DMP III: Pleistocene and Holocene palaeonvironments and prehistoric occupation of Fazzan, Libyan Sahara

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Abstract

The palaeoanthropological and geomorphological sub-projects of the Desert Migrations Project (DMP) focus on the Pleistocene and early Holocene environment and prehistory of Fazzan so as to assess the timing and extent of hominin and human movement across the Sahara through time. This paper reports on the findings of the 2008 field season, with a focus on the prehistoric evidence along the northern margin of the Ubari sand sea.

The geomorphological record of the area preserves evidence of at least five past episodes of lake formation. The exact chronology of these, as well as the spatial extent of these lakes, remains the focus of further study.

The archaeological record of hominin and human occupation of Fazzan prior to the establishment of the Garamantian civilisation is extraordinarily rich. Between 2007 and 2008, the DMP palaeoanthropological project surveyed thirty-five localities along the northern margin of the Ubari sand sea, recording a range of assemblages spanning all Palaeolithic industries. Most of the archaeological remains found consisted of stone-tools, while grinding stones were comparatively restricted geographically. Mode 1/Oldowan tools were found at two localities, contrasting with the widespread presence of Mode 2/Acheulean, Mode 3/Middle Stone Age and Mode 5/microlithic artefacts. This indicates that, although hominin presence in the area is probably earlier than previously thought, populations were comparatively sparse until the Middle Pleistocene. Twenty-one localities within the Ubari sand sea, as well as seven south of the Messak Settafet were also surveyed between 2007 and 2008. The detailed study of the lithics from these areas will be carried out next year, but preliminary results stress the different nature of the assemblages found within interdune corridors – very low frequency of cores, no Mode 1 and extremely rare Mode 2 lithics (found at a single locality).

The 2009 field season will focus on obtaining further samples of palaeolake sediments for dating, on the evidence of Mode 1 assemblages south of the Messak, as well as on the refining of the archaeological indicators that may distinguish the different phases of hominin and human occupation of Fazzan during the Later Pleistocene and Holocene

Introduction

The Desert Migrations Project (or DMP) held its second season of fieldwork in January 2008, which included palaeoenvironmental and prehistoric research on the Pleistocene and Holocene human occupation of Fazzan. The work completed the survey of the northern margins of the Ubari sand sea initiated in 2007 and, in collaboration with the Department of Antiquities of Libya, included the survey of a number of localities identified during a preliminary survey carried out in 2006–2007 by the oil company OXY Libya LLC and surrounding areas (Fig. 1).

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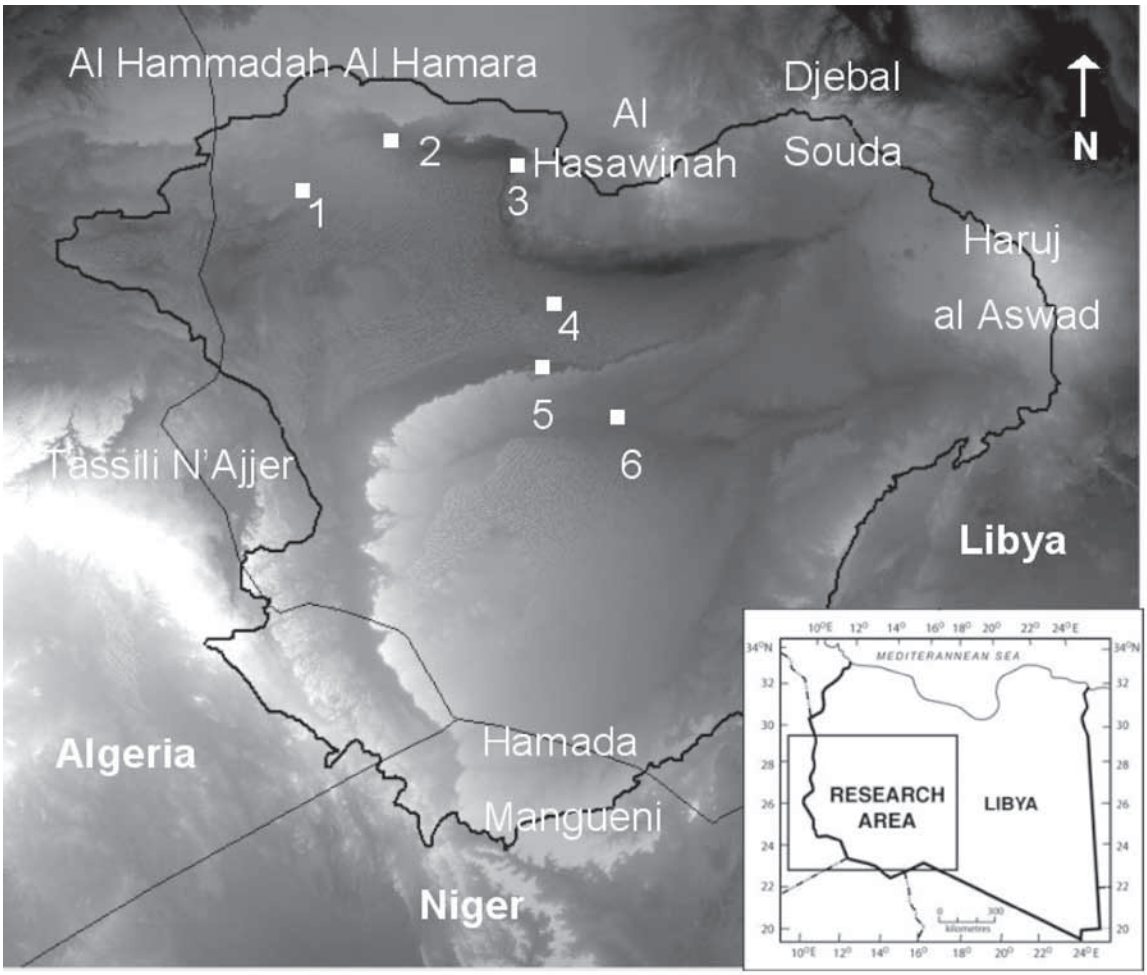

Figure 1. Digital elevation model of the Fazzan, with country borders and the catchment boundary of the Fazzan Basin marked in black. The areas that were investigated during the DMP 2008 field season are numbered 1 to 6 – 1: Al Wafa, 2: Hamada Tanghirt, 3: Qararat al Mrar, 4: the central Ubari sand sea, 5: Wadi al Hayat, and 6: Wadi Barjuj (drawing: N. Drake and K. White).

The geological and archaeological background to this research has been discussed in greater detail elsewhere (Mattingly *et al.* 2007). In synthesis, the aims of the palaeoanthropological and geomorphological sub-themes of the DMP are to extend our understanding of the stratigraphy and chronology of the lacustrine sediments of the Fazzan Basin in order to reconstruct its palaeoenvironmental history during the Pleistocene and Holocene and to map and record prehistoric archaeological remains throughout the area, with a view to reconstructing the main phases of hominin and human occupation of Fazzan.

The geoarchaeological fieldwork consisted of a traverse across the northern edge of the Ubari sand sea, with three focal areas – NUS8 and Al Wafa (27°59.383'N, 10°49.782'E), Hamada Tanghirt (28°40.701'N, 11°21.104'E) and Qararat al Mrar (28º20.051'N, 12º40.300'E). The geomorphological work focused on the study of the Al Mahruqah Formation, lacustrine

sediments deposited by Lake Megafazzan and other, subsequent, smaller lake formation episodes. The objectives this season were to study the stratigraphy of new sites, evaluate the accuracy of the stratigraphic interpretation of sites in the Al Mahruqah Formation mapped by Industrial Research Centre of Libya (IRC Geological Maps) and to compare the stratigraphy at these localities with those of others previously studied in the Fazzan Basin. The palaeoanthropological work had two main objectives – first, to carry out a more intensive sampling and excavation of the apparent fossiliferous bed in and around the Al Wafa Basin which was first visited in 2007; and second, to complete the archaeological survey of the northern margin of the basin between Al Wafa and Wadi ash-Shati. Archaeological samples were collected for lithic analysis at all sites and deposited at the Museum of Jarma; geological samples were collected for magnetostratigraphic dating, Optically Stimulated Luminesence (OSL) dating, thin section analysis and sediment provenance studies at all sites.

The area covered by the survey includes archaeological evidence from very different periods and thus of very different nature. The most important difference concerns the evidence left behind by sedentary (particularly urban) and non-sedentary groups of people, reflecting their different use of the landscape. In the first case, archaeological sites are defined by the extent of structures (buildings, cemeteries, *foggaras*, etc.) and/or evidence of modification of a given area (cultivation, corrals, etc.). This is the case for much of the Garamantian and subsequent archaeology of Fazzan. In the case of the archaeology of non-sedentary people, sites reflect the intensive use of a particular locality at a point in time as shown by the presence of dense archaeological scatters, burials, subsistence debris, etc.. However, the degree to which it is possible to determine their extent depends on the degree of spatial definition of each locality – a cave, a basin, an interdune corridor, or valley. With the exception of caves, the use of which can be treated as a single archaeological unit, most prehistoric archaeology is found not in sites, but scattered across often large landscapes. In densely inhabited places and sedimentary regions, such as Europe, that landscape is either buried or built upon and prehistoric sites become defined by the extent of the excavation of particular portions of palaeosurfaces. In uninhabited and weathered regions, the palaeosurfaces become exposed through erosion and the artefacts that were laid down by different peoples at different times become commingled through deflation. In these situations, 'sites' do not truly exist and archaeological localities become defined by the geomorphological surfaces/landscapes with which they are associated. This is the case of much of the prehistoric archaeology of Fazzan. Given these differences and the fact that both extreme situations are encountered in the region of Fazzan, the survey strategy varied substantially from one locality to another.

The survey of pre-Garamantian sites was based on off-site methods (Foley 1981). These, rather than predefining sites, use the overall distribution of artefactual material across the landscape to build up a picture of differential exposure, preservation and land-use. Off-site approaches are ideal in exposed landscapes such as deserts, in areas with a relatively continuous and dispersed distribution of surface material and where geo-morphological/geological context is critical, especially in the absence of well-stratified contexts. The surveys were supplemented by small-scale excavations at Al Wafa. Several sampling strategies were employed, depending

First visit	*Locality*	*Lat N (deg°min)*	*Long E (deg°min)*	*Excavation*	*Transects*	*Samples*	*ESA*	*MSA*	*LSA*	*Grinding tools*	*Pottery*	*Hearth*	*Cairns/ burials*
2008	GES8	28°42.801'N	10°33.126'E	No	0	Yes		√	√			√	
2007	NUS8	28°00.840'N	10°47.861'E	Yes	0	Yes		√	√	√	√	√	
2007	Al'Wafa	28°00.991'N	10°47.908'E	Yes	8	Yes	√	√	√	√	√	√	
2007	NUS9	28°01.021'N	10°49.710'E	No	0	Yes			√	√	√	√	
2008	NUS10	28°14.898'N	10°40.384'E	No	0	Yes			√			√	
2008	NUS11	28°14.100'N	10°41.551'E	No	0	Yes		√	√			√	
2008	NUS12	28°11.199'N	10°42.057'E	No	0	Yes		√					
2008	NUS14	28°01.125'N	10°47.978'E	No	0	Yes	√ ?	√	√			√	
2008	NUS16	27°59.876'N	10°49.101'E	No	0	No			√			√	
2008	NUS17	28°00.965'N	10°48.583'E	No	0	Yes			√	√		√	
2008	Cairn 1	28°20.698'N	10°43.976'E	No	0	No							√
2008	Cairn 2	28°21.131'N	10°43.669'E	No	0	No							√
2008	NUS18	28°35.550'N	11°01.869'E	No	1	No							
2008	Cairn3,4	28°40.090'N	11°18.097'E	No	0	No							√
2008	NUS20	28°42.500'N	11°19.667'E	No	8	Yes	√	√	√	√	√	√	
2008	NUS21	28°38.900'N	11°21.215'E	No	0	No		√					
2008	NUS22	28°41.998'N	11°22.300'E	No	7	Yes	√	√ ?					
2008	NUS23	28°42.044'N	11°21.427'E	No	7	Yes	√						
2008	NUS24	28°42.528'N	11°23.570'E	No	0	No		√					√
2008	NUS25	28°42.223'N	11°24.010'E	No	0	Yes	√	√ ?					√
2008	NUS26	28°40.511'N	11°21.361'E	No	0	No	√						
2008	NUS27	28°32.824'N	11°57.779'E	No	0	No							
2008	NUS28	28°27.756'N	12°16.054'E	No	2	Yes		√	√				
2008	NUS29	28°24.465'N	12°27.730'E	No	2	Yes			√				
2008	NUS30	28°18.905'N	12°39.760'E	No	0	Yes		√	√			√	√
2008	NUS31	28°22.397'N	12°46.366'E	No	3	Yes	√	√ ?					
2008	NUS32	28°27.227'N	12°40.644'E	No	6	Yes	√	√	√				

2008	NUS33	28°26.437'N	12°37.093'E	No	6	No		√ ?	√ ?					
2008	NUS34	28°25.434'N	12°36.841'E	No	6	Yes		√ ?	√ ?					
2008	NUS35	28°17.856'N	12°41.263'E	No	3	Yes		√	√			√	√	√
2008	NUS36	28°18.320'N	12°40.459'E	No	0	Yes			√			√		√
2008	USS10	26°57.569'N	13°04.957'E	No	0	Yes			√			√	√	√ ?
2008	USS11	26°48.960'N	13°13.021'E	No	0	Yes	√ ?	√	√	√		√	√	
2008	USS12	26°52.718'N	13°12.831'E	No	0	Yes			√	√		√	√	
2008	USS13	26°56.332'N	13°15.254'E	Yes	0	Yes			√	√		√	√	
2008	USS14	26°52.343'N	13°13.514'E	No	0	Yes		√	√	√		√	√	√
2008	USS15	26°51.916'N	13°19.810'E	No	0	Yes			√			√		
2008	USS16	26°54.275'N	13°22.390'E	Yes	0	Yes			√			√		
2008	USS17	26°54.183'N	13°22.403'E	No	0	Yes			√					
2008	USS18	26°55.998'N	13°22.824'E	No	0	Yes		√	√					
2008	USS19	26°42.230'N	13°19.534'E	No	0	Yes			√	√		√	√	
2007	USS20	26°42.480'N	13°19.325'E	No	0	Yes		√	√	√		√	√	
2008	USS21	26°35.017'N	13°19.987'E	No	0	Yes			√	√		√	√	
2008	MES1	26°20.302'N	13°06.155'E	No	12	Yes	√	√	√				√	
2008	BJJ1	26°06.592'N	13°05.012'E	Yes	1	Yes		√	√	√		√	√	
2008	BJJ2	26°06.592'N	13°06.718'E	No	0	Yes			√			√	√	
2008	BJJ3	26°04.421'N	13°09.372'E	No	3	Yes			√	√		√	√	
2008	BJJ4	26°05.481'N	13°13.002'E	No	3	Yes	√		√					
2008	BJJ5	26°07.402'N	13°11.674'E	No	1	Yes	√	√	√	√		√	√	
2008	BJJ6	26°09.876'N	13°00.061'E	No	0	Yes	√							

HAH: Hamada al Hamra; GES: Gargaf Escarpment; NUS: North Ubari sand sea; USS: Ubari sand sea; BJJ: Wadi Barjuj; MES: Messak Setafet.
ESA: Early Stone Age (Oldowan, Acheulean); MSA: Middle Stone Age (range of Mode 3 industries characterised by prepared-core technology, such as Mousterian, Levalloiso-Mousterian and the derived Aterian); LSA: Late Stone Age (range of industries, generally characterised by an important microlithic component, including those called Epipalaeolithic, Early and Late Acacus, Pastoral, and Neolithic).

Table 1. List of localities visited by the palaeoanthropology and geomorphology missions of the DMP, January 2008.

upon local conditions and circumstances. The off-site archaeological surveys carried out varied substantially from site to site, largely depending on time availability. These ranged from full off-site surveys, to focal visits. Each locality/site visited during the survey received a three-lettered locality/site name and sequential number, following the practice established by the Fazzan Project (Mattingly 2003, 2007) and employed by the Desert Migrations Project. The numbering follows existing sequences. The complete list of localities visited, the nature of the survey carried out and whether samples were collected, is given in Table 1.

This paper is organised in six sections, comprising the description of the geomorphological and morphological work carried out on the different areas visited along the northern margins of the Ubari sand sea and within the concession Block 131 to OXY Libya LLC, followed by a final discussion of the findings.

New archaeological localities between Daraj and Al Wafa

As was the case in 2007, a small number of localities on the Hamada al Hamra south of Daraj were surveyed while *en route* to Al Wafa:

HAH5: a small depression leading to a central lower area with bushes and trees, the latter forming a semi-circle enclosing a recently dried-up pond (mud-cracks were still visible in this part of the landscape). Both the dried-up pond and the surrounding sandy plain were very rich in archaeological remains, ranging from Middle Stone Age (MSA) (including Aterian) and Late Stone Age (LSA) artefacts, as well as pottery. At least two stone circles of approximately 5 m diameter and a few deflated hearths were also identified.

GES8: a small wadi, around which a small archaeological survey was carried out, without formal transects. The wadi, some 200 m across, runs north–south, among rocky hills dissected by smaller wadis. Archaeological materials were clustered in small areas in the hills and included deflated hearths, MSA and LSA artefacts.

Al Wafa and surrounding area (27°59.383'N, 10°49.782'E)

The NUS8 and Al Wafa localities were discovered and preliminarily evaluated in 2007; given the importance of the geological sediments and associated archaeological remains, a more detailed investigation was conducted this year. The stratigraphy at Al Wafa contains evidence for five arid/humid climate transitions (Fig. 2). The basal unit consists of a calcrete and palaeosol, overlain by indurated aeolian sandstones containing what appears to be fossil bones from as-yet unidentified animals, root-casts and calcrete-concretions, separated by layers of less cemented sands. We were able to identify consistent units within these aeolian sand layers which suggest periodic stabilisation of sands by high water tables and their cementation by discontinuous layers of water-table calcretes. The lower calcrete is clearly associated with a thick palaeosol at the base of the succession. The upper calcrete is coincident with a major bounding surface in the aeolian sands, which separates two different units and indicates that there were two distinct periods of aeolian activity separated by a more humid episode in which the sands became stabilised.

Figure 2. Section of lacustrine sediments exposed at Al Wafa. Note the presence of a person for scale (photo: N. Drake).

A less prominent and discontinuous interval of calcrete formation and more intensive rootletting occurs between these two. The sandstone sequence is overlain by lacustrine limestones and capped by a chert layer that contains fossil plant remains, probably reeds. This sequence of palaeolake sediments, aeolian sands and water table calcretes was found to extend under the dunes of the Ubari sand sea, indicating extensive regional-scale lacustrine sedimentation.

Locality NUS8 and its surrounding area (Fig. 3) are archaeologically extremely rich and potentially fossiliferous. The palaeoanthropological work centred around five activities: (i) excavation of sub-surface sediments at NUS8 terrace; (ii) excavation of apparent fossiliferous bed at Al Wafa; (iii) off-site survey of Al Wafa; (iv) further survey of NUS9 and excavation of hearths; and (v) survey of neighbouring new localities – NUS10, NUS11, NUS12, NUS14, NUS16 and NUS17 (NUS15 being a geological locality).

Excavation of sub-surface sediments at NUS8 terrace

Three 1 m by 1 m squares on the surface of the large LSA site on the middle terrace of NUS8 (Northeast) were marked and 100% of the surface artefacts collected. These complemented similar excavations carried out in 2007. Two of these squares were excavated 20 cm down, until reaching green aeolian deposits. Despite the extraordinary density of artefacts on the surface (>200 pieces in a 1 m^2), no sub-surface archaeological material was found.

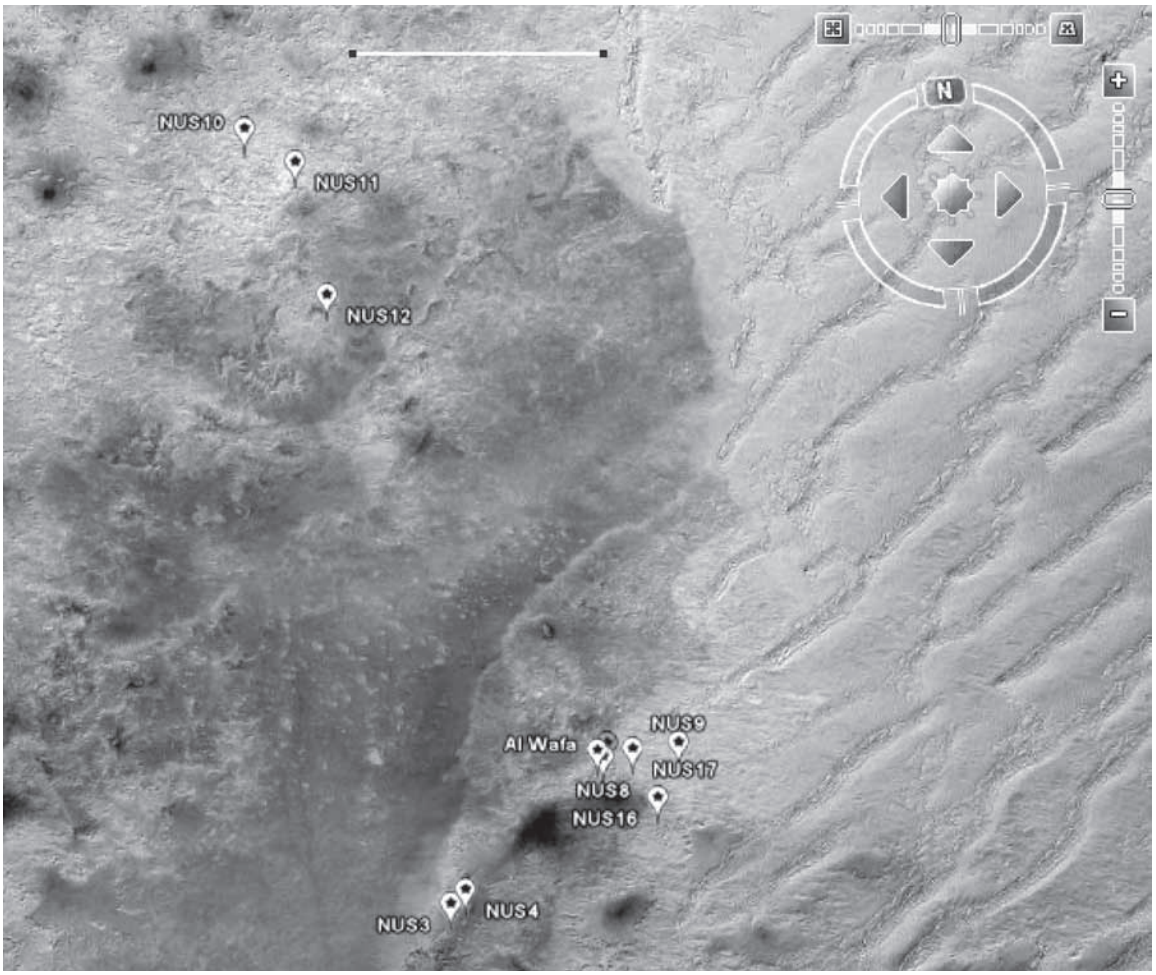

Figure 3. Geographic position of localities around NUS8 visited in 2008 (background image: GoogleEarth).

Excavation of potential fossiliferous bed at Al Wafa Basin

A 4 m by 4 m trench was excavated on the potential fossiliferous bed at Al Wafa. A depth of approximately 1 m was reached, exposing the formation identified last year (Mattingly *et al.* 2007, 126). Although the exposed elements seemed to indicate a vertebrate fossil source, as the calcrete was excavated it revealed itself to be a very large amorphous and labyrinthine structure, with many connected branches. It was concluded that the entire formation is a calcrete formation most probably formed around a spring, in which major vegetation structures formed the template for its shape. However, it may also have been composed of vertebrate elements, not just because of the apparent morphology, but also the fact that thin sections demonstrate bone structures within the calcrete. Nonetheless, even if the observed calcrete originally formed around organic remains, no diagnostic morphological features were found. Notwithstanding this, potentially diagnostic samples were collected for further analysis. The trench was covered after completion.

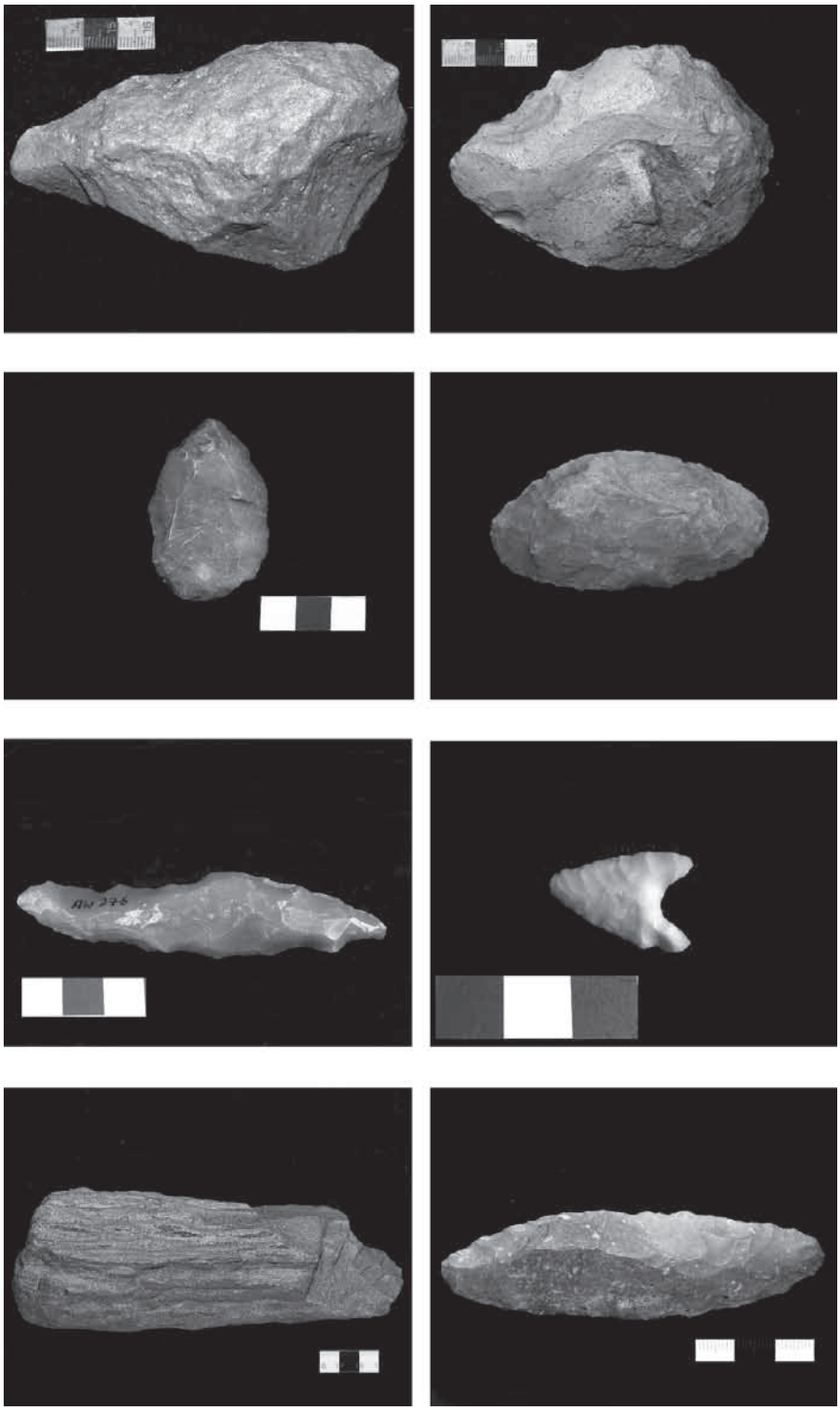

Figure 4. Details of artefacts from Al Wafa and NUS8. Scale in cm. (photos: M.M. Lahr, R.A. Foley and T. Savage).

Survey of Al Wafa (Fig. 4)
Eight transects across the southern half of the Al Wafa Basin were carried out, recording all archaeological finds and making a collection of diagnostic pieces. The survey recorded 706 artefacts. Among the lithics, 116 were tools, 136 cores and 440 flakes, blades and chips. Fragments of grinding slabs (6), handstones (3) and pottery sherds (5) were relatively rare. The lithic tools included complete handaxes (16), choppers (2), incomplete bifaces (2), Levallois points (8), scrapers (20), borers (5), retouched flakes (55) and blades (3), notched (2) and backed (5) pieces, as well as a point, a burin, a lanceolate and an arrowhead. Thus the material at Al Wafa includes Early Stone Age (ESA) (Acheulean), MSA and LSA–Neolithic artefacts, as well as hearths and small amounts of pottery and grinding tools near the NUS8 margin.

Survey of NUS9
The smaller NUS9 basin was revisited to record in more detail some information about the large number of hearths within it. The work this year focused on a single hearth, recording in detail the archaeological context surrounding it and sampling it for OSL dating. The hearth was composed of fist-size cobbles of burnt limestone. In 2007, a fragment of groundstone was found next to the hearth, as well as a number of lithics. This year, the density of lithics within and around the hearth (7 m radius) was recorded; the finds included two pieces of pottery.

Survey of new neighbouring localities: NUS10, NUS11, NUS12, NUS14, NUS16, and NUS17

NUS10: locality dissected by numerous wadis of different dimensions (feeding into larger ones), exposing palaeolake sediments off the escarpment. One of these small wadis (approximately 30 m wide) was surveyed and revealed a continuous surface cover of natural chert fragments and nodules, among which clustered dense scatters of chert debitage and pottery, including in and around a hearth. Between five and ten deflated hearths were identified along the 200 m length of the wadi surveyed.

NUS11: a similar landscape to NUS10, but located around a larger wadi, approximately 200 m across, surrounded to the west by a relatively high escarpment with a sequence of at least two (and possibly three) palaeolake sediments exposed. Archaeological material was identified on the slopes of the moderately steep western hills/scarps (very low density) and on the wadi floor and terraces on the other side (with some high density scatters of lithics). Both MSA and LSA artefacts were found. No pottery was present, but a number of hearths were visible on the terraces bordering the eastern margins of the main wadi (Fig. 5).

NUS12: very brief survey to look at exposures of outcropping sandstone, which had been used as raw material for some of the archaeological artefacts found elsewhere in the region. Upon examination of the outcrops it became apparent that this locality had been used as a quarry in prehistory, as a number of large naturally outcropping pieces had been intentionally flaked and were surrounded by a dense scatter of primary flakes and cores of large size.

Figure 5. Landscape view of locality NUS11 (photo: M.M. Lahr).

NUS14: a small basin to the east of Al Wafa. This is not a closed basin, as its southern end drains into a wadi. The basin was geologically similar to Al Wafa, with the same system of terraces and exposed palaeolake sediments. Archaeological artefacts were present, but in smaller density than either NUS8 or Al Wafa. Mainly MSA and LSA flakes, but possibly earlier, ESA, material was identified.

NUS16: dune edge southeast of NUS8, of similar altitude as the escarpments surrounding the basin's southern margin. Small scatters of archaeological artefacts along the edge of the dunes, mainly LSA chert debitage and deflated hearths.

NUS17: this is not a palaeolake basin, but a flat area between slopes, close to NUS9, dissected by small, shallow channels. Two stone structures (one rectangular, the other square) were found, built with intentionally cut blocks of porous limestone. In between, there was a large deflated hearth, which used some of the stones of the smaller of the two structures and thus probably post-dates them. A few lithics and fragments of grinding stones were found in the vicinity.

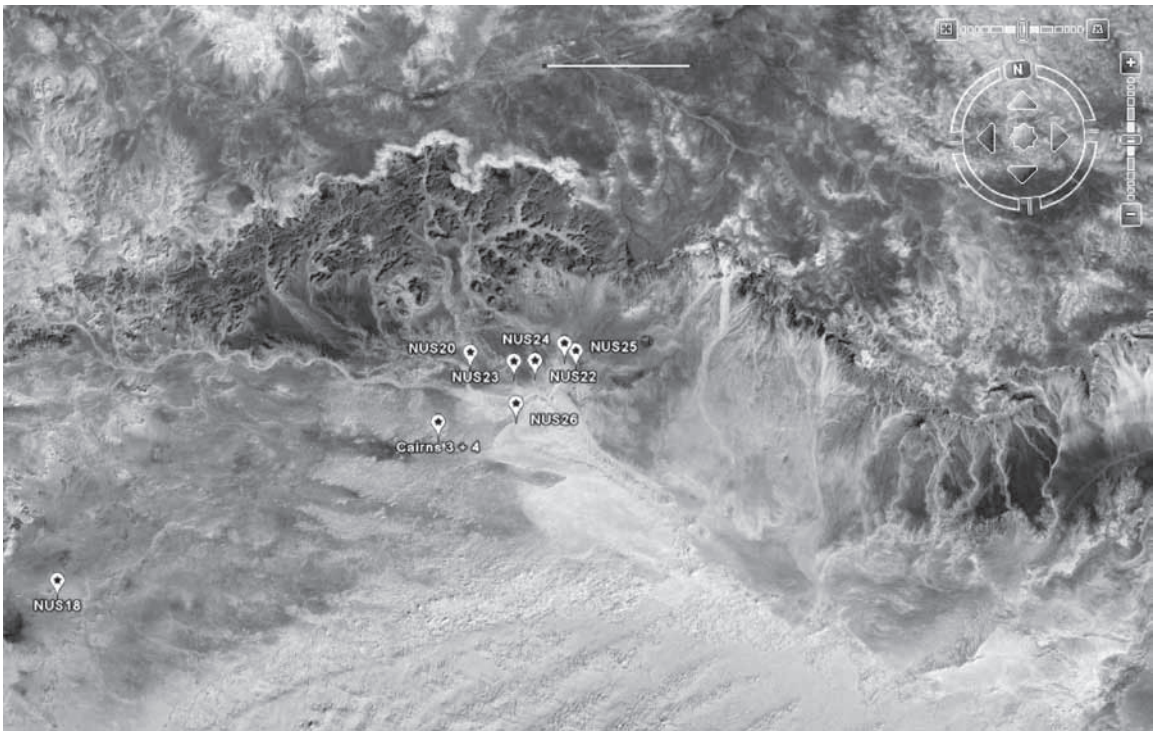

Figure 6. Geographic position of archaeological localities surveyed in the Hamada Tanghirt (NUS20 to NUS26) (background image: GoogleEarth).

On the way to the Hamada Tanghirt, bordering the Ubari sand sea along the edge of the Gargaf Escarpment, three new localities of archaeological interest for the presence of medium to large cairns were recorded (as no survey of the surrounding area was carried out, these were not formally named). A further locality, NUS18 is noted for the complete absence of archaeological remains.

Cairn 1: an isolated large cairn, seemingly undisturbed, of irregular oval shape, made of grey stones ranging in size between fist-size to blocks of 0.20 m by 0.30 m by 0.20 m.

Cairn 2: isolated cairn located near Cairn 1, substantially smaller than the latter and also of irregular shape. Situated on the slope of an eroded rock outcrop/dune. Similar grey stones make up the structure, but it also includes a second, smaller and reddish rock.

Cairns 3 and 4: two cairns, located approximately 50 m apart, on the slope of the hill. The larger of the two (Cairn 3) was oval/circular in shape (approximately 2.5 m high) and had evidence of having been robbed. The second one (Cairn 4) was relatively small (approximately 1 m high, 1.5 m by 1.5 m in diameter) and located amidst the outcropping bedrock. Both were built of similar grey stones to Cairns 1 and 2.

NUS18: locality on a flat plain around a wadi, bordered by low escarpments to the north and more gentle hills and eventually the dunes of the Ubari sand sea to the south. The area of the escarpment to the north was briefly surveyed and a transect across the wadi/plain to the southeast carried out. The whole area is archaeologically sterile.

Hamada Tanghirt (28°40.702'N, 11°21.105'E)

The Hamada Tanghirt is located at the northernmost edge of the Ubari sand sea, an area of high escarpments dissected by deep wadis, which strongly shaped the landscape by varying volumes of water from the Hamada to the Ubari sand sea basin. The geomorphological work confirmed the stratigraphy described in the IRC map sheet type-section for the area, which differs in certain aspects from that found at Al Wafa. The base of the section consists of 6.5 m of interbedded lacustrine clays, siltstones, sandstones and carbonates overlain by a considerable thick layer of carbonate-cemented conglomerate containing silicified tree fragments and basement sandstone fragments. This was overlain by more than 12 m of cross-bedded aeolian sandstones that exhibits root casts, gypsum nodules and beds of carbonate cementation. This was followed by 2 m of brecciated and conglomeratic limestone; the brecciation probably relates to early patchy cementation, rather than re-deposition. The abundance of conglomerates at this site in comparison with Al Wafa could be due to its close vicinity to Wadi Taharat, one of the largest palaeorivers draining the Hamada al Hamra southwards into the Fazzan Basin.

The archaeological work focused on three wadis, one large and two small ones, which drain the high escarpment to the north and the areas in between, surveying seven localities (NUS20 to NUS26) (Fig. 6).

NUS20: paired alluvial terraces on either side of a sandy wadi running north–south; a smaller adjacent wadi was immediately to the east of the main one, also with fluvial terraces on its other margin. Four transects were carried out from the main alluvial terrace and across the main wadi to the hills on its opposite margin to the west; two along the alluvial terrace (on a north–south axis); and two across the smaller wadi to the east. The area proved to be archaeologically extremely rich, with some very dense concentrations of ESA (Acheulean) artefacts, as well as MSA material nearer the wadi beds. An important collection of diagnostic artefacts identified throughout the transects was made (Fig. 7).

NUS21: small basin with exposures of palaeolake sediments identified as part of the Al Mahruqah Formation. A number of deflated hearths were observed within it, with small, low density scatters of LSA chert artefacts in the surrounding area.

NUS22: a locality in the flat Hamada surface, dissected by a north–south flowing sandy wadi. The area was surveyed through seven 50 m long transects radiating from a central point at the wadi's eastern margin. Low density ESA and possibly MSA artefacts were found on the surface.

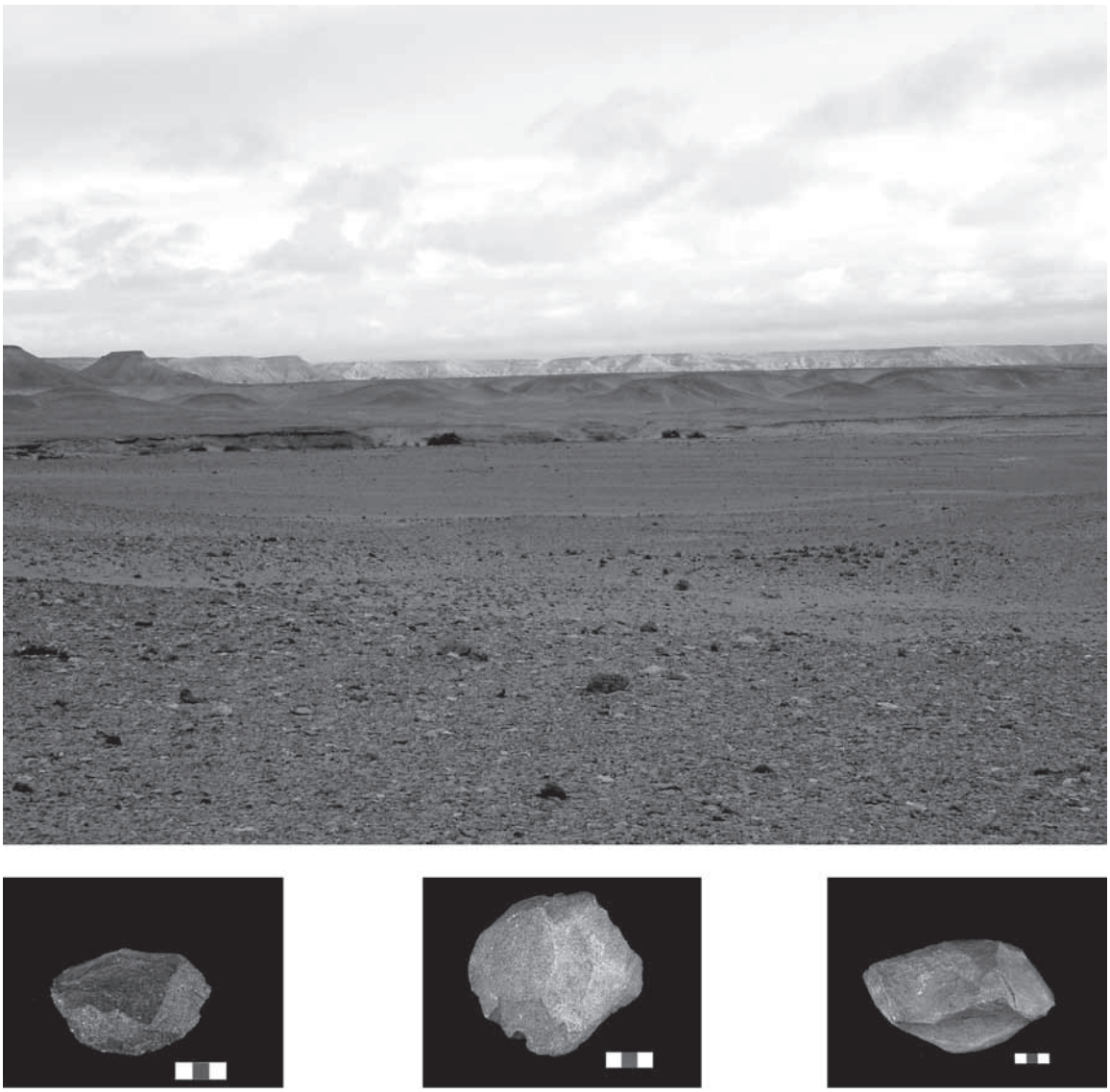

Figure 7. Landscape view of locality NUS20 and examples of ESA artefacts. Scale in cm. (photos: M.M. Lahr).

NUS23: similar geological context to locality NUS22, flat Hamada surface dissected by a north–south flowing sandy wadi. The area was surveyed through seven 100 m long transects radiating from a central point at the wadi's eastern margin. Low density ESA artefacts were found on the surface, including a handaxe.

NUS24: a group of three small cairns and one Islamic burial found in a small area (all within 30 m) of flat Hamada surface; a low density of MSA artefacts was also found, although as part of the background surface scatter rather than associated with any of the burial features.

Figure 8. Antennae tomb at locality NUS26 viewed from the top of a nearby hill (photo: M.M. Lahr).

NUS25: a locality within a complex landscape of flat-topped hills amidst flat surfaces of the Hamada, where a large antennae tomb and a low density of ESA artefacts on the surrounding area were found. The antennae tomb (Fig. 8) appeared to have been robbed at an earlier date.

NUS26: depression between small dunes at the edge of the sand-sea, where the camp was set-up. A survey of the surrounding landscape revealed a low density scatter of ESA artefacts, mainly in small depressions amongst the dunes, but also on the dune slopes.

On the way to the Qarart al Mrar, three localities bordering the Hamada and the Ubari sand sea were briefly surveyed. Of these, one (NUS27) was archaeologically sterile.

NUS27: a locality at the edge of the escarpment, overlooking a flat plain that separates the foothills from the sand sea. No archaeological remains observed.

NUS28: locality on the edge of a wadi with tamarisk trees and other desert plants, surrounded by low hills to the southwest and a flat, pebbly plain of approximately 500 m to the northeast,

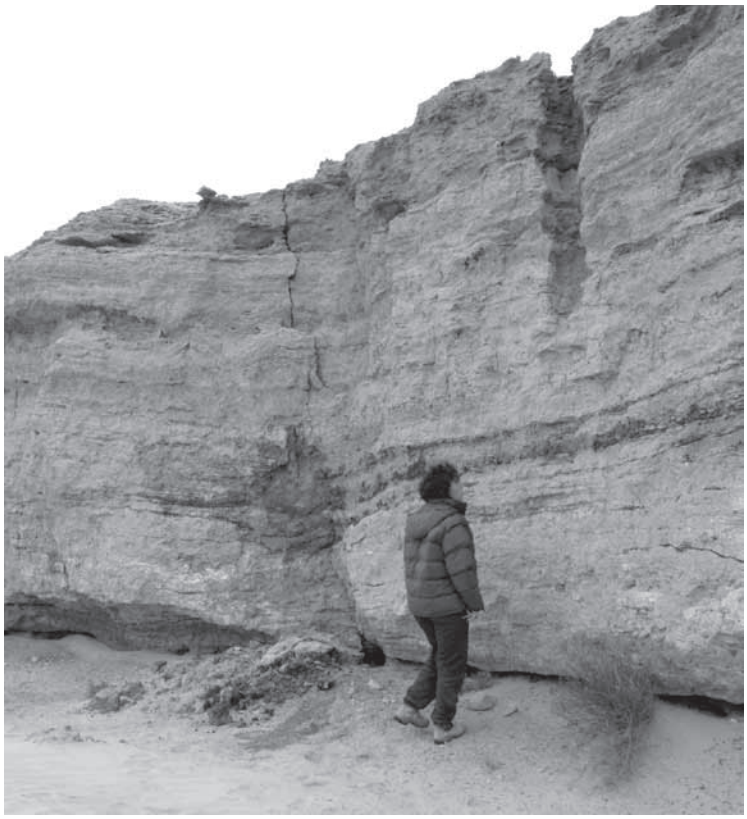

Figure 9. Section of postulated 'Holocene' lacustrine sediments exposed at Qararat al Mrar (photo: M.M. Lahr).

then higher hills and the Hamada. Two transects of approximately 150 m length were carried out, starting at the wadi and extending to the plain. A low density scatter of MSA and LSA artefacts was found.

NUS29: flat plain north of the dunes and on the edge of a steep hill with a major stratigraphic exposure of sediments; the plain ends at a small wadi some 400 m to the south of the hill. Two transects from the edge of the hill towards the wadi along the plain were carried out, along which substantial scatters of LSA artefacts were observed, including a small number of deflated hearths.

Qarart al Mrar (28°18.273'N, 12°40.370'E)

Qarart al Mrar, the northeastern edge of the Ubari sand sea, exhibits a complex stratigraphy consisting of what we interpret as Holocene lacustrine sediments infilling valleys cut into much older Lake Megafazzan sediments. The stratigraphy of the postulated Holocene section was evaluated in detail at site NUS35 (28°18.273'N, 12°40.370'E); the sediments were similar to those found in Wadi al Hayat at Jarma, Al Grayfah and west of Ubari, all of which have been dated by both optically stimulated luminescence dating (OSL) and radiocarbon methods

to between 11,000 and 8,000 years ka (Armitage *et al*. 2007). However, the NUS35 section preserves a considerably greater depth of lacustrine sediments than that in Wadi al Hayat, potentially recording a longer, more detailed record of palaeohydrological changes (Fig. 9). The base of the section consists of 3 m of dark grey organic silt, with numerous black organic rich layers in the lower 2 m and notably less in the top 1 m. The sediments contain fossil gastropods, predominantly *Bulinus truncatus* at NUS35, but with *Melenoides tuberculata* and species of *Planorbis* and *Lymnea* dominating at nearby localities. A complete species identification will be undertaken by comparison with mollusc collections at the British Museum. Root casts and gypsum crystals are also prevalant throughout the section, suggesting a lacustrine environment that periodically underwent episodes of evaporative concentration and desiccation. This deposit is overlain by 0.75 m of cross-bedded aeolian sands, capped by 0.30 m of grey lacustrine silts, followed by 0.30 m of coarse aeolian sands. This part of the stratigraphic succession suggests a significant period of desiccation followed by a brief return to humid conditions. The section is capped by 0.30 m of gypsum that is interpreted as being paedogenic in origin.

The highest exposure of the postulated Holocene lake sediments in the wadi occur where the lake sediments finally pinch out into beach sands, a facies change that suggests that the site is close to the palaeolake shoreline. GIS analysis using the altitude of this point derived from the shuttle radar topography mission digital elevation model (SRTM DEM) of the Qararat al Mrar Basin suggests that the lake had a shoreline altitude of 423 m asl. Using GIS techniques to 'fill up' the DEM to this shoreline produces an estimated lake area of 1,500 km^2. Thus a substantial lake appears to have developed in this basin during humid periods, the exact timing of which will be determined by magnetic and OSL dating. The older lake sediments into which the valley is cut are not too dissimilar from their Holocene counterparts, but are much better indurated. The approximate 7.5 m of section has a 0.5 m layer of conglomerate resting on basement, above which is a succession of rootleted siltstones and limestones, with the limestones laterally passing into siltstones over distances of approximately 50 m due to discontinuous cementation rather than deposition. The upper-most part of the section is marked by a marker bed of brecciated limestone. This succession infills the irregular palaeotopography on the steep-dipping basement rocks, so that at other nearby locations, a less complete succession is preserved, but with the younger part onlapping onto the basement. A possibility to be tested is that this succession (like that of the Holocene) represents a lake-margin deposit of Lake Megafazzan. Our interpretation of the sediments at this site differs significantly from that of the IRC, despite both studies being conducted at the same location. The IRC fail to distinguish between the Megafazzan lake sediments that form the valley and the later Holocene sediments that infill it. This discrepancy in interpretation will hopefully be resolved by our detailed magnetostratigraphy and OSL dating at this locality.

Five localities of archaeological interest were investigated amongst an extremely rich archaeological area that should be studied in detail further (Fig. 10).

NUS30: plateau surface dissected by wadis flowing into a large basin to the northwest. A low density scatter of MSA (Aterian) and LSA artefacts was found on the surface, as well as at

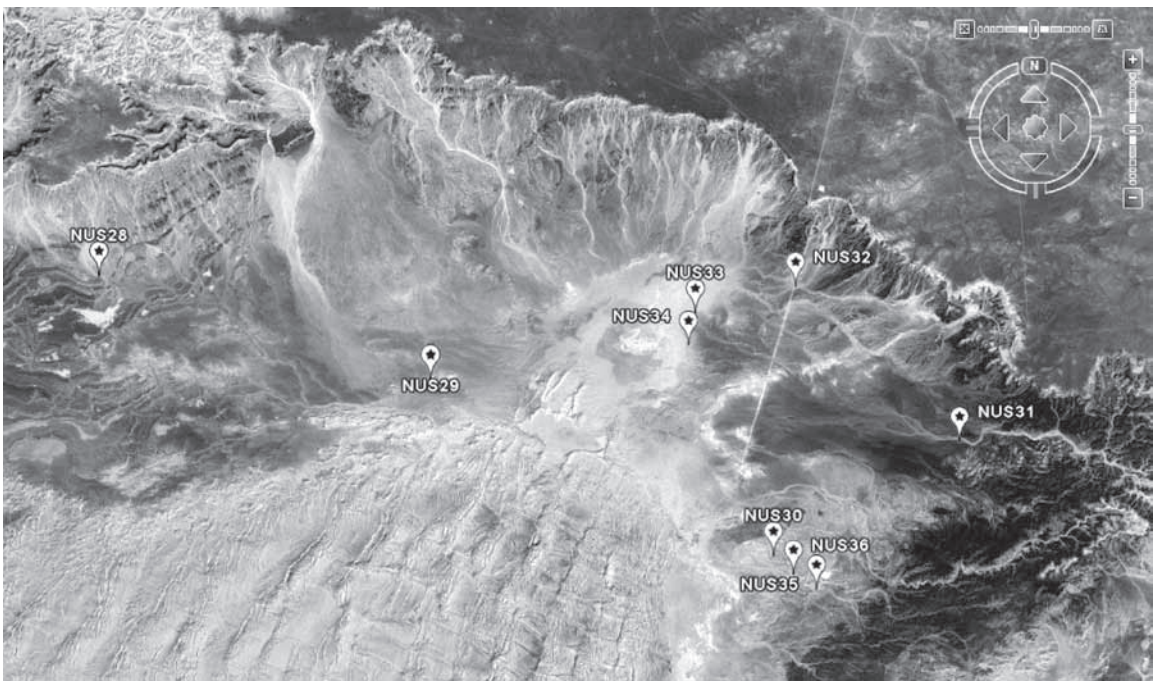

Figure 10. Geographic position of archaeological localities surveyed in the Qararat al Mrar (NUS 29 to NUS36) (background image: GoogleEarth).

least four cairns located at the edges of one of the wadis. All four cairns had been disturbed in the past.

NUS31: locality near the escarpment shaped by fluvial deposits flowing southeast towards a large basin some 5 km away. It contained a recent wadi, with trees and bushes, but the whole surface was formed by earlier fluvial events as the water volume changed through time. Three east–west transects were carried out on banks on either side of the wadi, across the latter and up the terraces on the western side. Very little archaeological material was found, all ESA and possibly MSA and all part of the fluvial wash.

NUS32: locality surrounding a spring and extending towards the escarpment to the north. Six transects were carried out, along which clusters of ESA and MSA artefacts were found. A stone circle of approximately 3 m in diameter was found, possibly the remains of a recent campsite.

NUS33: area at the edge of the large basin, at the mouth of a wadi. Six transects of approximately 100 m length were carried out, radiating from a central point. Very few archaeological remains were observed and were all clustered within a small 5 m^2 area, all without diagnostic features (probably MSA).

NUS34: similar locality to NUS33, further to the south, with outcrops of bedrock on the surface. The same survey strategy was used, with six radiating transects of approximately 100 m length. Only a single isolated flake was found.

NUS35: wadi and surrounding banks and terraces, where long lake sediments are exposed (Fig. 5). Three transects were carried out, one across the wadi and up to the lower hills above the eastern bank, one along the eastern high hills and one along the top of the western bank. The area was rich in archaeological finds, including a few MSA artefacts, many LSA and Neolithic artefacts, hearths and a disturbed cairn.

NUS36: a cairn field on a plateau overlooking the deeply incised wadi of NUS35. Over 70 cairns were observed, some 25 of which were described and photographed, most of which had been disturbed in the past. LSA lithics, pottery and a bead were found in the vicinity; probably Late Pastoral and Garamantian in age. A small antennae tomb, disturbed in the past, was identified between NUS35 and NUS36.

Localities surveyed within the concession area to OXY Libya LLC

In collaboration with the Department of Antiquities of Libya, a number of localities identified during a preliminary survey carried out in 2006–2007 by the oil company OXY Libya LLC and surrounding areas were surveyed to record in greater detail their archaeological remains. These were located within interdune deposits in the Ubari sand sea in the area north of Jarma (named USS) and between the southern margins of the Messak Setafet (named MES) and northern edge of the Wadi Barjuj (named BJJ) (Figs. 11 and 12).

USS10: interdune depression with a well and with exposed lake sediments forming three isolated terrace-like deposits. Archaeological material was found on the surface of all three, but concentrated in one. Mainly LSA lithics, some pottery and a few hearths. Fragmented portions of a human cranium were found on the surface.

USS11: interdune depression with exposed swampy sediments containing large calcreted plant roots. Very rich in archaeological material, mainly composed of a bifacial industry, but also including some LSA lithics, hearths, grinding stones and a small amount of pottery. The bifaces were mainly distributed along the slopes of the dunes surrounding the depression. An important reference collection, mainly of the bifacial assemblage, was made.

USS12: sand-slope above interdune depression, with existing vegetation (including palm trees). This was a small survey, during which a few lithics (LSA?), grinding stones and pottery were identified.

USS13: long interdune depression with extensive vegetation amidst a rugged surface of small dunes and tamarisk mounds surrounded by wind-made holes. Very few archaeological remains

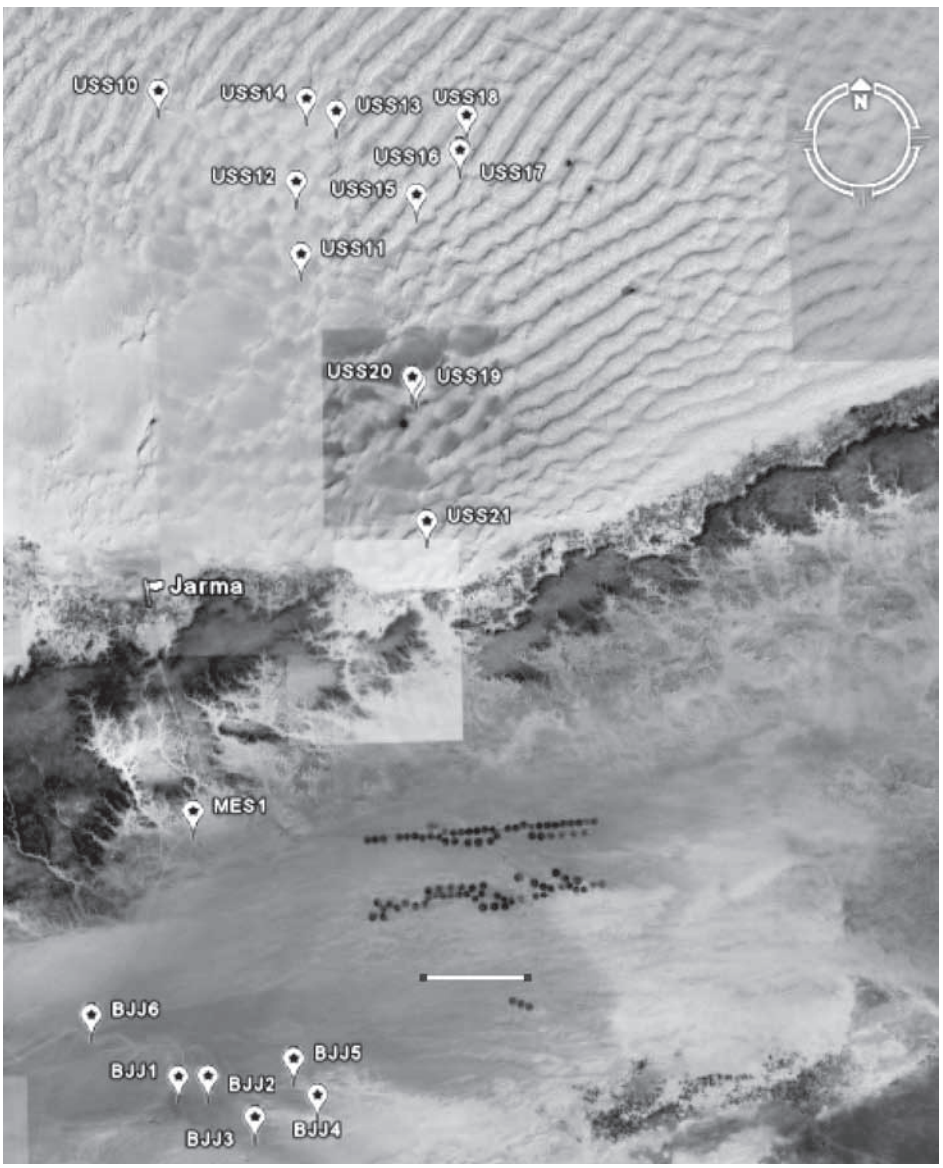

Figure 11. Geographic position of archaeological localities surveyed within the area of oil exploration, Block 131, OXY Libya LLC (background image: GoogleEarth).

found overall. A small area of approximately 50 m by 50 m with a flat pebbly surface of outcropping bedrock was characterised by a number of circular pits (filled by sand) and a surface scatter of LSA and Neolithic lithics, as well as pottery. One of these pits was excavated and had a depth of approximately 0.50 m, but it contained only sand.

USS14: long interdune depression, very similar to USS13, with similar geological and environmental contexts. Similarly to USS13, relatively low densities of archaeological

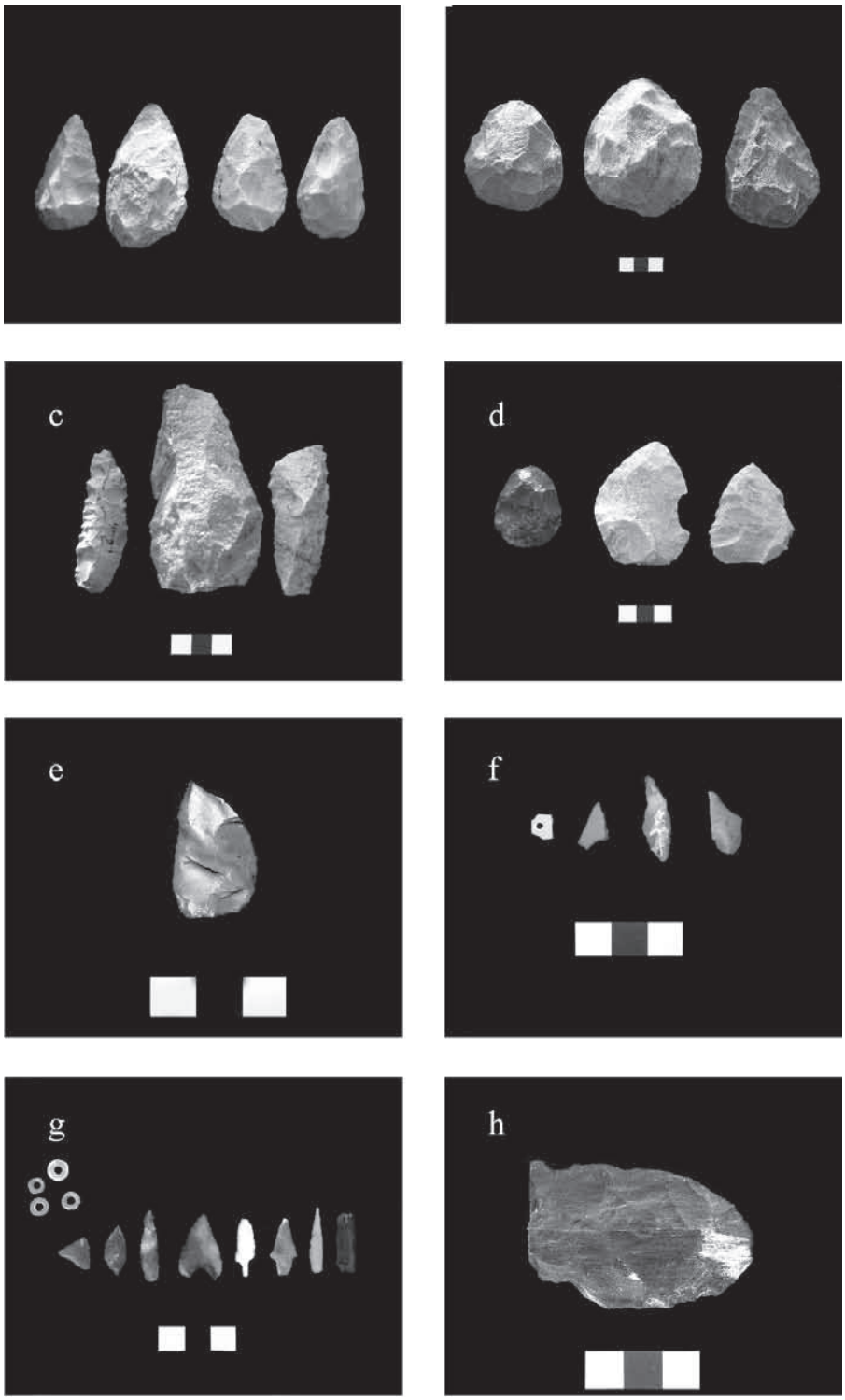

Figure 12. Details of artefacts from localities in the Ubari Sand Sea: a to d, USS11; e: USS14; f: USS20; g and h: USS21. Scale in cm (photos: M.M. Lahr, R.A. Foley and T. Savage).

material were observed at this locality. Three transects were carried out, as well as an overall reconnaissance of the entire interdune depression by car to establish whether very dense lithic scatters occurred elsewhere in the depression, but none was observed. The archaeological material found range from MSA, LSA and Neolithic artefacts, pottery and grinding stones, as well as an Islamic burial.

USS15: this is a small interdune depression in the sand sea, with crossing dunes less than 5 m high, with outcrops of palaeolake sediments. The archaeological material was small in quantity, consisting mainly of LSA lithic artefacts and a small number of pottery sherds.

USS16/17: exposure of palaeolake sediments in a small depression (approximately 100 m in length), in which there is existing vegetation. A small number of lithic artefacts, as well as pottery, were found on the flat surface surrounding the depression and within it. A small excavation of the sub-surface sediments did not disclose archaeological remains.

USS18: locality on a terrace above Lake Trouna (visible approximately 2 km to the east). A low density scatter of MSA and LSA artefacts was identified.

USS19: locality on a linear (longitudinal) dune flank, on scour holes on the northwest side of the dune. Located approximately 1.5 km south of Umm al'Maa lake. The site (approximately 50 m by 30 m) contained a dense scatter of pottery sherds of different types, as well as some LSA lithic artefacts. A sequential dune flank (to the south) was also surveyed, which contained very similar material. A transect eastwards, climbing the dune to the summit and surveying the sequentially higher dune flanks, was carried out and pottery sherds were found to occur in all of them (including the very last one, some 90 m above the site).

USS20: locality approximately 3 km west from USS19, where a series of outcrops of palaeolake sediments is found. The slopes of the largest of these (some 70 m by 25 m) were covered by a dense scatter of LSA and Neolithic artefacts, as well as some pottery and grinding tools; although evidence of earlier periods of occupation were also found, including a handaxe. The largest of the exposed palaeolake surfaces was characterised by similar circular pits filled with sand as observed at locality USS13. One of these pits excavated in 2007, was found to have a depth of approximately 2 m; only sand and a few date pits were found within. Three palaeolake outcrops were surveyed and a transect up the dune to the west carried out. Lithics and pottery were found on and around all three outcrops, as well as on most of the dune flanks, which also contained a number of hearths.

USS21: locality within an interdune depression close to the Sabah–Jarma road, but in a relatively inaccessible position due to the height and steepness of the surrounding dunes. The depression has a rugged topography of dunes up to 4 m in height, vegetation (including large tamarisk mounds and wind-blown holes surrounding them) and interspersed outcropping palaeolake

sediments. Only a small portion of the area was surveyed, consisting of a large palaeolake outcrop flat surface (of approximately 70 m by 50 m) and surrounding smaller outcrops, as well as tamarisk holes. A very dense archaeological site, with large numbers of LSA and Neolithic artefacts, grinding stones, pottery and ostrich egg-shell beads.

MES1: locality on a fluvial flat landscape, some 10 km south of the Messak and 500 m to the east of the road crossing the Messak from Jarma and bordered by low hills on the eastern side. ESA artefacts were found on the fluvial plain, including bifacial pieces. A twelve-person radial transect was carried out on the plain, as well as a survey of the slopes of the eastern hill (some 200 m away) and the top surface of the hill itself (some 300 m by 100 m). ESA artefacts were found on the slopes, as well as on the western surface of the hill (including a quarry locality of the local outcropping bedrock), while MSA artefacts, as well as hearths and burial mounds, were found on the eastern end of the hill (away from the pluvial plain).

BJJ1: locality on a silt/clay pan within a wadi, with some exposed palaeolake sediments of the Bir al Zallaf Formation, at the northern edge of the Wadi Barjuj. Archaeological remains are not restricted to this locality, but rather extend in an east–west transect all along the similar geological context for several kilometers. A cluster of pottery sherds and exposed animal bones was visible on the sandy pan flat surface, which was excavated. The surrounding area was surveyed for archaeological material and a detailed 350 m by 10 m transect was carried out from the plain up to and across the two terraces of exposed palaeolake sediments. A very high density of MSA and LSA artefacts, grinding tools, pottery, as well as some ostrich egg-shell beads and a fragment of decorated ostrich egg-shell were recorded.

BJJ2: small locality on clay pan exposures among zibar sand ripples, on which a medium scatter of MSA and LSA lithic artefacts was found. The geological context extends further in an east–west direction.

BJJ3: sandy plain with interspersed ridges of fluvial sandy gravel, surrounded by small dunes to the south and north. Three transects were carried out and a low to medium density scatter of lithic artefacts (MSA, LSA), pottery, grinding tools and a few hearths was found. The geological and environmental contexts of this site extend for a large area, which probably contains a similar low density of archaeological finds.

BJJ4: locality around large palaeolake sediments (sampled by the geologists) exposed in interdune depression. Two transects bordering the lake exposures to the southeast and east were carried out, as well as one along the sandy hill that borders the depression to the east. A very high density scatter of lithic artefacts was found on all surfaces surveyed, probably amounting to over a hundred bifaces (including possibly a cleaver). The bifaces ranged in size between 3 and 12cm and thus characterise a particular bifacial industry that differs from traditional Acheulean assemblages. A very small number of LSA microlithic artefacts was also observed.

		Tools		Cores		Debitage		Grinding Stones		Handstones		Pottery	
Locality	Quantity	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
NUS1	25	3	11.5	1	3.8	19	73.1					2	7.7
NUS2	29	6	17.6	1	2.9	22	64.7						
NUS3	8			3	37.5	4	50.0			1	12.5		
NUS4	146	29	19.9	16	10.9	97	66.4	2	1.4	1	0.7	1	0.7
NUS8	370	86	23.2	65	17.6	199	53.8	9	2.4	7	1.9	4	1.1
Al Wafa	706	116	16.4	136	19.3	440	62.3	6	0.8	3	0.4	5	0.8
NUS9	95	23	24.2	13	13.7	47	49.5	1	1.0	2	2.1	9	9.5
NUS10	3	1	33.3			2	66.7						
NUS11	33	12	36.4	8	24.2	13	39.4						
NUS12	9	4	44.4	3	33.3	2	22.2						
NUS14	11	6	54.5	3	27.3	2	18.2						
NUS17	28	1	3.6	1	3.6	7	25.0	18	64.3	1	3.6		
NUS18	0												
NUS20	205	8	3.9	44	21.5	152	74.1					1	0.5
NUS22	12	4	33.3	3	25.0	5	41.7						
NUS23	20	2	10.0	3	15.0	15	75.0						
NUS24	3			3	100.0								
NUS25	11	2	16.7	2	16.7	7	58.3						
NUS27	0												
NUS28	19	3	15.8	3	15.8	13	68.4						
NUS29	13	2	15.4	1	7.7	10	76.9						
NUS30	7	1	11.1			6	77.8						
NUS31	8	2	13.3	1	6.7	5	33.3						
NUS32	75	11	12.9	14	16.5	50	58.8						
NUS33	2	1	50.0			1	50.0						
NUS34	1					1	100.0						
NUS35	154	23	14.9	7	4.5	123	79.9					1	0.6
SHT1	53	5	9.4	3	5.7	45	84.9						
SHT2	26			1	3.8	25	96.1						
SHT11	11	1	9.1	1	9.1	9	81.8						

Table 2. Percentage of archaeological artefacts recorded at localities along the northern margin of the Ubari sand sea.

SHT12	8			7	87.5	1	12.5						
SHT13	31	1	3.2	13	41.9	17	54.8						
SHT14	3			3	100.0								
SHT15	24	2	8.3	3	12.5	19	79.2						
SHT16	24	1	4.2	2	8.3	20	83.3	1	4.2				
Total	*2173*	*356*	*16.4*	*352*	*16.2*	*1378*	*63.4*	*37*	*1.7*	*15*	*0.7*	*23*	*1.1*

Table 2. Percentage of archaeological artefacts recorded at localities along the northern margin of the Ubari sand sea (cont.).

BJJ5: very rich and spatially bounded locality on a raised palaeosurface of black cobbles, extending for a few kilometers. A general survey around the eastern end of the exposure, continuing up to the sandy hills to the north, as well as a 1 km long east–west transect was carried out. Archaeological materials were concentrated on the eastern end, although present at low density throughout the site. ESA, MSA and LSA artefacts, as well as pottery and grinding stones were found, including *in situ* knapped Neolithic bifacial points, with associated core and flakes.

BJJ6: locality approximately 1 km from the road south from Jarma across the Messak, on a palaeoriver channel surface forming sinuous ridges dissected by more recent wadis and extending for several kilometers in an east–west direction. A very brief survey was carried out, during which very eroded ESA (Oldowan) chunky artefacts were identified. The extent of this site is difficult to assess without further study, but the nature of the industry makes it important.

Summary, discussion and future prospects

The DMP geomorphological work during the 2008 field season revealed important aspects of the Pleistocene palaeoenvironmental record of Fazzan. Its most important achievement has been to complete a comparative study of the stratigraphic record of palaeolake episodes on the northern margins of the Ubari sand sea, comprising major sites at the western (Al Wafa), northern (Hamada Tanghirt), northeastern (Qarart al Mrar) and eastern (Wadi ash-Shati) margins of the basin. These have identified at least five episodes of high water levels, in which the whole or part of the Ubari Basin contained lakes.

The palaeoanthropology team of Desert Migrations Project 2008 consisted of six scientists and completed a programme of 15 days field investigations and six days analysis in Jarma. A total of 51 localities were investigated for archaeological evidence. The 2007 and 2008 field seasons combined surveyed 35 localities along the northern margin of the Ubari sand sea, from Al Wafa to Wadi ash-Shati. All but two localities visited contained archaeological material, although the density varied greatly. Most of the archaeological remains consist of lithics (96%); six localities also had remains of grinding tools (all but one restricted to the area around Al Wafa), while pottery sherds were found geographically more widespread (Table 2).

Locality	No.	Chopper	Handaxe	Biface pre-form	biface	Levallois point	Retouched Levallois flake	Aterian point	Point	Arrowheads + micro-points	Scraper	Borer	Burin	Perforator	Lanceolate	Foliate	Polished adze/axe	Perforator	Retouched flake	Retouched blade	Notched flake	Notched blade	Notched + retouched flake	Notched + retouched blade	*Backed piece*
NUS1	3										1								2						
NUS2	6				1														2	2			1		
NUS4	29		1			2		1			5		1						12	2	1	1		1	2
NUS8	82		1		1			2			6		1				1	1	10	26	1	1	1	10	20
Al Wafa	122	2	14	2	2	8			1	1	20	5	1		1				55	3			1	1	5
NUS9	25		6	2	2	4	1				3				1				3	2		1			
NUS10	1										1														
NUS11	12			2	2						2					1			2						3
NUS12	4			1							1								2						
NUS14	6				1				1		2				1				1						
NUS17	1				1																				
NUS20	14		3								2								9						
NUS22	4			1							1								2						
NUS23	2		1																1						

NUS25	2										2															
NUS28	6			1							1										3					
NUS29	2										2															
NUS30	1							1																		
NUS31	2		2																							
NUS32	11		1	1							2									5						2
NUS33	1					1																				
NUS35	24			1	5				3	1	1	1				1				10	1					
SHT1	5		1			1														3						
SHT11	1		1																							
SHT13	1																			1						
SHT15	2															1								1		
SHT16	1																			1						
Total	370	2	31	11	15	16	1	4	5	2	52	6	3	0	3	2	1	1	121	39	2	3	2	14	32	
%		0.5	8.4	3.0	4.0	4.3	0.3	1.1	1.3	0.5	14.0	1.6	*0.8*		0.8	0.5	0.3	0.3	32.7	10.5	0.5	0.8	0.5	3.8	*8.6*	

Table 3. Distribution of lithic tools at localities along the northern margin of the Ubari sand sea.

Site	Number of cores	Total number of artefacts	Percent
GES8	1	2	50.0
NUS8	38	223	17.0
NUS8-AW	124	662	18.7
NUS9	3	26	11.5
NUS10	0	3	0.0
NUS11	8	33	24.2
NUS12	3	9	33.3
NUS14	3	11	27.3
NUS17	1	28	3.6
NUS20	44	205	21.5
NUS22	3	12	25.0
NUS23	3	20	15.0
NUS24	3	3	100.0
NUS25	2	11	18.2
NUS28	3	19	15.8
NUS29	1	13	7.7
NUS30	0	7	0.0
NUS31	1	8	12.5
NUS32	14	75	18.7
NUS33	0	2	0.0
NUS34	0	1	0.0
NUS35	7	154	4.5
USS10	0	1	0.0
USS11	11	192	5.7
USS12	0	6	0.0
USS13	0	14	0.0
USS14	5	96	5.2
USS15	0	6	0.0
USS16/17	0	2	0.0
USS18	0	3	0.0
USS19	0	1	0.0
BJJ1	4	63	6.3
BJJ2	3	22	13.6
BJJ3	4	88	4.5
MES1	11	152	7.2
Total	*300*	*2173*	*13.8*

Table 4. Number and proportion of cores per locality.

The range of tools found at these sites reflects the multi-period occupation of the area (Table 3). Interestingly, Mode 2/Acheulean artefacts were found in all four focal areas along the northern margin of the Ubari Basin, indicating a relatively widespread hominin presence in the late Lower and early Middle Pleistocene.

Regarding the range of localities studied during the 2008 field season, an analysis of the cores is used here to provide particular evidence about prehistoric activities, as they can indicate both patterns of production and also insights into the technology. Across the 2008 sample localities the number of cores as a percentage of the overall assemblage varied from zero to 33% (GES 8 was excluded as it consisted of only two artefacts, one of which was a core) (Table 4). There was, however, marked differences between regions, with localities within interdune corridors in the sand sea (USS) having very few (mean = 1.2%) and those along its northern margin, between the sand sea and the Hamada (NUS) the most (mean = 17.8%). Localities south of the Messak Settafet visited in 2008 (BJJ and MES) were intermediate, with a mean average of between 6% and 8% (Table 5). The inference that may be drawn is that, probably regardless of period, the relationship between raw material sources and areas of activities, especially stone

Sampling region	NUS	USS	BJJ	MES
Mean percentage of cores	17.8	1.2	8.2	7.2
Standard deviation	21.6	2.9	4.7	21.6

Table 5. Mean percent and standard deviation of cores in the assemblages for each of the major regions in the sample.

	Core Type								
Locality	*Levallois*	*Discoid*	*Pyramidal /sub-pyramidal*	*Wedged*	*Cuboid*	*Cobble*	*Amorphous*	*other*	*Total*
NUS8	0	1	15	8	8	1	2	2	37
NUS8-AW	0	16	3	2	7	26	62	4	120
NUS9	0	0	0	1	0	0	2	0	3
NUS11	0	1	1	0	0	1	2	2	7
NUS12	0	1	0	1	0	1	0	0	3
NUS14	0	0	1	1	0	1	0	0	3
NUS17	0	0	0	0	0	0	1	0	1
NUS20	3	1	0	0	0	32	4	2	42
NUS22	0	1	1	0	0	1	0	0	3
NUS23	0	1	0	0	0	1	0	1	3
NUS24	0	0	1	0	0	0	1	1	3
NUS25	0	0	0	0	0	1	1	0	2
NUS28	0	0	0	0	0	1	2	0	3
NUS29	0	0	0	0	0	0	1	0	1
NUS31	0	0	1	0	0	0	0	0	1
NUS32	1	2	1	0	1	5	3	1	14
NUS35	0	0	0	1	0	4	0	2	7
BJJ1	0	2	1	0	0	1	0	0	4
MES1	0	3	0	0	0	5	1	0	9
Total	4	29	25	14	16	81	82	15	266

Table 6. Distribution of core types by locality.

Site	*No.*	*Length (mm)*	*Width (mm)*	*Thickness (mm)*
NUS8	38	43.9	35.6	25.7
NUS8-AW	120	49.8	41.1	27.5
NUS9	3	54.2	30.2	17.0
NUS11	8	54.3	72.0	47.7
NUS12	3	105.4	79.4	55.6
NUS14	3	53.0	47.0	27.8
NUS17	1	48.1	39.5	25.9
NUS20	44	89.6	74.8	46.5
NUS22	3	45.6	82.5	74.2
NUS23	3	82.7	64.2	32.4
NUS24	3	52.9	64.2	39.9
NUS25	2	91.7	62.1	41.6
NUS28	3	57.3	46.4	30.8
NUS29	1	63.2	43.0	20.8
NUS31	1	99.4	122.8	84.7
NUS32	14	79.0	71.2	41.0
NUS35	7	66.4	43.8	26.5
BJJ1	4	62.8	50.8	31.3
MES1	11	84.0	64.1	41.4
Total	272	60.7	51.2	33.4

Table 7. Mean length, breadth and thickness of the cores by locality

tool manufacture, was markedly different along the edge of the Hamada to the north, where raw material was relatively easily available and within the Ubari sand sea itself, where it was far scarcer.

The cores also provide insights into the probable chronological and technological assignments of the assemblages. Given the nature of the geomorphological context of the collected material, there is a possibility that some of these are mixed assemblages. In three cases, however, the cores, which in many ways are the most diagnostic pieces as they indicate modes of production more systematically, show a strong signal. NUS8, with its high proportion of bipolar, wedge and cuboid forms, is clearly a predominantly later Pleistocene/Holocene technology; NUS20, on the other hand, is completely dominated by simple cobble cores, suggestive of a Mode 1 industry; while Al Wafa, although in very close proximity to NUS8, has an entirely different signal, with a mixed complex of cobble and discoid cores (Table 6). In all probability, Al Wafa is a mixed assemblage, accumulated over a long period of time. The types of core also differentiate the localities more clearly than do the metrics, suggesting that raw material, which is fairly consistent across the areas, is less of a constraint on mode of production than it is on the overall size of the artefacts (Table 7).

In summary, the primary findings of the DMP 2008 Palaeoanthropology field season are:

- The North Ubari region and the Ubari sand seas are both areas of immense archaeological wealth. This confirmed and extended the findings from the 2007 mission;

- The archaeological record of the region is characterised by a very dispersed and continuous background density of lithic and other material, punctuated by areas of high density that may cover a few square metres or several square kilometers;

- The archaeological signal is strongest in interdune depressions, duricrusts, wadi floodplains and flanks, palaeolake margins and to a less predictable extent, desert deflation zones and some dunes;

- The archaeological material is predominantly lithic, although pottery is occasionally present. Animal bone is very rare. Other archaeological features included hearths, cairns and tombs, the first being by far the most abundant;

- The lithic material represents a range of chronological units. Although Mode 1 (ESA, Oldowan) technology was observed, it could not be demonstrated that this occurred exclusive of Mode 2 (ESA, Acheulean) technology, except at BJJ6, which was not intensively sampled. It is worth noting that diagnostic Mode 1 industries were discovered in the 2007 mission at Wadi ash-Shati. Mode 2 technologies were found extensively across the survey region, with particularly rich samples collected at localities in the areas between the Ubari sand sea and the Hamada (NUS localities) and north of the Wadi Barjuj. Mode 3 (MSA) technologies were among the most interesting finds, with clear evidence for prepared core and Levallois industries. Although blades were found extensively, these did not constitute a clear industry, being found in association with part of more microlithic assemblages. It is currently not clear whether this represents mixed assemblages, or the fact that this technology does not form an exclusive group in this area (as is the case in many parts of sub-Saharan Africa). The remainder of the material found broadly belonged to either microlith dominated assemblages (Mode 5), which can be considered to be terminal Pleistocene (Epipalaeolithic, Late Stone Age), or belonging to Holocene groups that were either hunter-gatherers or early pastoralists. The latter are also represented by pottery and/or technology showing polishing and grinding;

- Dating these assemblages is currently a major research priority and geological samples were collected for this purpose. At this stage, it can be proposed tentatively that hominins were present in Fazzan at least intermittently from the Lower Pleistocene, extensively through the Middle Pleistocene and certainly in the later parts of the Upper Pleistocene and Holocene. Given the association of the archaeology with evidence for lakes, swamps and more active rivers, it is our hypothesis that this occupation was intermittent and related to the periodic wetter phases of the Sahara.

Key issues that remain to be resolved are:

- The existence and extent of Mode 1 industries in the area, which may be evidence for the first dispersals out of sub-Saharan Africa;

- Dating of the lake phases throughout the Quaternary as a proxy for archaeological patterns;

- More fine tuning of the archaeological signature that will distinguish the different phases and populations of the Later Pleistocene and Holocene.

Further survey and excavations in 2009 will be focused on these issues.

Acknowledgements

The field work reported upon here took place in January 2008. This could not have taken place without the support and assistance of our colleagues in the Department of Antiquities in both Tripoli and Jarma. Special thanks go to Dr Giuma Anag, President of the Department, who not only has continuously supported and facilitated the work of the DMP as a whole, but always provides fascinating feedback on our Palaeolithic findings. Mohammed Arreda, Controller of Fazzan, again offered the project the support of staff at Jarma and the facilities at the Museum; Saad Salah Abdul Aziz, responsible for foreign missions in Jarma, was again indispensable, organising the needs and in-and-outs of the different field teams throughout. While in Jarma, all members of the DMP enjoyed the excellent cooking of Suleiman Mohammed and Mohammed Koraman. Four Libyan archaeologists and staff of the Department of Antiquities joined the DMP-palaeoanthropology field work for a few days and their help and enthusiasm was extremely important for the success of the mission – Muftah Ahmed (Leicester), Misbah Ismayer (DoA Tarhuna), Mohammed Ali Suleiman Krayda (DoA Jarma) and Nouridene Mohammed Ahmadi (DoA Tripoli). Mustapha Turjman, from the Tripoli office, again provided much assistance in the processing of the visas for all DMP team members.

We would like to thank the Society of Libyan Studies for their continuous funding of the DMP from their annual grant from the British Academy – BASIS – research allocation and the Leverhulme Trust, UK, for their generous support to one of us (MML) and their consent to use these funds towards this project. As with last year, the palaeoanthropological and geomorphological fieldwork of the DMP was only possible because of the planning of our colleague Mustapha Salem, who brilliantly organised and supervised all logistic arrangements while in the desert. Toby Savage provided support, dietary treats and expresso coffee while in the desert, and photography. To both Mustapha and Toby, our most special thanks.

References

Armitage, S., Drake, N., Stokes, S., El-Hawat, A., Salemm M.J., White, K., Turner, P. and Mclaren, S.J. 2007. Multiple phases of North African humidity recorded in lacustrine sediments from the Fazzan Basin, Libyan Sahara. *Quaternary Geochronology* 2: 181–186.

Foley, R.A. 1981. *Off-site archaeology and human adaptation in Eastern Africa: an analysis of regional artefact density in the Amboseli, southern Kenya*. Cambridge Monographs in African Archaeology 3. British Archaeological Reports International Series 97, Oxford.

Mattingly, D.J. (ed.) 2003. *The Archaeology of Fazzān. Volume 1, Synthesis*. Department of Antiquities, Tripoli and Society for Libyan Studies, London.

Mattingly, D.J. (ed.) 2007. *The Archaeology of Fazzān. Volume 2, Gazetteer, Pottery and Other Finds*. Department of Antiquities, Tripoli and Society for Libyan Studies, London.

Mattingly, D.J., Lahr, M., Armitage, S., Barton, H., Dore, J., Drake, N., Foley, R., Merlo, S., Salem, M., Stock, J. and White, K. 2007. Desert Migrations: people, environment and culture in the Libyan Sahara. *Libyan Studies* 38: 115–156.