Sudan & Nubia

The Sudan Archaeological Research Society

Bulletin No. 19 *2015*


ASWAN
1st cataract
Middle Kingdom forts
Egypt
RED SEA
Wadi el- Allaqi
2nd cataract
Wadi Gabgaba
Seleima Oasis
Sai
3rd cataract
Sudan
ABU HAMED
Nile
Kurgus
El-Ga'ab Basin
Kawa
Jebel Barkal
4th cataract
5th cataract
el-Kurru
Dangeil
Debba-Dam survey
Berber
ED-DEBBA
ATBARA
Ganati
Wadi Howar
Meroe
Hamadab
Atbara
Muweis
Wad ben Naqa
Wadi el- Melik
Wadi Muqaddam
6th cataract
OMDURMAN
Wadi Muqaddam survey
KHARTOUM
KASSALA
Eritrea
Blue Nile
MODERN TOWNS
Ancient sites
WAD MEDANI
GEDAREF
White Nile
Jebel Moya
KOSTI
SENNAR
N
Ethiopia
South Sudan
0
250 km

SUDAN & NUBIA

The Sudan Archaeological Research Society — *Bulletin No. 19* — *2015*

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Front cover: QSAP Dam-Debba Archaeological Survey Project. Site DS7, Ganati: the re-erected columns in the church (photo: Fawzi Hassan Bakhiet).

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Reports

Middle Stone Age and Early Holocene Archaeology in Central Sudan: The Wadi Muqadam Geoarchaeological Survey

Rob Hosfield, Kevin White and Nick Drake

Introduction

The presence of the Nile Valley combined with the changing palaeoclimates of the Sahara (e.g. Drake *et al.* 2011) provide an intriguing landscape and palaeoenvironmental context to hunter-gatherer archaeology in Sudan. The Nile Valley, the Sahara Desert, and the western Red Sea coast fall within Sudan's borders and highlight the potential of its archaeology to inform understanding of the 'Out of Africa' dispersals of the Early and Late Pleistocene (e.g. Van Peer 1998; Rose 2004a; Bailey 2009), because all three of these landscapes have been proposed as dispersal routes for Palaeolithic peoples out of Africa (Stringer 2000; Vermeersch 2001; Drake *et al.* 2011). The presence of key Green Sahara fluvial and lacustrine habitats such as Wadi Howar and the West Nubian palaeolake have also focused attention on Holocene hunter-gatherer strategies for the exploitation of now-arid environments (e.g. Hoelzmann *et al.* 2001; Keding 2006; Jesse and Keding 2007). Yet despite sustained interest in these issues, Palaeolithic and, to a lesser extent, early Holocene research beyond the confines of the Nile in Sudan has been relatively limited in recent times, in contrast to more extensive work along the valley (e.g. Van Peer *et al.* 2003; Rose 2004b; Usai and Salvatori 2005; Osypiński *et al.* 2011). This paper reports on the first phase of a new programme of fieldwork, exploring the distribution and palaeo-landscape settings of Palaeolithic and Holocene hunter-gatherer archaeology along a Saharan tributary of the Nile known as Wadi Muqadam.

1.1 Background

Sudan (defined here as incorporating both the Republic of the Sudan and the Republic of South Sudan) offers an opportunity to explore the impacts of climate, landscape and palaeogeography on hunter-gatherer behaviour during both the Pleistocene and the early Holocene. The variable aridity and wetness of the eastern Sahara in both the Pleistocene and the Holocene allow similarities and differences in the 'desert' landscape exploitation strategies of Palaeolithic and Mesolithic groups to be evaluated, while the role of Sudan in Pleistocene hominin dispersals can also be explored.

Usai and Salvatori (2005, 475) have emphasised significant gaps in the prehistoric sequences of central Sudan when compared to the north of the country, covering both the Palaeolithic and the early Holocene. This situation has been markedly improved along the Nile in recent times, particularly for Holocene prehistory, through their Is.I.A.O el-Salha project (e.g. Salvatori *et al.* 2011; 2014; Figure 1). The project identified *c.* 200 sites, from the Palaeolithic through to the historical period, although preservation was highly variable and the majority of sites lacked stratified deposits (Salvatori *et al.* 2011, 179-180). Three aspects of the project are particularly noteworthy with regards to our own investigations:

(i) a series of radiocarbon dates associated with Mesolithic and Neolithic phases (Salvatori *et al.* 2011, tables 1 and 2);

(ii) the identification of an early and middle Holocene palaeoswamp to the west of Omdurman and the Nile, fringed by Mesolithic and Neolithic sites, and probably fed by seasonal Nile flooding and higher regional water availability during the Holocene African Humid period (Cremaschi *et al.* 2006; Salvatori *et al.* 2011, 205);

(iii) a characterisation of Mesolithic and Neolithic pottery based on new stratified sites, particularly at el-Khiday (Salvatori 2012; Salvatori *et al.* 2011, 195-200).

While the el-Salha project has generated extensive new data, Salvatori *et al.* (2011, 208) note that their model's wider applicability can only be demonstrated by further work, particularly in light of the current lack of other well-stratified Mesolithic and Neolithic sites in central Sudan (Dal Sasso *et al.* 2014, 139). Initiating such further work, and seeking evidence for early Holocene occupations at greater remove from the Nile Valley, was the first goal of the geoarchaeological survey of Wadi Muqadam (Figure 1) reported in this paper. Surveying Wadi Muqadam was of particular interest in light of the ACACIA project's (e.g. Keding 2006; Jesse and Keding 2007) key survey of the Wadi Howar region and characterisation of changing environmental conditions and shifting subsistence, settlement and material culture patterns through the Holocene. In the specific case of the West Nubian palaeolake, Hoelzmann *et al.* (2001) documented predominantly hunter-gatherer subsistence patterns and a sedentary or semi-sedentary existence along the margins of the West Nubian palaeolake during its larger, coherent phase (*c.* 6300-5300 ^{14}C yr BP [*c.* 5200-4100 cal yr BC]). This was followed by increasing aridity in the palaeolake environment, prior to abandonment of the area. The specific presence of Mesolithic and possibly Neolithic sites has previously been noted in Wadi Muqadam to the north west of Omdurman: the 1997 Omdurman to Gabolab SARS survey identified a number of sites on gravel beds close to the wadi channel. These were characterised by pottery, flaked and groundstone artefacts, molluscs, freshwater snails and fish-bones (Mallinson 1998, 43).

Sudan also occupies an intriguing geographical position with respect to the African Palaeolithic and the dispersals which took hominins, both archaic and modern, out into Asia

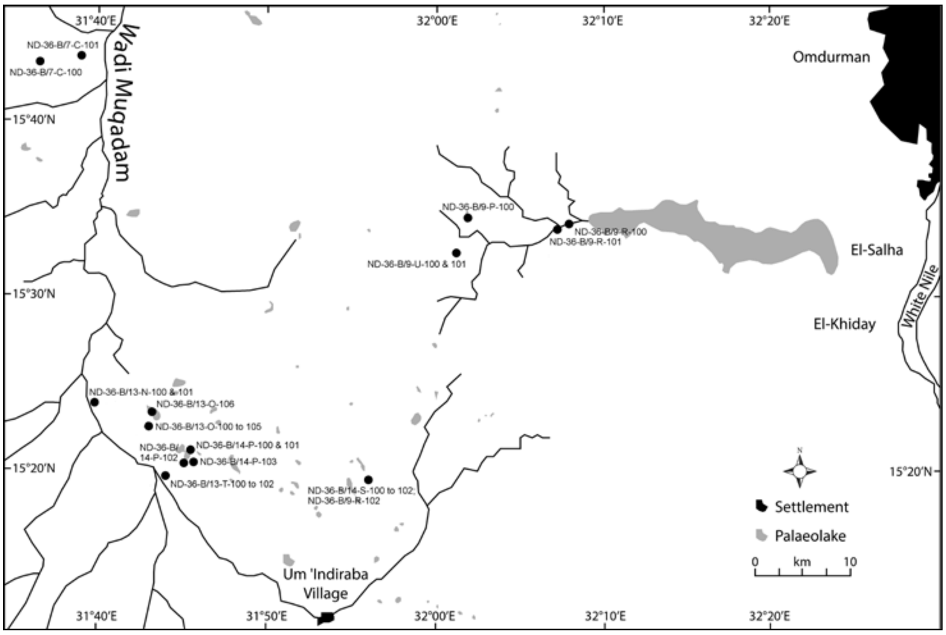

Figure 1. Location map of the Wadi Muqadam headwaters, showing locations mentioned in the text. Note that sites ND-36-B/9-R-100 and 101, ND-36-B/9-P-100 and ND-36-B/9-U-100 and 101 are in the drainage basin of a palaeochannel that drains east into the Nile. Remaining sites are in the Wadi Muqadam catchment that drains north, joining the Nile near Korti.

and Europe (Gamble 1993). This intrigue stems from current debates as to the areas occupied, and ultimately moved beyond, by hominins during the Old World dispersals of, respectively, the Early Stone Age (ESA; most likely *H. ergaster*) and the later Middle Stone Age (MSA; *H. sapiens*). Discussions have primarily focused on the Nile Valley and Delta, en-route to the Levant (Van Peer 1998; Vermeersch 2001), and the Bab-el-Mandeb Straits and the Red Sea coast, separating the Horn of Africa from the Arabian Peninsula (Rose 2004a; Bailey 2009; Armitage *et al.* 2011), although recent consideration has also been given to the potential role of Green Saharan routes (Drake *et al.* 2011; 2013). Sudan lies to the north west of both the Bab-el-Mandeb Straits (although it has an extensive Red Sea coastline) and the key ESA/MSA landscapes of East Africa (Ethiopia/Kenya/Tanzania; Clark 1992), and is, therefore, an important region for testing the relative importance of the three different dispersal routes (Beyin 2006).

Despite this, published Palaeolithic research in Sudan has been relatively limited in recent years (but cf. Marks 1990; Idris 1994). The main other exceptions include:

(i) Van Peer's excavations at Sai Island in the Nile (Van Peer *et al.* 2003; Figure 2), which documented a sequence of inter-stratified Acheulean and Sangoan assemblages, overlain by Lupemban-related Nubian Complex material.

(ii) Osypiński *et al.*'s (2011) excavations of Middle Palaeolithic-type material in a Late Palaeolithic context at Affad 23, in the Southern Dongola Reach;

(iii) Nassr's (2014) survey of late cutting tool sites along Wadi Elhudi and Wadi Abu Adar in the lower reaches of the Atbara river.

(iv) Rose's (2004b) analysis of the MSA Station One site in the extreme north of Sudan (Figure 2; there is a much richer series of Palaeolithic sites across the border in Egypt; e.g. Van Peer and Vermeersch 1990; Van Peer 1998; see Rose *et al.* 2011, fig. 1 and table 1).

(v) The re-dating of the hominin calvaria from Singa to the late Middle Pleistocene (Woodward 1938; McDermott *et al.* 1996; Figure 2).

The 1997 SARS survey from Omdurman to Gabolab identified 12 Acheulean handaxes in Wadi Muqadam, to the north of our own survey area (Mallinson 1998; Smith 1998). Prior to this more recent attention, Marks (1968a, b and c) and Guichard and Guichard (1968) reviewed Acheulean, Middle Palaeolithic/Mousterian, Khormusan and Halfan industries in Nubia, from the Egyptian border to Firka, while Chmielewski (1968) reported Early and Middle Palaeolithic sites near Arkin (Figure 2: site 3).

A key earlier survey was Arkell's (1949a) review of the Old Stone Age (Palaeolithic) of Sudan, which documented a range of Acheulean and Tumbian (= Sangoan) assemblages along the Nile and Atbara valleys (Figure 2), while the University of Khartoum's archaeological expedition to the Middle Nile Valley in 1977 recorded handaxes and Levallois artefacts (Callow, unpub. man.; Figure 2: sites 9, 13 and 19). The clear outcome of this research is evidence for multi-period Palaeolithic occupations in Sudan, but also a very limited appreciation of the presence, or absence, of Palaeolithic activity beyond the immediate surroundings of the Nile (see also Nassr 2014, fig. 1). This latter issue is particularly important in light of current appreciations of palaeoclimatic variability in the Pleistocene and the extension of the Green Sahara concept prior to the Holocene (Osborne *et al.* 2008; Drake *et al.* 2011), both of which emphasise the potential for Palaeolithic occupations in areas of Sudan beyond the Nile. Evaluating this potential was the second key goal of our investigations.

Methodology

Wadi Muqadam (Figure 1) is a left bank Nile tributary with headwaters in the semi-desert some 70km west of Khartoum. It then flows 300km north to join the Nile near Korti (Figure

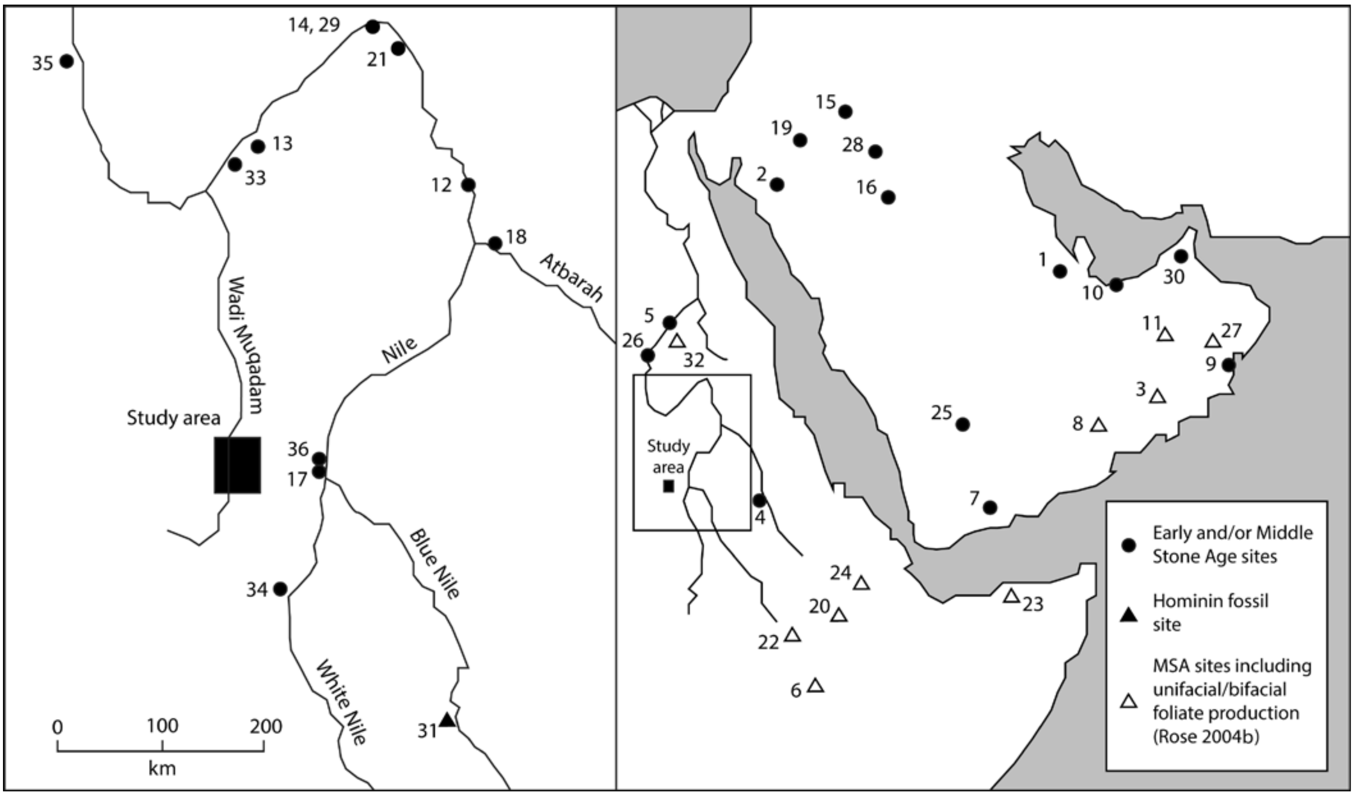

Figure 2. Selected Early and Middle Stone Age sites in Sudan and surrounding regions. 1: Abqaiq; 2: Bir Hima; 3: Bir Khasfa; 4: Butana Railway Bridge, east of Kashm el-Girba; 5: Egypt/Sudan border to Third Cataract (incl. Wadi Halfa and Arkin); 6: Gademotta and Kulkuletti; 7: Hadramawt; 8: Hanun; 9: Huqf; 10: Jebel Barakah; 11: Jebel al Hammah; 12: Jebel Nakharu; 13: Jebel Nuri; 14: Jebel Salateb; 15: Jebel Umm Wual, Turaif and Jebel Aneiza; 16: Jubbah; 17: Khor Abu Anga; 18: Khor Hudi; 19: Kilwa; 20: K'One; 21: Kurgus; 22: Melka Kunture; 23: Midhishi 2; 24: Porc Epic; 25: Rub' al-Khali; 26: Sai Island; 27: Saiwan; 28: Sakaka; 29: Shamkhiya; 30: Sharjah and Ras al Khaimah; 31: Sinjah; 32: Station One; 33: Tangasi; 34: Wadi Afu; 35: Wadi el-Ga'ab (Laqiya); 36: Wadi Siru (after Arkell 1949a; Chmielewski 1968; Guichard and Guichard 1968; Marks 1968a; Rose 2004b; Beyin 2006; Crassard 2009; Scott-Jackson et al. *2009; Jagher 2009; Wahida* et al. *2009; Rose* et al. *2011; Callow unpublished manuscript).*

2). Currently Wadi Muqadam is an ephemeral channel and only experiences significant flow following heavy rainfall, which is associated with northward movement of the African monsoon in the northern hemisphere summer. However, during wetter Saharan climate phases the monsoon was enhanced by increased insolation, moving much further north. Thus not only was rainfall higher but the wet season would have been much longer. This increased water supply activated rivers, and there is evidence from nearby Wadi Howar (another Saharan tributary to the Nile that flows into it 230km to the north of our study area) that flow was perennial during the early to middle Holocene (Pachur and Kröpelin 1987; Kuper and Kröpelin 2006):

> [In Lower Wadi Howar] diverse deposits indicate a chain of wadi sections and pools enabling intermittent river activity and overflows of one sheet of water into the next after seasonal or episodic flooding (Kröpelin 2007, 30)

Lakes in northern Sudan were also perennial during this period, suggesting extensive rainfall 800km further north than at present (Abell and Hoelzmann 2000). Pollen records from these lakes indicate that vegetation responded to this ameliorated environment with savanna woodlands dispersing 600km further north in response to the increased rainfall (Ritchie and Haynes 1987). This suggests that during prolonged wetter climate phases, such as the early to middle Holocene and parts of MIS 5, Wadi Muqadam would most likely have experienced perennial flow and the surrounding environment would most likely have been a wooded savanna. Therefore, the palaeohydrology of the wadi responds to climatic changes in the Sahara Desert itself, in marked contrast to the Nile. The archaeological record should reflect this contrast, making the wadi a potentially important location for field survey.

To this end, a study area (Figure 1) was selected to cover the headwaters of Wadi Muqadam (from 15° 10' to 15° 57' N and from 31° 20' to 32° 15' E). This was to the south of the area of Wadi Muqadam covered in the previous SARS survey (Mallinson 1997; 1998). The region includes residual gravel terraces formed as Wadi Muqadam cut down into the Nubian Sandstone bedrock, along with several small (1-4km diameter) palaeolake basins, characterised by flat surfaces with small desiccation cracks, composed of silts and clays. Candidate sites for fieldwalking investigation were identified based on our palaeohydrological interpretation using a combination of multispectral Landsat Enhanced Thematic Mapper (ETM+) imagery, higher spatial resolution Google Earth imagery and digital elevation models (ASTER GDEM and SRTM3). The multispectral ETM+ images were processed to show the distribution of clays and hydrous minerals using band ratio methods (Jackson 1983). In the study area, this method successfully picks out areas which have accumulated clays and, when in conjunction with digital elevation data, can be used to map basins which may have held palaeolakes during previous wetter climate phases. An example of the image products used to find candidate sites in the study area is shown in Figure 3. In addition to palaeolake basins, we also targeted the riparian zone at points along the Wadi Muqadam channel. Previous research has demonstrated that archaeological sites tend to be concentrated in riparian and palaeolake contexts in the Sahara (Reynolds 2006; Drake *et al.* 2011). However, not all sites were identified using satellite interpretations of the palaeohydrology. Whilst evaluating the Google Earth imagery we identified a number of possible tumuli cemeteries that we also investigated. Furthermore, when driving between selected locations we stopped at sites that were remote from any fluvial or lacustrine landforms in order to determine if archaeology was only associated with these features or was more widely distributed across the landscape. In total, 14 candidate sites were surveyed during fieldwork (Figure 1). Sites ND-36-B/9-R-100 and 101, ND-36-B/9-P-100 and ND-36-B/9-U-100 and 101 are in the basin of a palaeochannel that drains east through the Jebel Baroka region into the Nile, and are located immediately to the west of the early–mid Holocene palaeoswamp environment and associated sites mapped by Cremaschi *et al.* (2006).

Reconnaissance fieldwalking surveys were undertaken at these candidate sites, with the archaeological methodology following those of Finlayson and Mithen (2007) in Jordan and Barker *et al.* (2007) in Libya. Artefacts were identified, categorised and photographed in the field, and were not removed from the sites. Flaked lithic artefacts were recorded and classified according to existing technological modes (e.g. Foley and Lahr 2003) and regional industry and artefact types (e.g. Van Peer 1998) to enable comparison with extant records from Sudan (e.g. Arkell 1949a; Marks 1987; Salvatori *et al.* 2011) and regions to the north and north west (e.g. Clark 1980; Van Peer 1991; Foley *et al.* 2013; Scerri 2013) and to the south and south east (e.g. Clark 1988). Pottery decorations were cross-referenced from the field survey's photographic record with identified types in the Wadi Howar and West Nubian Palaeolake regions (Hoelzmann *et al.* 2001; Jesse 2004), the Mesolithic and Neolithic types identified at el-Khiday (Salvatori 2012; Dal Sasso *et al.* 2014), and to the earlier material from Jebel Moya (Caneva 1991; see also Brass and Schwenniger 2013).

Results

The site codes (after Hinkel 1977), settings and geomorphological background for each of the 14 surveyed sites, the

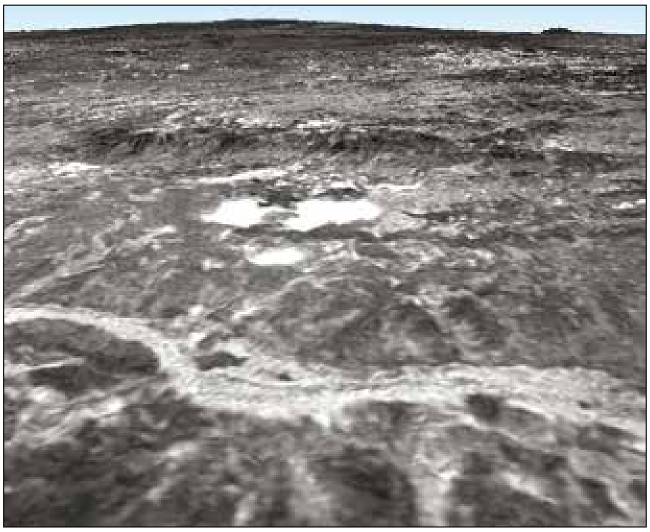

Figure 3. A ratio of ETM+ band 5 divided by band 7, showing clays and carbonates as bright areas, draped over the ASTER GDEM and looking to the north east. The three bright patches in the centre of the image lie in small palaeolake depressions and include our sites ND-36-B/14-P-100 through 103. A 5km reach of Wadi Muqadam can be seen crossing the foreground. This is an example of the image products used to select candidate sites for field survey.

majority of which were located close to fluvial and lacustrine landforms, are summarised in Table 1. The presence/absence of the major artefact categories (lithic and non-lithic) identified at each of the sites through surface reconnaissance is summarised in Table 2. Unmodified blades (typically proximal fragments) and flakes were found at nearly all of the sites, while retouched flake and blade tools, including unifacial and bifacial points, notches, denticulates and scrapers, and cores (Levallois, disc, blade and bladelet) occurred more occasionally. The most frequent period-diagnostic pieces consisted of Levallois cores, flakes and points and unifacial/bifacial points (MSA), and bladelet tools (early Holocene). The flaked lithic technology, therefore, primarily spanned modes 3 (Middle Stone Age/Middle Palaeolithic) and 5 (Microlithic), with the majority of the material assigned to mode 5. Holocene ground stone artefacts included grinding stones, quern stones and stone rings, and were frequently associated with pottery fragments, both with and without surface decoration. Small ostrich eggshell fragments, typically < 30mm, were also infrequently identified, but no other archaeological faunal remains were identified at any of the sites.

3.1 ESA archaeology (mode 2)

A single diagnostic Early Stone Age (ESA) artefact was identified: a thick, cordiform handaxe, associated with a gravel bar of the Wadi Muqadam at site ND-36-B/13-N-101. The handaxe was heavily water rolled, and was undoubtedly derived from an earlier surface. The absence of other ESA technology was notable, particularly in light of the rich Acheulean and Sangoan site of Khor Abu Anga at Omdurman (Arkell 1949a; Figure 2: site 10).

Table 1. Site locations, settings and geomorphology.

Site	Location N	Location E	Description
ND-36-B/9-R-100	15° 34' 08"	32° 07' 42"	**Palaeolake A**: Cluster of small palaeolakes bounded by sand dunes and Nubian Sandstone bedrock outcrops around margins of lakes. Quartzarenite with siliceous cement, and chert, provided source of raw material for artefacts found in vicinity.
ND-36-B/9-R-101	15° 33' 02"	32° 07' 00"	**Gravel Plain**: Relief less than 1m. Composed of weathered fragments of Nubian Sandstone and small outcrops of *in situ* bedrock.
ND-36-B/9-P-100	15° 34' 28"	32° 01' 43"	**Palaeolake B**: Surrounded by aeolian sands, with modern wells on eastern margin and dense vegetation to north, south and east. Little or no archaeology within margins of palaeolake. Fieldwalking beyond eastern margins of lake located outcrops of marl with extensive archaeology in vicinity.
ND-36-B/9-U-100	15° 32' 32"	32° 01' 03"	**Cemetery**: Located on top of small hill of Nubian Sandstone and consisted of area of cairn burials (Figure 5, Plate 7), located using Google Earth prior to fieldwork.
ND-36-B/9-U-101	15°32' 36"	32° 01' 01"	**Quarry**: Chert bedrock outcrop identified that was probable source of artefacts at site ND-36-B/9-U-100.
ND-36-B/14-S-100	15° 19' 25"	31° 55' 54"	**Muqadam Tributary**: Located in headwater tributary of Wadi Muqadam. At this location wadi was large and diffuse. Bedrock outcrops of Nubian Sandstone found on margins of *wadi* and as islands within it. Main channel hard to discern and consisted of series of small basins filled with floodwaters and associated sediments during wet periods, currently the annual monsoon.
ND-36-B/14-S-101	15° 19' 18"	31° 55' 47"	
ND-36-B/9-R-102	15° 33' 52"	32° 07' 00"	
ND-36-B/14-S-102	15° 19' 24"	31° 55' 31"	
ND-36-B/13-T-100	15° 19' 31"	31° 43' 53"	**Wadi Muqadam**: Located along L-shaped transect starting along edge of Wadi Muqadam just upslope of recent strandline of woody debris, then running perpendicular from its edge inland. Site furthest from wadi consisted of weathered Nubian Sandstone bedrock surface comprised of nodular, angular clasts, with material becoming more rounded as *wadi* approached, with variety of different sandstone lithologies represented. Site ND-36-B/13-T-102 located *c.* 20m upslope from edge of channel strandline, whilst site ND-36-B/13-T-100 was 840m upslope.
ND-36-B/13-T-101	15° 19' 17"	31° 43' 41"	
ND-36-B/13-T-102	15° 19' 07"	31° 43' 40"	
ND-36-B/14-P-100	15° 20' 37"	31° 45' 17"	**Palaeolake C**: Clay surface consisting of eroded mud-cracks grading into vegetated zone with surface of trapped aeolian sands leading up to bare hillslopes of Nubian Sandstone bedrock. DEM analysis shows that, when full, palaeolake C would have maximum depth of 8m, with maximum area of 1.34km^2, whereupon it would have over-spilled into Wadi Muqadam.
ND-36-B/14-P-101	15° 20' 24"	31° 45' 10"	
ND-36-B/14-P-102	15° 20' 21"	31° 45' 03"	
ND-36-B/14-P-103	15° 19' 50"	31° 45' 10"	
ND-36-B/13-O-100	15° 22' 27"	31° 42' 50"	**Palaeolake D margin**: Palaeolake D receives runoff predominantly from the west and, when full, has maximum water depth of 7m and area of 12.7km^2. Maximum depth is controlled by overspill channel in north-west that delivers water into Wadi Muqadam. Sites found along transect from margin of palaeolake D to ridges overlooking palaeolake.
ND-36-B/13-O-101	15° 22' 29"	31° 42' 42"	
ND-36-B/13-O-102	15° 22' 33"	31° 42' 39"	
ND-36-B/13-O-103	15° 22' 29"	31° 42' 41"	
ND-36-B/13-O-104	15° 22' 36"	31° 42' 34"	
ND-36-B/13-O-105	15° 22' 43"	31° 42' 27"	
ND-36-B/13-O-106	15° 22' 49"	31° 43' 05"	**Palaeolake D**: Surface consisting of clay/silt with meandering fine gravel ridges running across it (Figure 7). In plan form these appear to represent inverted relief of fluvial channels, bringing clastic material onto palaeolake surface, interpreted as ancient swamp with channels running into it. Inverted relief of alluvial channels and upstanding lithics on lake surface suggests deflation of palaeosurface of over 1m.
ND-36-B/13-N-100	15° 22' 59"	31° 40' 52"	**Wadi Muqadam Transect**: Fieldwalked transect across Wadi Muqadam, starting on east side and crossing large gravel bar. Eastern bank of channel composed of very weathered bedrock. Gravel bar composed of wide range of clast sizes, mostly very fine gravel but in places up to 40-50mm in diameter. All gravel on bar was well rounded and covered by black rock varnish. In contrast to eastern side, western bank of channel composed of gravel. Near channel gravel is well rounded, but further from channel gradually grades into fragments of angular weathered bedrock.
ND-36-B/13-N-101	15° 23' 00"	31° 39' 23"	
ND-36-B/7-C-100	15° 43' 18"	31° 36' 18"	**Wadi Muqadam Tributary**: Headwaters of channel draining into Wadi Muqadam. Site consisted of exposed Nubian Sandstone bedrock surface on margins of *wadi*.
ND-36-B/7-C-101	15° 43' 40"	31° 38' 44"	**Wadi Muqadam Interfluve**: Interfluve between Wadi Muqadam to east and tributary channel to west. High ground consisted of bedrock ridge of sandstone. Low gravel terrace lay between bedrock ridge and contemporary channel.

Table 2. Presence/absence of artefact categories at surface sites identified during Wadi Muqadam Geoarchaeological Survey (April 2013 Season). Diagnostic artefacts/pottery motif styles are named where appropriate. Combinations of ticks and diagnostic type codes indicate the presence of both diagnostic and non-diagnostic artefacts of that general type. 1) Core types. B: Blade; Bl: Bladelet; D: Disc; L: Levallois; MP: Migrating Platform. 2) Flake/blade tool types. D: Denticulate; N: Notch; NB: Notched Blade; Po: Point; Po(F): Bifacial Foliate Point; Po(L): Levallois Point; Po(SL): Pseudo-Levallois Point; Pi: Piercer; S: Scraper. 3) Microlith types. BB: Backed Bladelet; BS: Backed Segment. 4) Core tool types. H: Handaxe. 5) Flake types. L: Levallois. 6) Raw material types. C: Chert; FS: Ferruginous sandstone; Q: Quartzarenite; Qu: Quartz. 7) Pottery decoration types (see text for details). DPZ: Dotted packed zigzag. 8) Burial types. G: Grave; T: Tumulus. Site codes after Hinkel (1977).

Site no.	Flaked lithics						Raw materials[6]	Ground stone lithics				Pottery[7]	Ostrich eggshell	Burials[8]	MSA?
	Cores[1]	Flake/blade tools[2]	Microliths[3]	Core tools[4]	Blades	Flakes[5]		Grinding stones	Quern stones	Stone rings	Stone beads				
ND-36-B/9-R-100	D				✓	✓	C, FS, Q		✓						
ND-36-B/9-R-101	L	Po(L)			✓	✓	C, Q	✓							✓
ND-36-B/9-P-100		Po(SL)	BB		✓	✓	C, FS, Q	✓	✓			✓ (DPZ)		G	✓
ND-36-B/9-U-100					✓	✓	C, FS							T	
ND-36-B/9-U-101	D?	D, N, Pi?, S			✓	✓ (L)	C		✓						✓
ND-36-B/14-S-100 to 102; ND-36-B/9-R-102	✓ (L?)					✓ (L?)	C, FS, Q	✓					✓		✓?
ND-36-B/13-T-100 to 102	✓ (MP, Bl)	D, Po, S	BB		✓	✓	C, FS, Q, Qu	✓	✓						
ND-36-B/14-P-100 to 102	L	D, S	BS			✓	C, FS, Q	✓				✓		T	✓
ND-36-B/14-P-103		D, N, S			✓	✓	C, FS	✓	✓			✓	✓		
ND-36-B/13-O-100 to 105	✓ (Bl)				✓	✓	C, FS, Q	✓			✓	✓			
ND-36-B/13-O-106		Po(F), NB, S			✓		C, Q					✓			✓
ND-36-B/13-N-100 & 101				H		✓	C, FS, Q	✓	✓	✓		✓			
ND-36-B/7-C-100	✓ (B)				✓	✓	C, FS	✓	✓			✓			
ND-36-B/7-C-101		D			✓	✓	C, Q					✓			

3.2 MSA archaeology (mode 3)

The Levallois cores included the classical centripetal flaking method (Van Peer 1991, fig. 3.3; Rose *et al.* 2011, fig. 2; Plate 1), with no evidence of Nubian Core types (Van Peer 1991, fig. 3.1-2) or of other diagnostic MSA artefacts (e.g. Aterian points). While two possible tanged or shouldered pieces were identified (site ND-36-B/13-O-106), these were not diagnostic (particularly in light of Scerri's [2013] argument that MSA tanged tools met a functional requirement and that their widespread appearance across northern Africa reflects technological convergence not a shared tradition). The cores were typically produced on relatively thin, tabular raw materials, and were usually less than 100mm in maximum dimension (length and width). This likely reflects local raw material limitations as well as the size requirements of the Levallois blanks, and is also in-keeping with Levallois flake core shapes and sizes documented previously in Nubia (e.g. Marks 1968a, 209, 222, 246 and figs 12d, 18b). The dorsal scar patterns on the Levallois points (particularly at site ND-36-B/9-P-100; Plate 2) were of the preferential unidirectional-convergent type (Rose *et al.* 2011, fig. 2). Both bifacial and unifacial points were identified, particularly at site ND-36-B/13-O-106 (Plate 3).

While surface collections always carry the potential risk of confusing MSA Levallois for later prehistoric core working techniques (Crassard 2009, 152), it was notable that the Levallois pieces were typically more abraded than other lithic artefacts found at the same sites. While we argue that condition should never be a primary dating tool for surface collections (but *cf.* Hardaker 2011), the association of the most abraded categories with the strongest candidates for diagnostic pieces (a single biface and the prepared core [Levallois] artefacts) was noteworthy in light of their typo-technological interpretation as ESA and MSA artefacts. The disc cores may also have been of MSA age, given the associated presence of Levallois cores and flakes at a number of sites, but it is recognised that they can occur throughout the majority of the African Plio-Pleistocene archaeological record (Barham and Mitchell 2008, 114-115).

The richest occurrence of MSA archaeology was at the palaeolake surface site ND-36-B/13-O-106, where the range of points (bifacial, unifacial and Levallois; Plate 3) would seem likely to reflect animal hunting in this landscape. The geomorphology of this site (Figure 4) includes gravel ridges left by streams that once flowed into the basin, suggesting

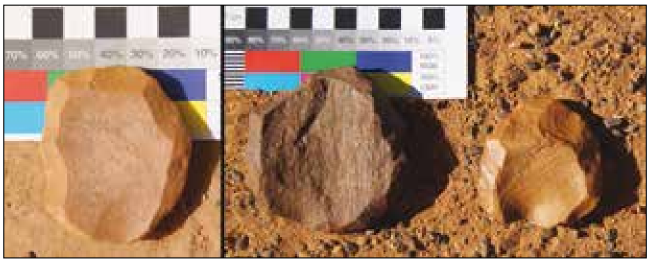

Plate 1. *Levallois cores (site ND-36-B/14-P-101 [left; classical centripetal flaking method; c. 50x60mm] and site ND-36-B/9-R-101 [right]). Scale intervals: 10mm.*

Plate 2. *Levallois and Pseudo-Levallois points (sites ND-36-B/9-R-101 [left] and ND-36-B/9-P-100 [right]). Dorsal view. Scale intervals: 10mm.*

Plate 3. *Bifacial and unifacial points (and offset convergent scraper; bottom-left) of probable MSA age (site ND-36-B/13-O-106). Dorsal view (left) and ventral view (right). Scale intervals: 10mm.*

that this was an important local palaeohydrological feature. These ridges are up to 1m high, up to 4m wide and composed of fine to coarse gravel (2-60mm), overlying the flat silt/clay palaeolake surface. More generally the MSA artefacts were associated primarily, but not exclusively, with palaeolake margins, suggesting some shared landscape preferences with those of the early Holocene hunter-gatherers. Similar associations, between Middle Palaeolithic occupations and Pleistocene lake episodes, were also observed by Wendorf *et al.* (1987) at Bir Tarfawi.

3.3 LSA archaeology

One of the few diagnostic blade cores to be identified was relatively large in size (the three blade scars were each *c.* 20 x 60mm), and was the strongest candidate for a Later Stone Age artefact identified during the survey.

3.4 Terminal Pleistocene/Holocene archaeology (mode 5)

Backed bladelets, bladelet cores and bladelet core rejuvenation flakes were strongly suggestive of a terminal Pleistocene or early Holocene age. Although there were relatively few chronologically diagnostic Holocene lithics, the repeated spatial association of relatively fresh flake cores and unmodified/retouched flakes and blades with pottery and ground stone artefacts was strongly suggestive of Holocene ages for this material. A characteristic range of flake and blade-based retouched tools were identified: scrapers, denticulates, notches, segments and piercers. The most diagnostic piece was a large lunate-shaped 'orange wedge' from site ND-36-B/14-P-100, of likely terminal Pleistocene or early Holocene age (after Marks 1987, fig. 3w and 4p, r and s). Very few complete blades were identified, suggesting their regular snapping and reworking, although other taphonomic factors cannot be ruled out. The general absence of diagnostic blade and bladelet cores was notable given the numbers of blade fragments observed. While limitations in raw material availability may have resulted in the extreme exhaustion of blade/let cores, the casual production of flakes and blades on irregular cores is supported by the nature of those cores which were found. Interestingly a combination of less patterned cores and skilfully made backed tools, using blade-like blanks, was also identified in the earlier Mesolithic phases at el-Khiday (Salvatori *et al.* 2014, 249). The general presence of blades was also noteworthy since Khartoum Mesolithic tools have previously been argued to be predominantly made on flakes, with blade production virtually unknown (Arkell 1949b; Marks 1987; but *cf.* Salvatori *et al.* 2014).

Pottery fragments occurred on over half of the sites (Table 2; Plates 4a-c), although diagnostic pottery was less frequent and the overall character of the pottery samples was suggestive of mixed assemblages. Diagnostic pieces were identified on the basis of surface decoration. It has previously been noted in reference to Sudanese pottery that over-reliance on motif appearance rather than on the tools used to produce them can be problematic (Brass and Schwenniger 2013, 5). However, as it is not possible to identify the full range of those tools, an approach emphasising surface motif appearance can still be useful. The most frequently occurring decorations in our sample were:

Dotted packed zigzag (made with a cord-wrapped implement producing the dashes; Plate 4b);

Criss-cross pattern, combined with undecorated portions (Plate 4c).

Parallels with existing types were not clear-cut, but the dotted packed zigzag pattern may be compared to examples in Arkell (1949b, pls 75-76), Jesse (2004, fig. 3.3; packed

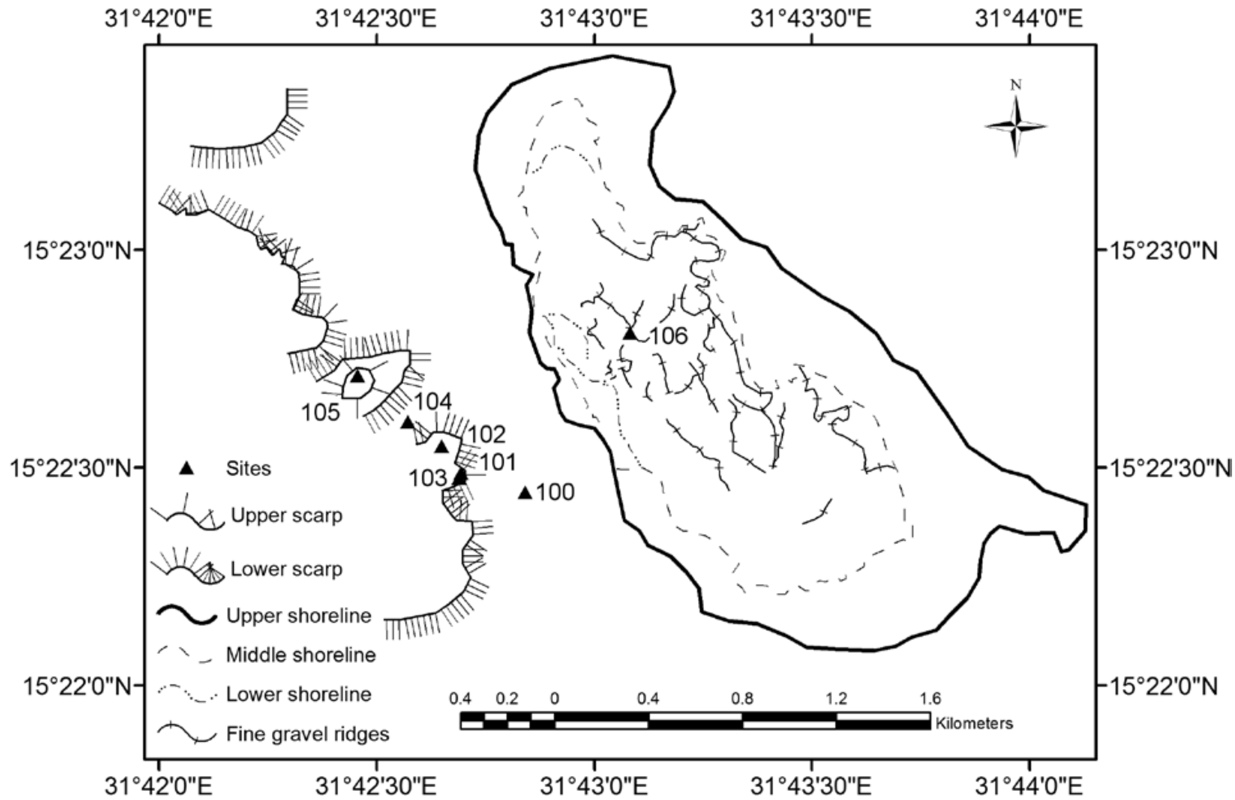

Figure 4. Geomorphological setting of sites ND-36-B/13-O-100 through 105 and ND-36-B/13-O-106, showing the fine gravel ridges within the palaeolake basin (ND-36-B/13-O-106) interpreted as ancient stream channels. All site codes are ND-36-B/13-O-#, with # numbers indicated on the plan.

zigzag, site Dreizack 95/2; Plate 4d), and Salvatori (2012, fig. 16; rocker stamp drop decorations in a fan-like arrangement; Plate 4e). Salvatori (2012, 410-414 and table 1) noted a consistent increase in rocker stamp drop decorations in the second phase of the el-Khiday site 16-D-5 (second and third quarters of the seventh millennium cal. BC), while Jesse (2004) associates the packed zigzag patterns with the Dotted Wavy Line (DWL) and Laqiya Horizon in Wadi Howar (*c.* 5200-4000 BC). However Jesse (2010, 230) has also noted that dotted zigzag patterns and horizontal lines of impressed dots and dashes are ubiquitous in the early Holocene (tenth and ninth millennia BP [eight and seventh millennia cal. BC]) and not suitable for further differentiation.

Stone rings were also identified (Plate 5), along with grinding stone fragments. A small stone bead (Plate 6) was recovered at site ND-36-B/13-O-100, although its association with the other material at the site was uncertain.

Holocene archaeology occurred at all of the surveyed sites. However it was most frequent either on higher ground overlooking palaeolakes, or around palaeolake margins, reflecting the importance of resource (e.g. game) observation and acquisition locations for Holocene hunter-gatherers. It occurred in lower densities on alluvial terraces and along channel margins. This raises the question of whether the apparently lower density of Holocene archaeology in alluvial settings along Wadi Muqadam reflects a genuine behavioural preference for lake-focused occupations, or rather the greater extents of alluvial channel margins: in other words, is a comparable amount of archaeology simply dispersed over a larger geographical area? The higher ground overlooking the channels and palaeolakes was also associated with tumuli of Holocene age, the largest concentration of which was located at site ND-36-B/9-U-100 and contained over 580 tumuli (Figure 5 and Plate 7). The specific chronology of these monuments currently remains unknown. While Salvatori *et al.* (2014, 248) have suggested Post-Meroitic ages for the tumuli cemetery at site 16-C-2, the association of tumuli with older periods, such the Kerma phase in the region of the Fourth and Fifth Cataracts, has also been suggested. Surface artefact finds were typically not distributed within or immediately adjacent to these burials.

Discussion

The identified archaeology suggests favourable environmental conditions along the Wadi Muqadam headwaters in parts of both the early Holocene and the MSA (sub-stages of MIS 5?), as previously suggested further downstream for the early Holocene on the basis of *Tilapia spp.*, *Pila wernei* and *Limicolaria cailliaudi* (Fuller 1998). During these periods hunter-gatherers exploited landscapes associated with both palaeochannels and palaeolakes, though they were not exclusively tied to these water sources, and when found near to palaeohydrological landforms there was an apparent preference for the latter. In these areas, sites were clearly associated with palaeolake

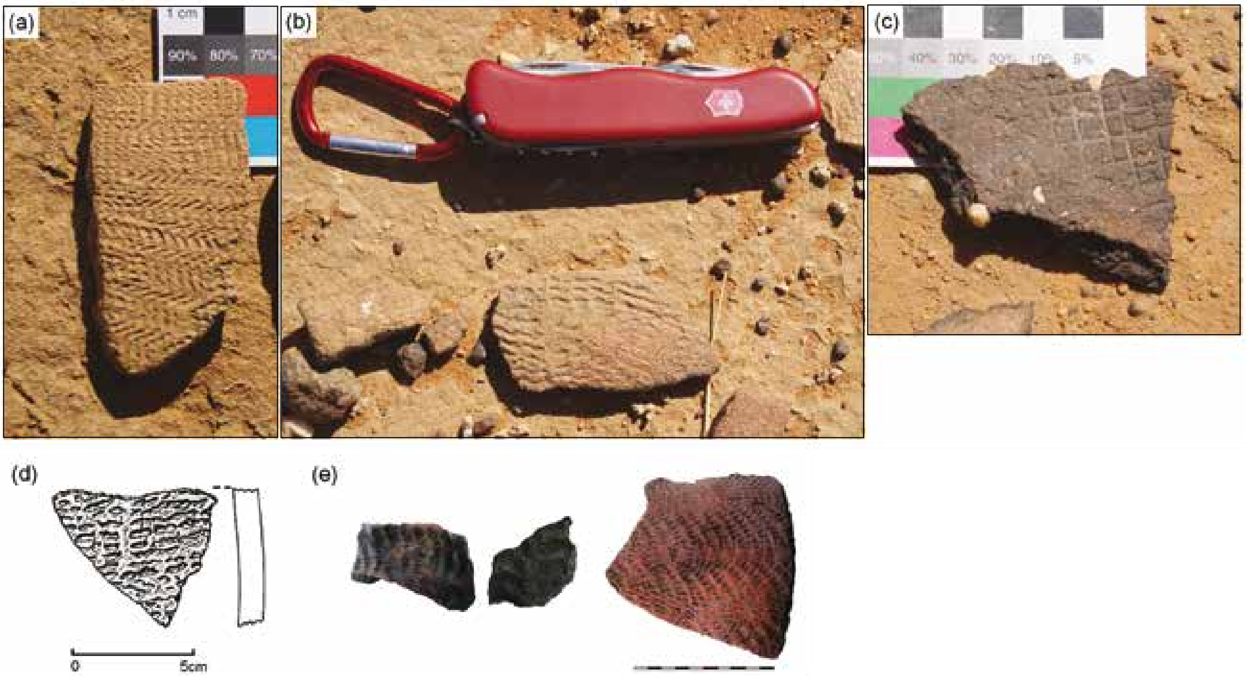

Plate 4. Typical Wadi Muqadam pottery decorations, from site ND-36-B/9-P-100 (a and b) and ND-36-B/13-O-101 (c), with suggested parallels for sherd (b): (d) Packed zigzag, site Dreizack 95/2 (Jesse 2004, fig. 3.3); (e) Rocker stamp drop decorations in a fan-like arrangement (Salvatori 2012, fig. 16). Scale intervals (for a and c): 10mm.

Plate 5. Stone ring fragments (ND-36-B/13-N-100). Scale intervals: 10mm.

Plate 6. Stone bead (site ND-36-B/13-O-100). Scale intervals: 10mm.

margins, being either immediately adjacent, or on higher ground overlooking the palaeolake basins.

With regard to Pleistocene hominin dispersals, the character of the Wadi Muqadam Palaeolithic archaeology permits a preliminary exploration of modern humans and the MSA in central Sudan during the late Middle/Late Pleistocene. The associations of archaeology and palaeolakes clearly demonstrate the scope for living away from the Nile Valley at various different periods (Osborne *et al.* 2008 would suggest MIS 5e and Drake *et al.* 2013 both MIS 5e and 5a, while Armitage *et al.* 2011 have identified wetter phases in southern Arabia in late MIS 6, 5e and 5a). Van Peer (1998, S120) has previously characterised the Middle Palaeolithic record of the Lower Nile Valley and adjacent deserts as consisting of the Nubian complex and the Lower Nile Valley complex (but see also Scerri *et al.*'s [2014, 208] critique of existing nomenclature and definitions of industrial units). The former is characterised by Nubian Core (Levallois) methods of point production (alongside classical Levallois methods of flake manufacture) and by distinctive tool types including bifacial foliates, Nubian endscrapers, Nazlet Khater points and truncated-faceted pieces. By contrast the Lower Nile Valley complex is characterised only by Classical Levallois methods, with point-production methods unknown. Van Peer (1998, S115) also notes that from MIS 5e onwards the Nubian complex is found beyond the Nile Valley, in contrast to the Lower Nile Valley complex which remains, as its name

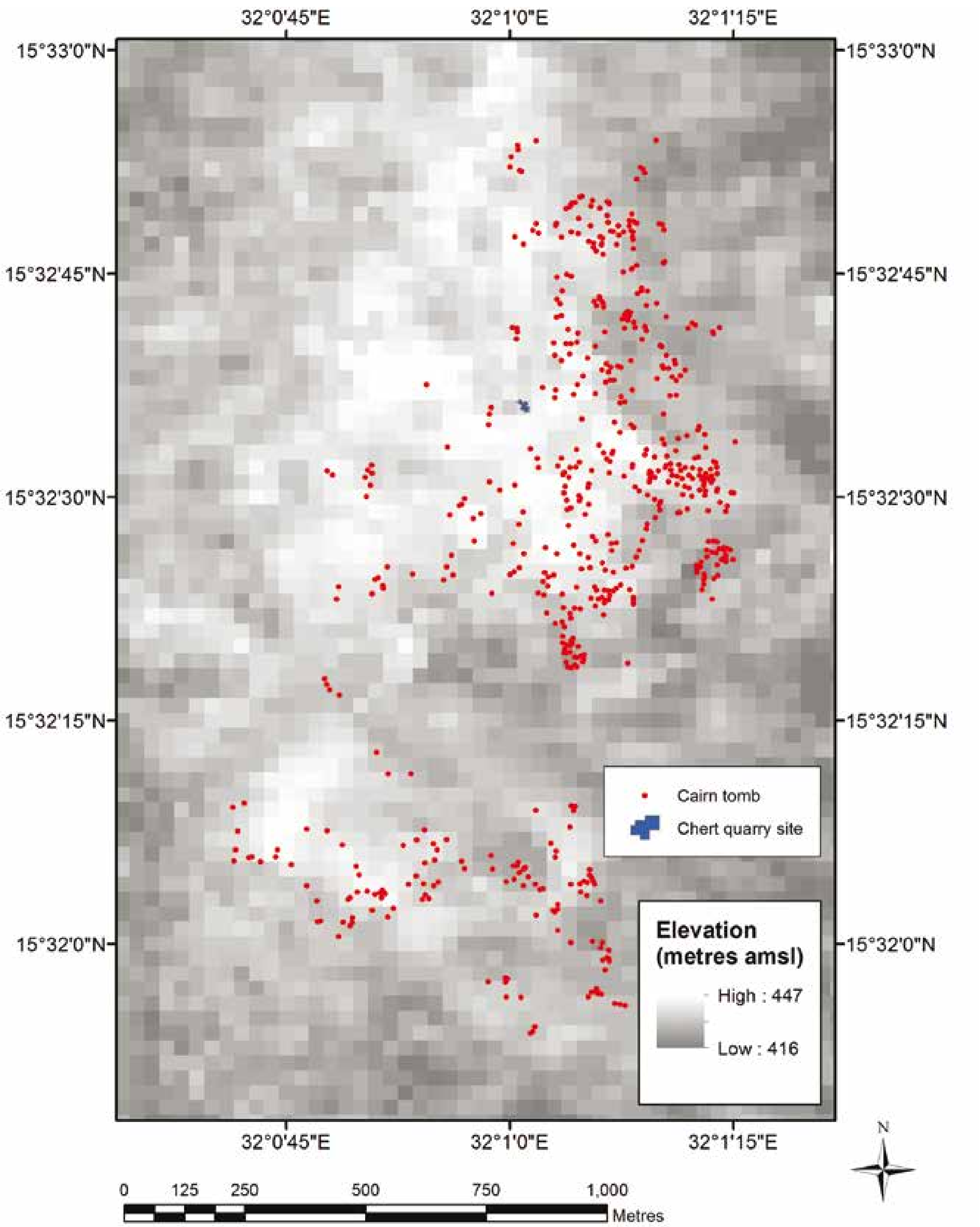

Figure 5. Site ND-36-B/9-U-100, with tumuli marked as red points and the chert quarry site shown in blue, plotted over the ASTER GDEM to show elevation, with higher areas shown as brighter cells. Tumuli were mapped from Google Earth.

suggests, restricted to the river valley. By contrast the Nile record in central Sudan has a more limited later MSA record, with Arkell (1949a) primarily documenting Acheulean (ESA) and Tumbian (= Sangoan; late ESA/early MSA) material. However Van Peer *et al.* (2003) recorded Lupemban-related Nubian Complex material (overlying inter-stratified Acheulean and Sangoan assemblages) at Sai Island, while Osypiński *et al.* (2011) identified Middle Palaeolithic-type material at

Plate 7. View of tumuli (site ND-36-B/9-U-100).

technological convergence (e.g. Will *et al.* 2015). The apparent paucity of ESA material (e.g. Acheulean and Sangoan) along Wadi Muqadam, in contrast to sites along the Nile of central Sudan (Arkell 1949a) and along the lower Atbara River (Nassr 2014), might also suggest different settlement histories in central Sudan between the ESA (Nile and Atbara-focused?) and the MSA (extending into the Sahara, as represented by Wadi Muqadam?).

Affad 23. Nassr (2014) has also reported MSA material along the lower Atbara River. Finally Rose (2004b, 205) has argued that the Middle Palaeolithic (= MSA) industries of Sudan (e.g. the Nile-focused sites reported by Marks 1968a, b) are, with the exception of Station One, distinct from those of Kenya and Ethiopia. The exception of Station One is based on the presence of small bifacial foliates and ovates with flat, invasive retouch which (along with small unifacial points, sidescrapers and naturally-backed crescents) are argued to be reminiscent of East African late MSA sites (Rose 2004b, 211). This led Rose to conclude that:

> With the exception of Station One, eastern Sahara, and Sai Island assemblages, there is no compelling archaeological evidence demonstrating an early Upper Pleistocene movement of anatomically modern humans northward through the Nile Valley.
> (Rose 2004b, 212)

Does our material from Wadi Muqadam support or challenge this picture? The MSA samples are reminiscent of the Lower Nile Valley complex (and the occasional finds from the University of Khartoum's archaeological expedition to the Middle Nile Valley; Callow, unpub. man.) in terms of Levallois core types. There is an absence of Van Peer's (1998) distinctive Nubian Complex elements, which have also been characterised by Scerri (2013, table 6; Scerri *et al.* 2014, table 1) at Kharga Oasis, Sai Island and BT-14 (e.g. Nubian point methods and long thin bifacial foliates; e.g. Scerri 2013, fig. 3). Specifically in terms of core reduction, the absence of Nubian Type cores might be suggestive of limited connections between the Wadi Muqadam region and northern Sudan/southern Egypt (following Rose 2004b). However caution should be exercised in the use of single Palaeolithic artefact types to infer diffusion or dispersal, rather than

Although unifacial and bifacial points were identified in selected Wadi Muqadam sites, these were not as diagnostic as the bifacial foliates demonstrated at a small number of other locations in northern Sudan (e.g. Rose 2004b, fig. 6a; Scerri 2013, fig. 3; Figure 2). While the distinctive Station One artefacts (Rose 2004b) have been linked to the sub-Saharan MSA of Kenya and Ethiopia (Clark 1988, fig. 6; Rose 2004b; Beyin 2006), unifacial and bifacial points occur elsewhere across northern Africa (e.g. at Arkin 5 near the Sudan/Egypt border; Chmielewski 1968), and it is thus difficult to evaluate either northern or southern connections on the basis of the Wadi Muqadam examples. Their occurrence on sites along the wadi does, however, suggest hominin range expansion into currently arid landscapes during mesic environmental episodes (see also Rose's [2004b, 213] discussion of bifacial foliates in Oman).

Detailed chronological evidence for our Holocene material was limited, reflecting the surface character of the archaeology, the narrow range of pottery surface decorations and paucity of parallels with well-dated types, and the lack of stratified deposits. The dotted packed zigzag pattern might suggest occupations from the seventh millennium (in light of the el-Khiday dates from site 16-D-5; Salvatori 2012) through to the fifth millennium cal BC (in light of the dates for the Dotted Wavy Line and Laqiya Horizon in Wadi Howar; Jesse 2004), but these should be treated with caution. Nonetheless the character of the lithic cores and the backed tools and the presence of grinding stones and stone rings, combined with those packed zigzag pattern decorations, also suggest an earlier Holocene (Mesolithic) presence in light of the dated sequences from the el-Khiday sites (Salvatori *et al.* 2011; Salvatori 2012) and the Wadi Howar region (Keding 2006).

It is perhaps noteworthy that dates for the DWL and Laqiya horizons in the Wadi Howar, spanning the late sixth and fifth millennium BC (after Hoelzmann *et al.* 2001, 206–207 and fig. 11; Jesse 2004), are slightly younger than the dates for the second phase at el-Khiday site 16-D-5, although the lack of stratified sites thus far in our Wadi Muqadam survey do not permit an assessment of whether western or eastern (or both) connections are present. Nonetheless the apparent absence of later pottery styles such as the Leiterband and Halbmond-Leiterband (Jesse and Keding 2007) in our newly identified sites is potentially noteworthy since Hoelzmann *et al.* (2001) associate those pottery phases with increasing aridity in the western Nubian palaeolake environment, prior to abandonment of the area. Jesse and Keding (2007) note that perennial water sources become more restricted throughout the Wadi Howar region as a whole during the Leiterband and Halbmond-Leiterband phase, although savannah-type vegetation persists, prior to the increasing aridity of the third millennium cal BC (associated with geometric patterns and mat-impression pottery). This raises the interesting possibility of a different palaeoclimatic regime in Wadi Muqadam, perhaps a more rapid onset of arid conditions? However such an interpretation must remain speculative prior to further fieldwork.

The co-occurrence of pottery, grindstones (wild plant food exploitation; Keding 2006) and flaked stone artefacts on the majority of Wadi Muqadam sites (Table 2), and their greater frequency on higher ground overlooking palaeolakes or around palaeolake margins, is in-keeping with Jesse and Keding (2007), who associated the Dotted Wavy-Line pottery phase with hunter-fisher-gatherer subsistence patterns and a sedentary or semi-sedentary existence close to watering places. This is also in-keeping with Salvatori's (2012) more general characterisation of the Khartoum Mesolithic as a pottery-producing hunter/gatherer/fisher occupation along the Nile Valley (see also Arkell 1949b).

In terms of both periods, the mixture of early/mid Holocene and MSA archaeology in Wadi Muqadam is comparable to the recently reported Middle Palaeolithic and Neolithic sites associated with the Mundafan palaeolake in southern Saudi Arabia (Crassard *et al.* 2013). The Mundafan Middle Palaeolithic assemblages have been suggested to date to wet periods of MIS 5, and to reflect a lacustrine adaptive focus in Arabia. It is possible that site ND-36-B/13-O-106 in Wadi Muqadam represents a glimpse of a comparable strategy in Sudan.

The preliminary fieldwork conducted to date has also highlighted future research questions and aims, in particular:

(i) extending the survey westwards into, e.g. Wadi el-Malik, to test evidence for changing archaeological signatures on a wadi-specific and/or east–west transect pattern;

(ii) conducting further systematic surveys at the sites identified in Wadi Muqadam to date, map and quantify artefact distributions;

(iii) coring palaeolake sediments to assess chronology and palaeoenvironmental conditions.

Conclusions

The fieldwork reported here has made a first tentative step towards meeting current gaps in knowledge regarding both Pleistocene and early Holocene hunter-gatherer occupations of the currently arid environments of northern Africa (Drake *et al.* 2011; Groucutt and Blinkhorn 2013). The detection of MSA archaeology along Wadi Muqadam indicates the presence of hominins, presumably early modern humans, in regions of central Sudan beyond the main Nile Valley during a key period. These regions are to the west of the Bab-el-Mandeb Straits, and the chronological and spatial relationships with possible dispersals into Arabia and the Levant and/or across the Sahara are currently unknown. The rich Holocene record in Wadi Muqadam similarly demonstrates that the area's resources supported Mesolithic hunter/gatherer/fisher occupations, with a comparable archaeological signature to the Wadi Howar region (Keding 2006), although the specific chronology cannot yet be resolved in terms of the regional context. For both periods, the demonstrated presence and distribution of archaeologically important palaeolakes, in particular, along Wadi Muqadam suggests a hydrological landscape in which, during favourable environmental conditions, a relatively stable hominin settlement would be feasible. Such contexts, alongside the MIS 5 riparian corridors and savannah grasslands mapped by Scerri *et al.* (2014, fig. 2) across north Africa, provide support for Green Saharan dispersal models, and for routes not tethered to major perennial rivers such as the Nile.

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Bibliography

Abell, P. I. and P. Hoelzmann 2000. 'Holocene palaeoclimates in northwestern Sudan: stable isotope studies on molluscs', *Global and Planetary Change* 26(1), 1-12.

Arkell, A. J. 1949a. *The Old Stone Age in the Anglo-Egyptian Sudan*. Sudan Antiquities Service Occasional Papers No. 1. Khartoum.

Arkell, A. J. 1949b. *Early Khartoum*. London.

Armitage, S. J., S. A. Jasim, A. E. Marks, A. G. Parker, V. I. Usik and H. E. Uerpmann 2011. 'The Southern Route "Out of Africa": Evidence for an Early Expansion of Modern Humans into Arabia', *Science* 331, 453-456.

Bailey, G. 2009. 'The Red Sea, Coastal Landscapes, and Hominin Dispersals', in M. Petraglia and J. Rose (eds), *The Evolution of Human Populations in Arabia*. Dordrecht, 15-37.

Barham, L. and P. Mitchell 2008. *The First Africans: African Archaeology from the Earliest Tool Makers to Most Recent Foragers*. Cambridge.

Barker, G., C. Hunt and T. Reynolds 2007. 'The Haua Fteah, Cyrenaica (Northeast Libya): renewed investigations of the cave and its landscape, 2007', *Libyan Studies* 38, 97-114.

Beyin, A. 2006. 'The Bab al Mandab vs the Nile-Levant: An Appraisal of the Two Dispersal Routes for Early Modern Humans Out of Africa', *The African Archaeological Review* 23(1/2), 5-30.

Brass, M. and J-L. Schwenniger 2013. 'Jebel Moya (Sudan): new dates from a mortuary complex at the southern Meroitic frontier', *Azania: Archaeological Research in Africa* 48(4), 455-472.

Callow, P. Unpub. Man. *University of Khartoum Archaeological Expedition to Middle Nile Region (West Bank). P. Callow, December 1977. Field Diary.*

Caneva, I. 1991. 'Jebel Moya revisited: a settlement of the 5th millennium BC in the middle Nile Basin', *Antiquity* 65(247), 262-268.

Chmielewski, W. 1968. 'Early and Middle Palaeolithic Sites near Arkin, Sudan', in Wendorf (ed.) 1968, 110-147.

Clark, J. D. 1980. 'Human populations and cultural adaptations in the Sahara and Nile during prehistoric times', in M. A. J. Williams and H. Faure (eds). *The Sahara and the Nile*. Rotterdam, 527-582.

Clark, J. D. 1988. 'Middle Stone Age of East Africa and the beginnings of regional identity', *Journal of World Prehistory* 2, 235-305.

Clark, J. D. 1992. 'African and Asian Perspectives on the Origins of Modern Humans', *Philosophical Transactions of the Royal Society of London Series B (Biological Sciences)* 337, 201-215.

Crassard, R. 2009. 'The Middle Palaeolithic of Arabia: The View from the Hadramawt Region, Yemen', in M. Petraglia and J. Rose (eds), *The Evolution of Human Populations in Arabia*. Dordrecht, 151-168.

Crassard, R., M. D. Petraglia, N. A. Drake, P. Breeze, B. Gratuze, A. Alsharekh, M. Arbach, H., S. Groucutt, L. Khalidi, N. Michelsen, C. J. Robin and J. Schiettecatte, 2013. 'Middle Palaeolithic and Neolithic Occupations around Mundafan Palaeolake, Saudi Arabia: Implications for Climate Change and Human Dispersals', *PLoS ONE* 8(7), e69665.

Cremaschi, M., S. Salvatori, D. Usai and A. Zerboni 2006. 'A further "tessera" to the huge "mosaic": studying the ancient settlement pattern of the El Salha region (south-west of Omdurman, Central Sudan)', in K. Kroeper, M. Chlodnicki and M. Kobusiewicz (eds), *Archaeology of the Early Northeastern Africa*. Poznań, 39-48.

Dal Sasso, G., L. Maritan, S. Salvatori, C. Mazzoli and G. Artioli 2014. 'Discriminating pottery production by image analysis: a case study of Mesolithic and Neolithic pottery from Al Khiday (Khartoum, Sudan)', *Journal of Archaeological Science* 46, 125-143.

Drake, N. A., R. M. Blench, S. J. Armitage, C. S. Bristow and K. H. White 2011. 'Ancient watercourses and biogeography of the Sahara explain the peopling of the desert', *Proceedings of the National Academy of Sciences* 108(2), 458-462.

Drake, N. A., P. Breeze and A. Parker 2013. 'Palaeoclimate in the Saharan and Arabian Deserts during the Middle Palaeolithic and the potential for hominin dispersals', *Quaternary International* 300, 48-61.

Finlayson, B. and S. J. Mithen 2007. *The Early Prehistory of Wadi Faynan, Southern Jordan: Archaeological Survey of Wadis Faynan, Ghuwayr and Al Bustan and Evaluation of the Pre-Pottery Neolithic A Site of WF16*. Oxford.

Foley, R. and M. Lahr 2003. 'On Stony Ground: Lithic Technology, Human Evolution, and the Emergence of Culture', *Evolutionary Anthropology* 12, 109-122.

Foley, R. A., J. M. Maíllo-Fernández and M. M. Lahr 2013. 'The Middle Stone Age of the Central Sahara: Biogeographical opportunities and technological strategies in later human evolution', *Quaternary International* 300, 153-170.

Fuller, D. Q 1998. 'Palaeoecology of the Wadi Muqaddam: a preliminary report on the significance of the plant and animal remains', *Sudan & Nubia: Bulletin of the Sudan Archaeological Research Society* 1, 52-60.

Gamble, C. S. 1993. *Timewalkers: the prehistory of global colonisation*. Stroud.

Groucutt, H. S. and J. Blinkhorn 2013. 'The Middle Palaeolithic in the desert and its implications for understanding hominin adaptation and dispersal', *Quaternary International* 300, 1-12.

Guichard, J. and G. Guichard 1968. 'Contributions to the study of the Early and Middle Palaeolithic of Nubia', in Wendorf (ed.) 1968, 148-193.

Hardaker, T. 2011. *New Approaches to the Study of Surface Palaeolithic Artefacts: A pilot project at Zebra River, Western Namibia*. Oxford.

Hinkel, F. 1977. *The archaeological map of the Sudan: a guide to its use and explanation of its principles*. Berlin.

Hoelzmann, P., B. Keding, H. Berke, S. Kröpelin and H.-J. Kruse 2001. 'Environmental change and archaeology: lake evolution and human occupation in the Eastern Sahara during the Holocene', *Palaeogeography, Palaeoclimatology, Palaeoecology* 169, 193-217.

Idris, G. 1994. *Die Altsteinzeit im Sudan*. Bonn.

Jackson, R. D. 1983. 'Spectral indices in n-space', *Remote Sensing of Environment* 13, 409-421.

Jagher, R. 2009. 'The Central Oman Palaeolithic Survey: Recent Research in Southern Arabia and Reflection on the Prehistoric Evidence', in M. Petraglia and J. Rose (eds), *The Evolution of Human Populations in Arabia*. Dordrecht, 139-150.

Jesse, F. 2004. 'The development of pottery design styles in the Wadi Howard Region (northern Sudan)', *Préhistoires Méditerranéennes* 13, http://pm.revues.org/129

Jesse, F. 2010. 'Early Pottery in Northern Africa — an Overview', *Journal of African Archaeology* 8(2), 219-238.

Jesse, F. and B. Keding. 2007. 'Holocene Settlement Dynamics in the Wadi Howar Region (Northern Sudan) and the Ennedi Mountains (Chad)', in O. Bubenzer, A. Bolten and F. Darius (eds), *Atlas of Cultural and Environmental Change in Arid Africa*. Köln, 42-43.

Keding, B. 2006. 'Were the hunter-gatherers in the Eastern Sahara of the "delayed return" type? An archaeological perspective from the Wadi Howar region/Sudan', in I. Caneva and A. Roccati (eds), *Acta Nubica. Proceedings of the X International Conference of Nubian Studies, Rome 9–14 September 2002*. Rome, 81-94.

Kröpelin, S. 2007. 'Wadi Howar: Climate change and human occupation in the Sudanese desert during the past 11,000 years', in P. G. Hopkins (ed.), *The Kenana Handbook of Sudan*. London, 17-38.

Kuper, R. and S. Kröpelin 2006. 'Climate-controlled Holocene occupation in the Sahara: motor of Africa's evolution', *Science* 313(5788), 803-807.

Mallinson, M. 1997. 'Preliminary report: SARS Survey from Omdurman to Gabolab 1997', *Sudan & Nubia* 1, 30-33.

Mallinson, M. 1998. 'SARS Survey from Omdurman to Gabolab 1997: The survey', *Sudan & Nubia* 2, 42-45.

Marks, A. E. 1968a. 'The Mousterian industries of Nubia', in Wendorf (ed.) 1968, 194-314.

Marks, A. E. 1968b. 'The Khormusan: an Upper Pleistocene Industry in Sudanese Nubia', in Wendorf (ed.) 1968, 315-391.

Marks, A. E. 1968c. 'The Halfan Industry', in Wendorf (ed.) 1968, 392-460.

Marks, A. E. 1987. 'Terminal Pleistocene and Holocene Hunters and Gatherers in the Eastern Sudan', *The African Archaeological Review* 5, 79-92.

Marks, A.E. 1990. 'The Middle and Upper Palaeolithic of the Near East and the Nile Valley: the problem of cultural transformations', in P. Mellars (ed.), *The Emergence of Modern Humans: An Archaeological Perspective*. Edinburgh, 56-80.

McDermott, F., R. Grün, C. T. Williams, V. K. Din and C. J. Hawkesworth 1996. 'New Late-Pleistocene Uranium-Thorium and ESR dates for the Singa hominid (Sudan)', *Journal of Human Evolution* 31, 507-516.

Nassr, A. H. 2014. 'Large Cutting Tools Variations of Early Sudan Paleolithic from the Site of Jebel Elgrain East of Lower Atbara River', *Der antike Sudan* 25, 105-121.

Osborne, A. H., D. Vance, E. J. Rohling, N. Barton, M. Rogerson and N. Fello 2008. 'A humid corridor across the Sahara for the migration of early modern humans out of Africa 120,000 years ago', *Proceedings of the National Academy of Sciences* 105(43), 16444-16447.

Osypiński, P., M. Osypińska and A. Gautier 2011. 'Affad 23, a Late Middle Palaeolithic Site with Refitted Lithics and Animal Remains in the Southern Dongola Reach, Sudan', *Journal of African Archaeology* 9(2), 177-188.

Pachur, H. N. and S. Kröpelin 1987. 'Wadi Howar: Paleoclimatic evidence from an extinct river system in the Southeastern Sahara', *Science* 237, 298-300.

Reynolds, T. 2006. 'The Importance of Saharan Lithic Assemblages', in D. Mattingly, S. McLaren, E. Savage, Y. al-Fasatwi and K. Gadgood (eds), *The Libyan Desert. Natural Resources and Cultural Heritage*. London, 81-90.

Ritchie, J. C. and C. V. Haynes 1987. 'Holocene vegetation zonation in the eastern Sahara', *Nature* 330(6149), 645-647.

Rose, J. I. 2004a. 'The Question of Upper Pleistocene Connections between East Africa and South Arabia', *Current Anthropology* 45(4), 551-555.

Rose, J. I. 2004b. 'New Evidence for the Expansion of an Upper Pleistocene Population out of East Africa, from the Site of Station One, Northern Sudan', *Cambridge Archaeological Journal* 14, 205-216.

Rose, J. I., V. I. Usik, A. E. Marks, Y. H. Hilbert, C. S. Galletti, A. Parton, J. M. Geiling, V. Černý, M. W. Morley and R. G. Roberts 2011. 'The Nubian Complex of Dhofar, Oman: An African Middle Stone Age Industry in Southern Arabia', *PLoS ONE* 6(11), e28239.

Salvatori, S. 2012. 'Disclosing Archaeological Complexity of the Khartoum Mesolithic: New Data at the Site and Regional Level', *The African Archaeological Review* 29(4), 399-472.

Salvatori, S., D. Usai and A. Zerboni 2011. 'Mesolithic Site Formation and Palaeoenvironment along the White Nile (Central Sudan)', *The African Archaeological Review* 28(3), 177-211.

Salvatori, S., D. Usai, M. F. Abdelrahman, A. Di Matteo, P. Iacumin, V. Linseele and M. K. Magzoub 2014. 'Archaeology at el-Khiday: New Insight on the Prehistory and History of Central Sudan', in J. R. Anderson and D. A. Welsby (eds), *The Fourth Cataract and Beyond: Proceedings of the 12th International Conference for Nubian Studies*. Leuven – Paris – Walpole, MA, 243-258.

Scerri, E. 2013. 'The Aterian and its place in the North African Middle Stone Age', *Quaternary International* 300, 111-130.

Scerri, E. M. L., N. A. Drake, R. Jennings and H. S. Groucutt 2014. 'Earliest evidence for the structure of *Homo sapiens* populations in Africa', *Quaternary Science Reviews* 101, 207-216.

Scott-Jackson, J., W. Scott-Jackson and J. I. Rose 2009. 'Palaeolithic Stone Tool Assemblages from Sharjah and Ras al Khaimah in the United Arab Emirates', in M. Petraglia and J. Rose (eds), *The Evolution of Human Populations in Arabia*. Dordrecht, 125-138.

Smith, L. M. V. 1998. 'Pottery and small finds', *Sudan & Nubia* 1, 45-52.

Stringer, C. 2000. 'Palaeoanthropology: coasting out of Africa', *Nature* 405(6782), 24-27.

Usai, D. and S. Salvatori 2005. 'The IsIAO Archaeological Project in the El Salha Area (Omdurman South, Sudan): Results and Perspectives', *Africa* 60(3-4), 474-493.

Van Peer, P. 1991. 'Inter-assemblage variability and Levallois Styles: The Case of the Northern African Middle Palaeolithic', *Journal of Anthropological Archaeology* 10, 107-151.

Van Peer, P. 1998. 'The Nile Corridor and the Out-of-Africa Model', *Current Anthropology* 39(S1), S115-S140.

Van Peer, P. and P. Vermeersch 1990. 'Middle to Upper Palaeolithic Transition: The Evidence for the Nile Valley', in P. Mellars and C. Stringer (eds), *The Emergence of Modern Humans: An Archaeological Perspective*. Edinburgh, 139-159.

Van Peer, P., R. Fullagar, S. Stokes, R. M. Bailey, J. Moeyersons, F. Steenhoudt, A. Geerts, T. Vanderbeken, M. De Dapper and F. Geus 2003. 'The Early to Middle Stone Age Transition and the Emergence of Modern Human Behaviour at site 8-B-11, Sai Island, Sudan', *Journal of Human Evolution* 45, 187-193.

Vermeersch, P. 2001. ''Out of Africa' from an Egyptian point of view', *Quaternary International* 75(1), 103-112.

Wahida, G., W. Yasin Al-Tikriti, M. J. Beech and A. Al Meqbali 2009. 'A Middle Palaeolithic Assemblage from Jebel Barakah, Coastal Abu Dhabi Emirate', in M. Petraglia and J. Rose (eds), *The Evolution of Human Populations in Arabia*. Dordrecht, 117-124.

Wendorf, F. (ed.) 1968. *The Prehistory of Nubia: Volume One*. Dallas.

Wendorf, F., A. E. Close and R. Schild 1987. 'Recent Work on the Middle Palaeolithic of the Eastern Sahara', *The African Archaeological Review* 5, 49-63.

Will, M, A. Mackay and N. Phillips 2015. 'Implications of Nubian-like core reduction systems in southern Africa for the identification of early modern human dispersals', *PLoS ONE* 10(6), e0131824.

Woodward, A. S. 1938. 'A fossil skull of an ancestral Bushman from the Anglo-Egyptian Sudan', *Antiquity* 12(46), 190-195.

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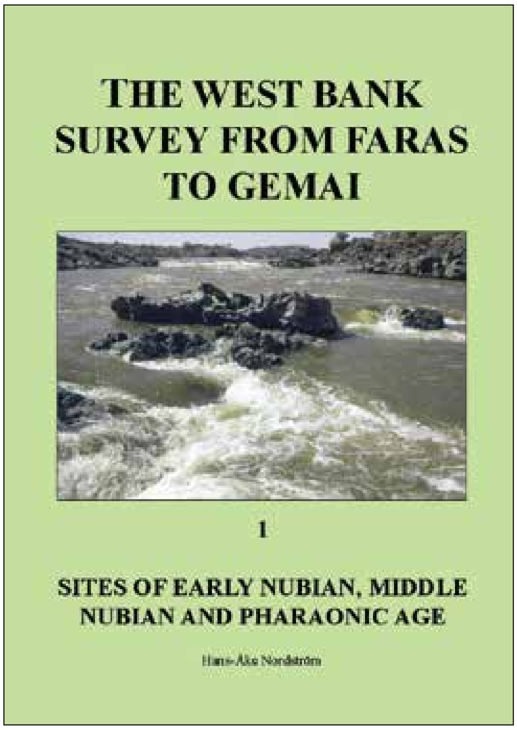

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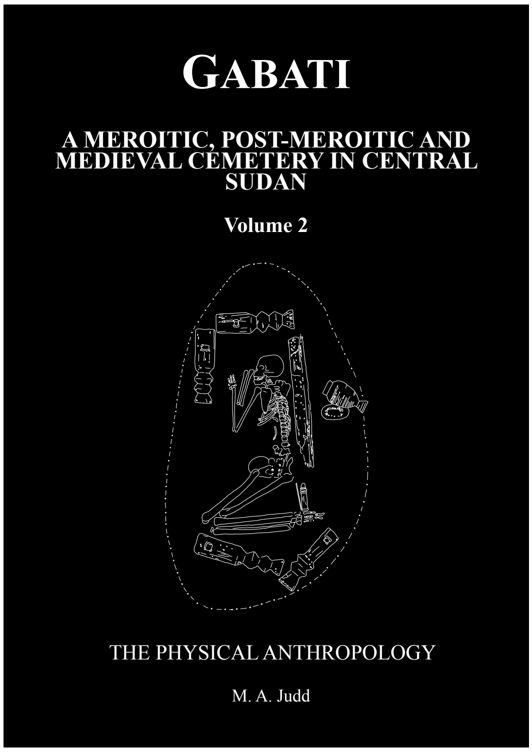

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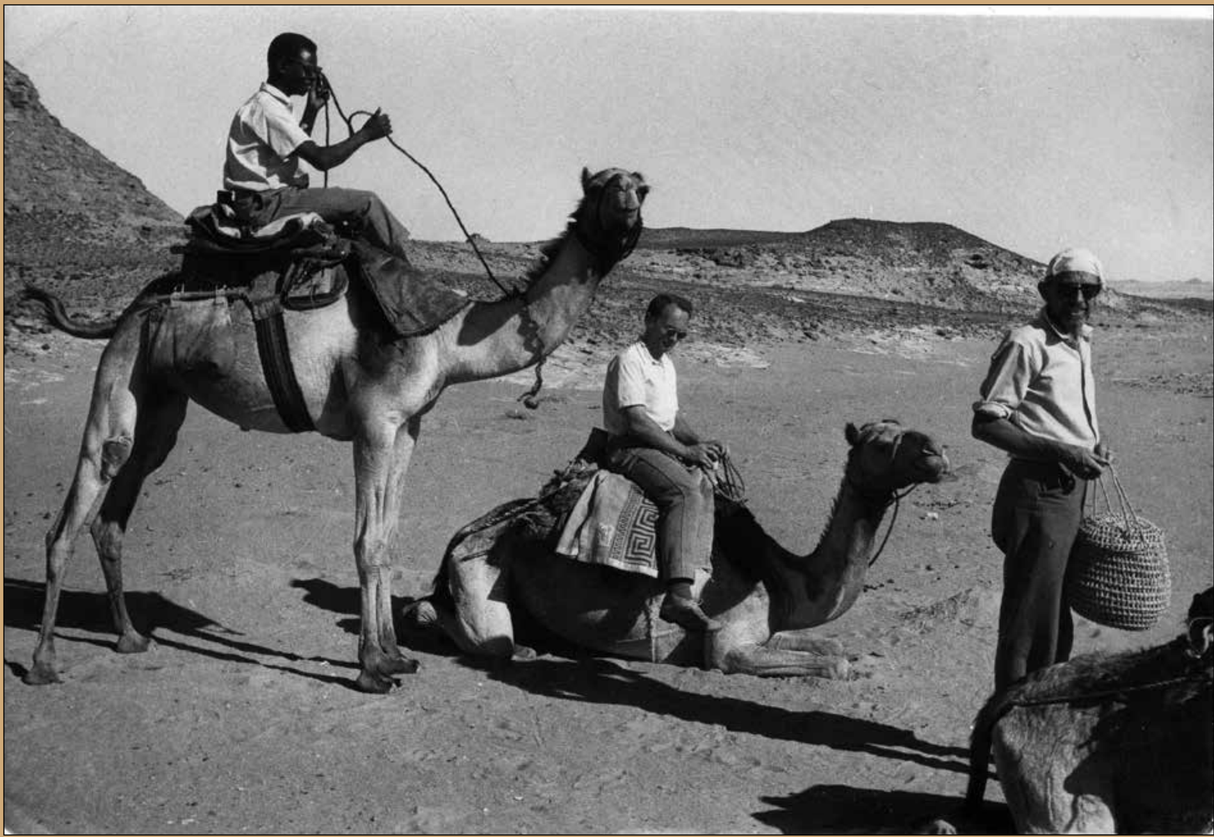
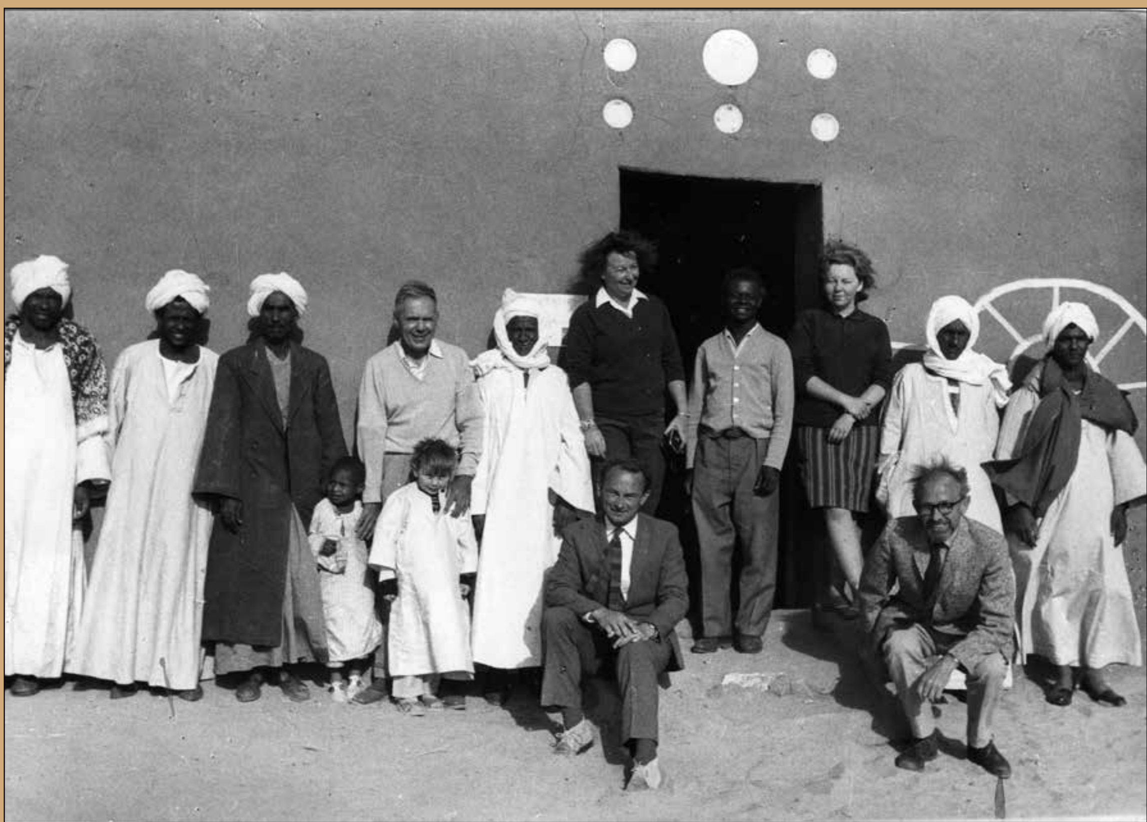


Members of the University of Ghana Expedition to Sudan. John Alexander (centre), James Anquandah (left), Tony Bonner (right) (photo: SARS Alexander Archive, ALE P003.05).



The Debeira West excavation team 1964 with amongst others, Peter and Margaret Shinnie, John Alexander, John Anquandah and Tony Bonner (photo: SARS Alexander Archive, ALE P003.04).

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