships between populations.

One potentially additional piece of evidence for this hypothesized Near Eastern/Arabian-derived human expansion is the anomalous Hargeisan Industry found in the Horn of Africa. Known from a small number of findspots around Hargeisa (Clark, 1954), Boosasso (Graziosi, 1954) and Midhishi Cave in the Golis Mountains of northern Somalia (Gresham, 1984; Brandt, 1986), the Hargeisan has been found overlying MSA material and beneath LSA occupation layers. The industry is characterized by the presence of end-scrapers and burins produced by a volumetric blade technology, sometimes found in conjunction with bifacial foliates. The Hargeisan is incongruous with other roughly contemporary material in East Africa, leading to the conclusion that it represents:

> a local and probably hybrid form…at first glance it would seem that these northern Somaliland industries are but a local form of the Magosian, but a detailed study shows that in the angle-burins and end-scrapers…are forms which are entirely foreign to the Magosian, and clearly demonstrate that we are dealing with a distinct cultural complex (Clark, 1954: 218-9).

On the western side of the Red Sea, Hargeisan sites are limited to the coast of the Horn of Africa, in proximity to the Bab al Mandab Strait. Taking into account: (1) the geographic distribution of Hargeisan-like findspots, (2) their MIS 3/MIS

4 age range, and (3) genetic signals for a back migration into Africa around this time, a tentative correlation is proposed between the bottleneck release of mtDNA haplogroup M1 into Africa with archaeological data that attests to the appearance of a "foreign" and "hybrid" lithic industry in the Horn of Africa at the MSA/LSA boundary. It is germane to consider the possibility that the Hargeisan is a fingerprint of early human groups expanding westward across the southern route of dispersal, back into Africa.

That is not to say this industry necessarily represents a single expansion event, but perhaps the southern extent of a relatively homogenous population spread throughout the Horn, Arabia, North Africa, and the Levant, marked by their widespread use of laminar technologies during MIS 4–MIS 2. Indeed, Amirkhanov (2006) notes parallels between his UP assemblages from Hadramaut and roughly coeval late MIS 3 industries in Northeast Africa.

This proposition raises several points that must be addressed to evaluate its efficacy. In addition to analysis and dating of more Arabian UP sites, we must better establish the timing of the Hargeisan and its relationship to Arabian UP assemblages, particularly those found in Yemen. Its geographic extent must be articulated; considering the Horn of Africa its western boundary, how far north and east does it extend? What is the relationship between Arabian UP assemblages and those flat, unidirectional-parallel blades cores reported from the Thar Desert in Rajasthan (James and Petraglia, 2005), the Aterian in the Sahara, and Nilotic UP assemblages?

We maintain that the evidence from Arabia indicates the post-MIS 4 human expansion did *not* originate in sub-Saharan Africa; rather, early modern humans have emerged from a geographic range encompassing areas of northeast Africa, Western Asia, Arabia, and South Asia. These populations would have been forced to contract into environmentally stable refugia around Arabia such as the Ur-Schatt River Valley, coastal oases, Yemeni Highlands, and/or the Dhofar Mountains during climatic downturns. As such, the fluctuating dynamic between landscape carrying capacity and population density may have been a critical mechanism driving early human dispersals from the region. Episodes of climate change caused large portions of the Arabian peninsula to become uninhabitable due to such calamities as the inundation of the emerged continental shelf and desertification throughout the interior. Given the potential importance of these once favorable, now uninhabitable zones, future investigations in and around Arabia should endeavor to explore the heart of the desert and bottom of the sea.

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