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Pastoral nomadic communities of the Holocene climatic optimum: excavation and research at Kharimat Khor al-Manāhil and Khor al-Manāhil in the Rub^c al-Khālī, Abu Dhabi

Richard Cuttler, Mark Beech, Heiko Kallweit, Anja Zander & Walid Yasin al-Tikriti

Summary

Survey work in 2004 identified two extensive lithics scatters in the south-eastern desert of Abu Dhabi at Umm az-Zumūl. Both scatters were within small interdunal areas to the south-east of large barchan dunes. At the first site (Khor al-Manāhil) a controlled pick-up of lithics recorded almost 3000 fragments of flint and stone artefacts. The typology of the artefacts suggests the scatter belongs to the so-called Arabian Bifacial Tradition (ABT). This dates the scatter to the mid-Holocene, between the seventh and fifth millennia, when the climate was wetter and the conditions more favourable. A series of undated "burnt mounds" at Khor al-Manāhil was also recorded and excavated.

The second scatter (Kharimat Khor al-Manāhil) was again comprised of flints belonging to the Arabian Bifacial Tradition. OSL dating suggested that these must date later than 9000 years ago. Two shell beads, found in association with the flint scatter resemble types well known from the Neolithic cemetery of Jebel al-Buhais 18, located in Sharjah emirate in the UAE.

Keywords: UAE; Neolithic; lithic assemblage; Arabia; archaeology

Introduction

Between 9000 and 6000 years ago many desert areas experienced a higher rainfall, described within the Arabian Peninsula as the "Climatic Optimum" (Parker, Davies & Wilkinson 2006). This paper examines new evidence about the pastoral nomadic communities during this period, with reference in particular to flint debitage collected from two sites within the north-eastern corner of the "Rub^c al-Khālī" or Empty Quarter in the south-eastern desert of Abu Dhabi in the United Arab Emirates. Survey and excavation undertaken over three seasons also included Optical Stimulated Luminescence dating on deposits above and below these flint horizons. The sites, Kharimat Khor al-Manāhil and Khor al-Manāhil, are located within 7 km of each other in the Umm az-Zumūl region, close to the border with Oman and Saudi Arabia (Fig. 1). These were first examined as part of a joint project by the Abu Dhabi Islands Archaeological Survey (ADIAS) and the Department of Antiquities and Tourism in Abu Dhabi's Eastern Region, now both absorbed by the Abu Dhabi Authority for Culture and Heritage (ADACH).

The Umm az-Zumūl region is characterized by relatively low-lying, rolling barchanoid dunes and interdunal plains. The plains comprise a deflated land surface of sub-horizontal fluvial sediments deposited during the later part of the Pleistocene when the climate fluctuated from hyper-arid to humid. During intermittent pluvial periods waterborne sediments were transported westwards from the Hajar mountains in Oman and deposited as alluvial fans that now form the interdunal plains (Glennie 2001). These plains are overlain by salt-covered sabkhas and much younger sands forming barchan dunes, the eastern limits of which coincide approximately with the Oman border.

Early surveys within the Rub^c al-Khālī discovered several Neolithic flint sites, mostly within the western extent of the desert, covering Saudi Arabia and Yemen (Zarins, Murad & Al-Yaish 1981; Edens 1982). The presence of a lithic scatter at Kharimat Khor al-Manāhil was first noted in 2003 by a team from the Terrestrial Environment Research Centre (TERC), part of the Environment Agency — Abu Dhabi, EAD (then known as the Environmental Research and Wildlife Development Agency, ERWDA). In November 2003 the sites were revisited and evaluated by Dr Mark Beech from

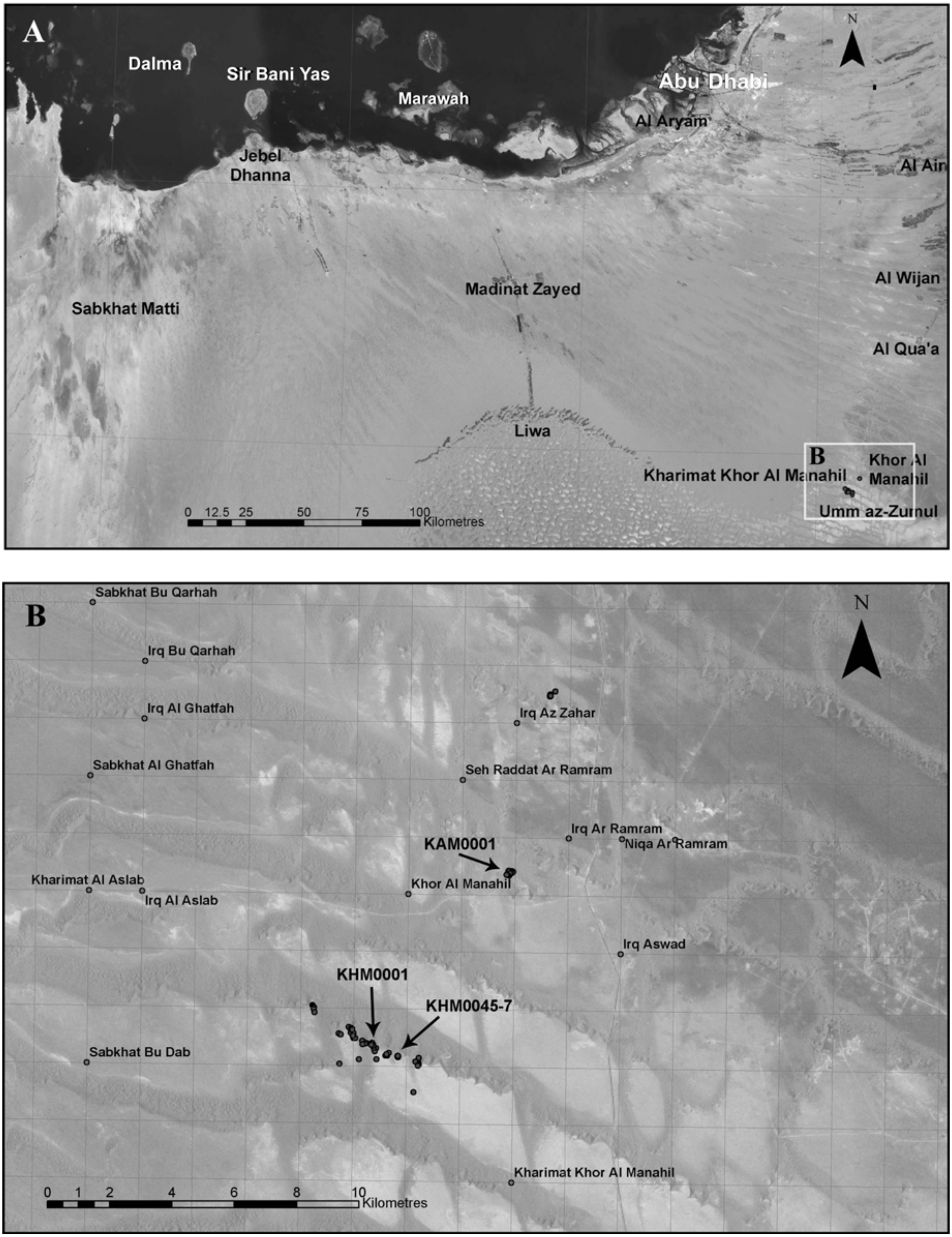

FIGURE 1. *Location maps of Khor al-Manāhil and Kharimat Khor al-Manāhil in Abu Dhabi.*

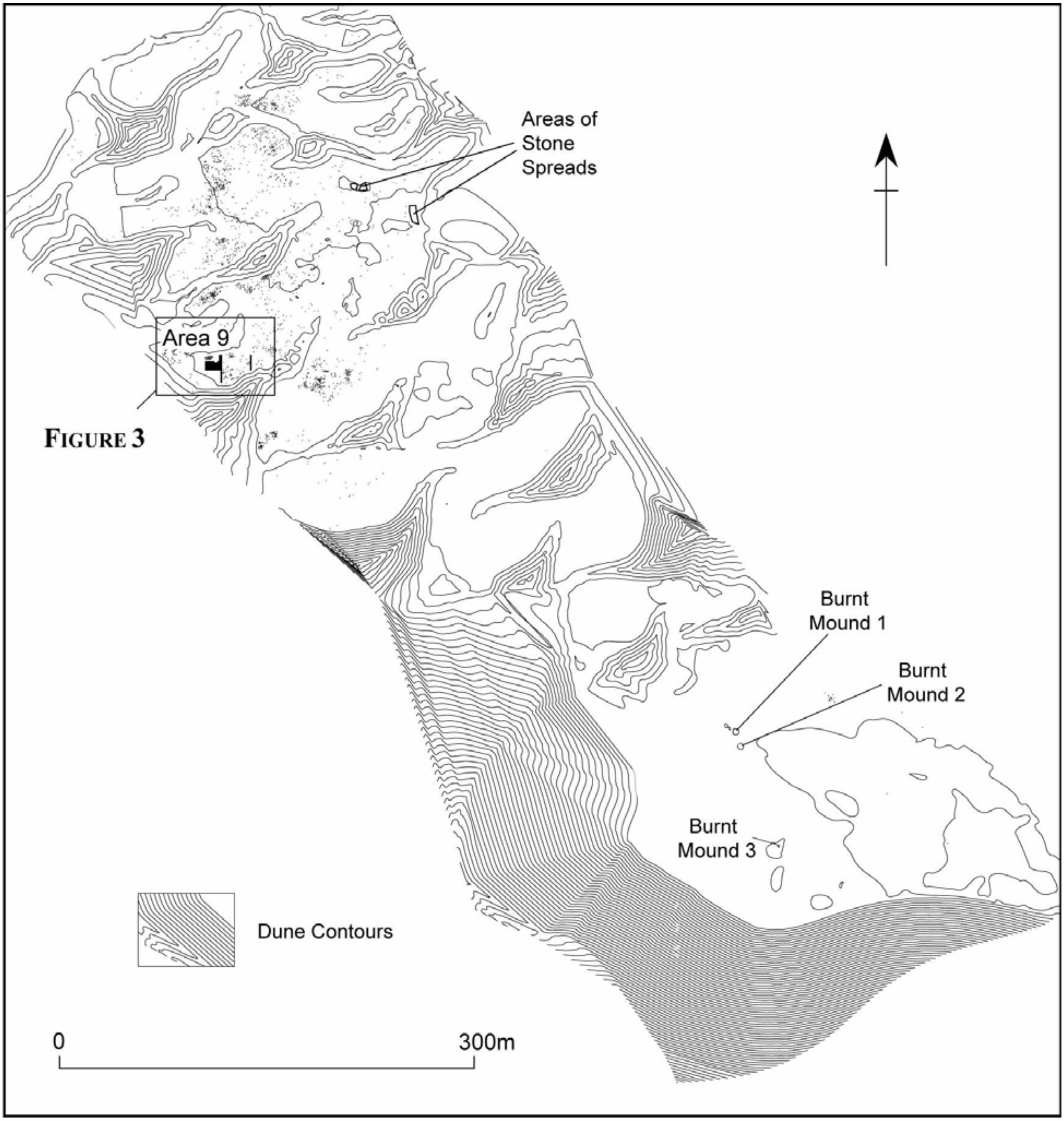

FIGURE 2. *The Khor al-Manāhil (KAM) survey area showing the location of the "burnt mounds" and interdunal areas with flint debitage.*

ADIAS, together with a team from TERC. It was realized that further fieldwork would be needed in order to map the extent of the lithic scatter, and the first season of work took place between 24th January and 6th February 2004. A total of eighty fragments were mapped at Khor al-Manāhil (KAM) where there were significant clusters of worked flint and other stone material.

In the Kharimat Khor al-Manāhil (KHM) region lithics were spread almost continuously along the northern edge of the plain for more than 3 km (Kallweit, Beech & Al-Tikriti 2005). Three possible building structures (KHM0045–KHM0047) at Kharimat Khor al-Manāhil were investigated but found to be the result of recent seismic studies.

Two further seasons have since been undertaken at KAM and KHM during January 2005 and January 2006. This involved a topographic survey of both sites and their landscape features. While survey work at Khor al-Manāhil concentrated on the systematic collection and mapping of lithics, a concentration of lithics was noted in an interdunal depression known as "Area 9". Given the density of flints a regime of recording and numbering each lithic find was clearly inappropriate, particularly for small pressure flakes, so this area was left for the third season (2006).

In April 2005, a team comprised of Dr Anja Zander (then based in the Geography department at Marburg University in Germany), Dr Heiko Kallweit, and Dr Mark Beech, visited the Umm az-Zumūl region to obtain suitable samples for OSL dating.

Aims and methodology

The fieldwork priorities for 2005 and 2006 were to map the locations of flint finds and the extent of the scatters at Kharimat Khor al-Manāhil (KHM) and Khor al-Manāhil (KAM). It was also hoped that topographic mapping and OSL dating would contribute to our understanding of the chronology of the lithic debitage and the depositional processes of the sites and their environs.

The area of the lithics scatter was walked in approximately 2 m transects. All finds, with the exception of those from Area 9, were collected from the deflated land surface. These were mapped using a Nikon C100 Total Station and data logger. Flints were logged as X, Y, Z data points in local grid co-ordinates and stations were fixed to national co-ordinates using a hand-held GPS. Each point was recorded with a relative positional accuracy of ± 0.01 m. Finds numbers were incremented by the logger, and the points processed using Geosite and AutoCAD software. The more general topographic survey mapped interdunal areas, terraces, archaeological features, and modern dunes, which accounts for an absence of debitage within parts of the site. A database of the lithic types was then combined with the topographic survey using ArcGIS. This enabled individual tool types to be plotted within the topography of the site.

Specific aims for the two seasons included:

Khor al-Manāhil (KAM)

— Dry-sieving of the lithics-bearing layer within Area 9 by 1 m-grid squares using 1 mm-mesh hand sieves.
— An investigation of discreet areas of stone within the western part of the site, to determine their natural or anthropogenic origin.
— Further investigation of the area south-east of the main lithics spread, including excavation and mapping of newly discovered "burnt mounds" and additional surface finds.

Kharimat Khor al-Manāhil (KHM)

— An investigation of a series of three possible limestone structures (KHM0045–47).

Results

Khor al-Manāhil (KAM)

Work at KAM concentrated on completing the mapping of lithics and a topographic survey of the immediate vicinity of the scatter (Fig. 2). The lithics collection and topographic survey was also augmented by the excavation of stone scatters within the north-eastern extent of the survey area, and "burnt mounds" recorded beyond the southern extent of the area.

A total of 2681 lithics find spots were recorded over three seasons from Khor al-Manāhil, with the vast majority (approximately 2000) being recorded during the second season (2005). New material was exposed each season, and as part of the 2006 season a further 600 flints were collected to the north and west of Area 9 (Figs 2 and 3), where flints had been collected the previous year. Clearly smaller quantities of material were constantly being exposed and buried.

The greatest part of the work in 2006 involved the controlled sieving of debitage concentrations within Area 9 where no flints had been collected the previous season. This comprised an interdunal depression about 20 m in width and 30 m in length (Fig. 3). A larger modern dune was aligned along the southern edge, and the northern edge of the depression was marked by a flat and rounded modern dune corpus. Flint debitage was

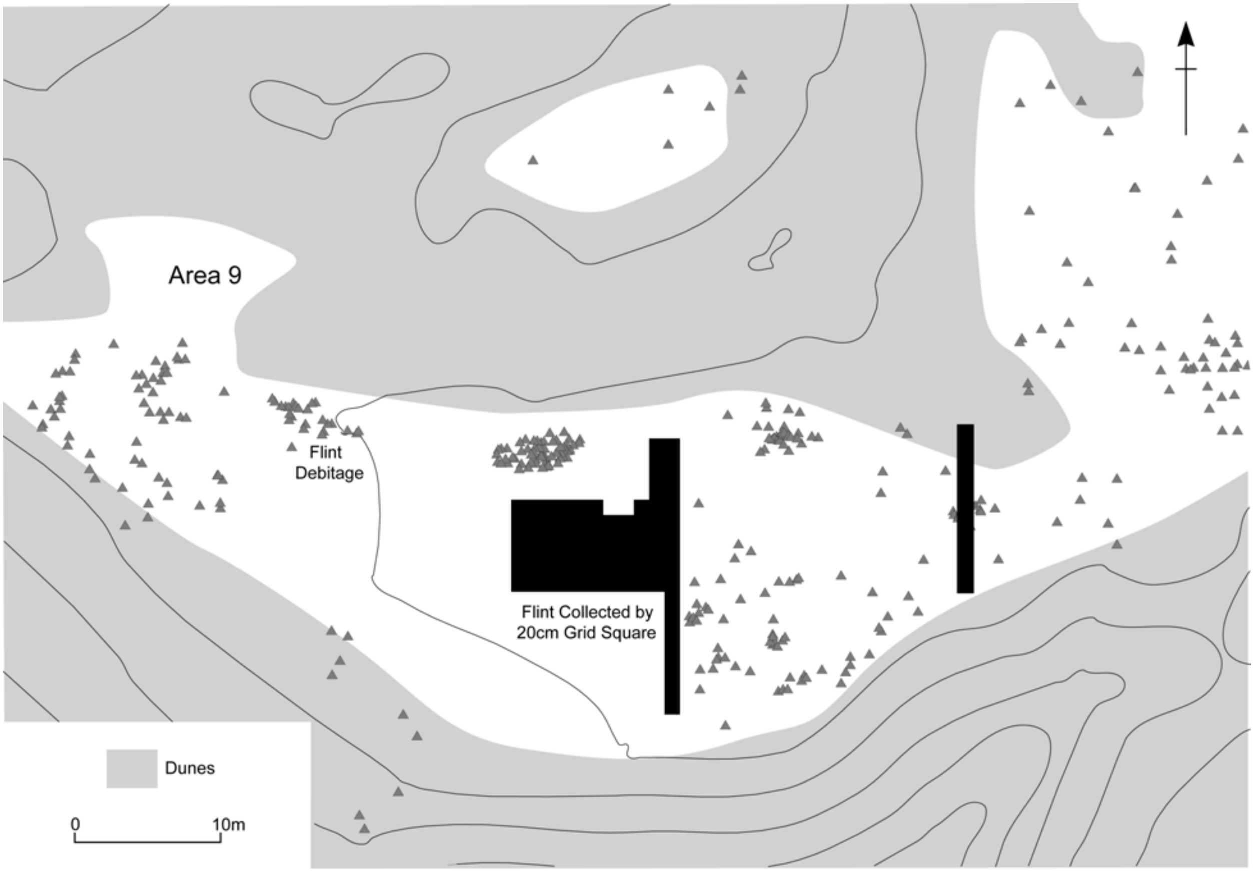

FIGURE 3. *Area 9, Khor al-Manāhil (KAM) showing flint debitage (as triangles) and the areas sieved for flint fragments by a 20 cm grid.*

also recovered from the surface of a palaeodune within the south-western extent of Area 9. A 1 m^2 planning frame was used to mark 20 cm grid squares along a north to south baseline with the sediments from a total sieved area of 90 m^2, using 1 mm-mesh hand sieves. All flints were recovered exclusively from the uppermost 2 cm of sand. Below this was a fine loose sand (approximately 0.15 m in depth), which in turn overlay a hardened, deflated surface. This was also the case at Kharimat Khor al-Manāhil (KHM 0035) where the debitage was concentrated in the uppermost few centimetres below the modern ground surface (Kallweit, Beech & Al-Tikriti 2005).

Analysis of the Khor al-Manāhil lithic assemblage

To date, 458 pieces of tools and debitage have been recorded and analysed by Dr Heiko Kallweit. The largest number and most important group were the weaponry, which includes thirty-seven arrowheads (two of them semi-products), five large projectile points (two of them semi-products), and fourteen bifacials (including eight semi-products). All the arrowheads are stemmed with the exception of a few very thin, elongated, willow-leaf shaped forms. The arrowheads are carefully manufactured and, usually bifacially pressure retouched. Most of the stemmed specimens are triangular-shaped. A few pieces are barbed and some have denticulated edges. The raw material is almost exclusively flint with a few exceptions of coarser grained material, most likely of volcanic origin.

From a typological perspective, all the arrowheads are typical of seventh–fifth-millennium Neolithic assemblages commonly reported from many sites in the UAE and the Arabian Peninsula. Larger projectile points are elongated, significantly larger, and heavier than arrowheads as they weigh in excess of 7 gm. Khor al-Manāhil also produced a number of interesting semi-products of large projectile points and bifacials, which serve to explain the necessary technical steps and stages

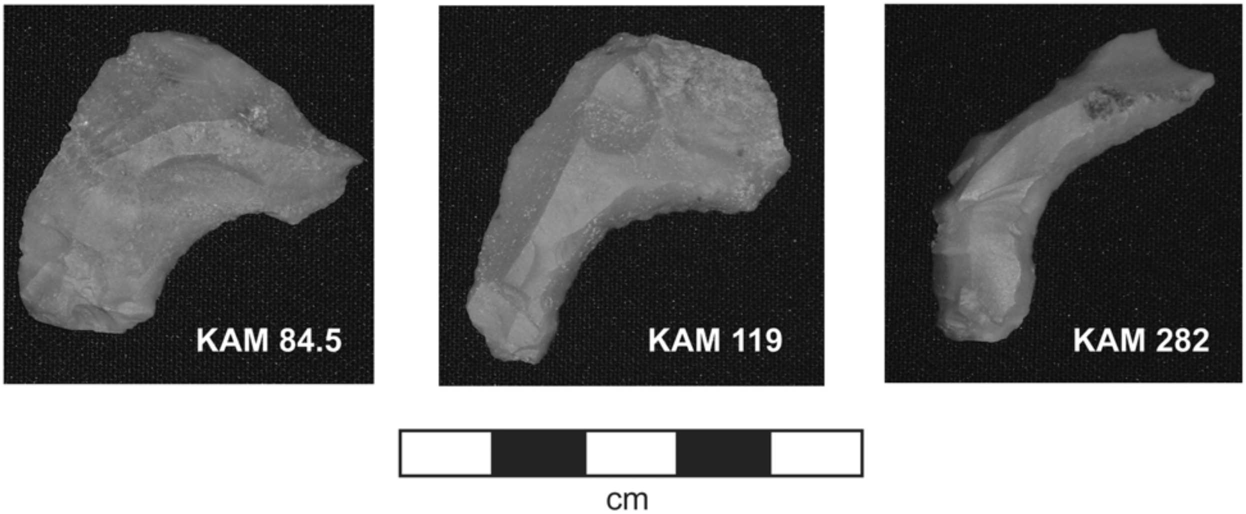

FIGURE 4. *Concave side scrapers from Khor al-Manāhil.*

of manufacture. Larger projectile points are made of either large blades or fragments of tile flint (the latter technically being core-tools). This also applies for almost all bifacials found in the stage of a semi-product. They are made from elongated, flat pebbles of locally available flint. Flint pebbles similar in colour, texture, and size have been found on the surface of different sites at Irq az-Zahar, just a few kilometres to the north of the KAM sites.

The assemblage, with its emphasis on weaponry, does not look domestic but appears to reflect the remains of temporary camps. The scraper, cutting tool, and piercing tool frequency is very low compared to the level of weaponry, particularly when compared to broadly contemporary assemblages. At the coastal Ubaid settlement of Dalma, for example, very few arrowheads were noted, but significantly more knives, drills, piercing tools, and wedges were recorded (Kallweit, in preparation). This would tend to suggest that the assemblage at Khor al-Manāhil is perhaps the result of seasonal husbandry missions into the desert with weapons to hunt, slaughter, and eat, as well as comprising tools for the repair of toolkits and for the manufacture of weapons.

Concave side scrapers

Of particular interest was a tool type new to the Khor al-Manāhil assemblage, which was classified as a concave side scraper (Kallweit 2006). In contrast to common end-scrapers or side-scrapers, the working edge is formed by steep retouch in a notch of winged flakes as shown on KAM282 (Fig. 4). On all examples so far (seven in total), the flake is torn to the right. The dorsal face of the flake displays scars of previous removals, and in some cases cortex remains are visible at the terminal edge. It is likely that curved flakes were produced intentionally to create this tool. Of course an accidental creation of such flakes cannot be excluded, but seems less likely. The scrapers are about 5 cm long, 1.5 cm in width, and less than 1 cm thick. Typically 2–3 cm of the right side of the concave edge is subject to a steep parallel retouch from the ventral to the dorsal face. Opposite to this, the left edge is also typically retouched, comparable to the modifications on a backed knife. This retouch could well form a finger rest because it has been designed to break sharp edges rather than providing a second working edge, although the backing modification was not observed on all examples. While the purpose of this tool remains uncertain, the single hand-held character of the tool suggests it may have functioned as a smoother, perhaps for wooden shafts or handles. Further investigation of the assemblage could include use-wear analysis, which may provide a better insight into the function of the tool, which so far does not have any parallels from similar sites in the UAE.

The excavation of features at Khor al-Manāhil (KAM)

The stone spreads

Towards the north-eastern edge of the lithics scatter were several spreads of loose stone (Fig. 2). Given that much of the deflated land surface comprised calcified

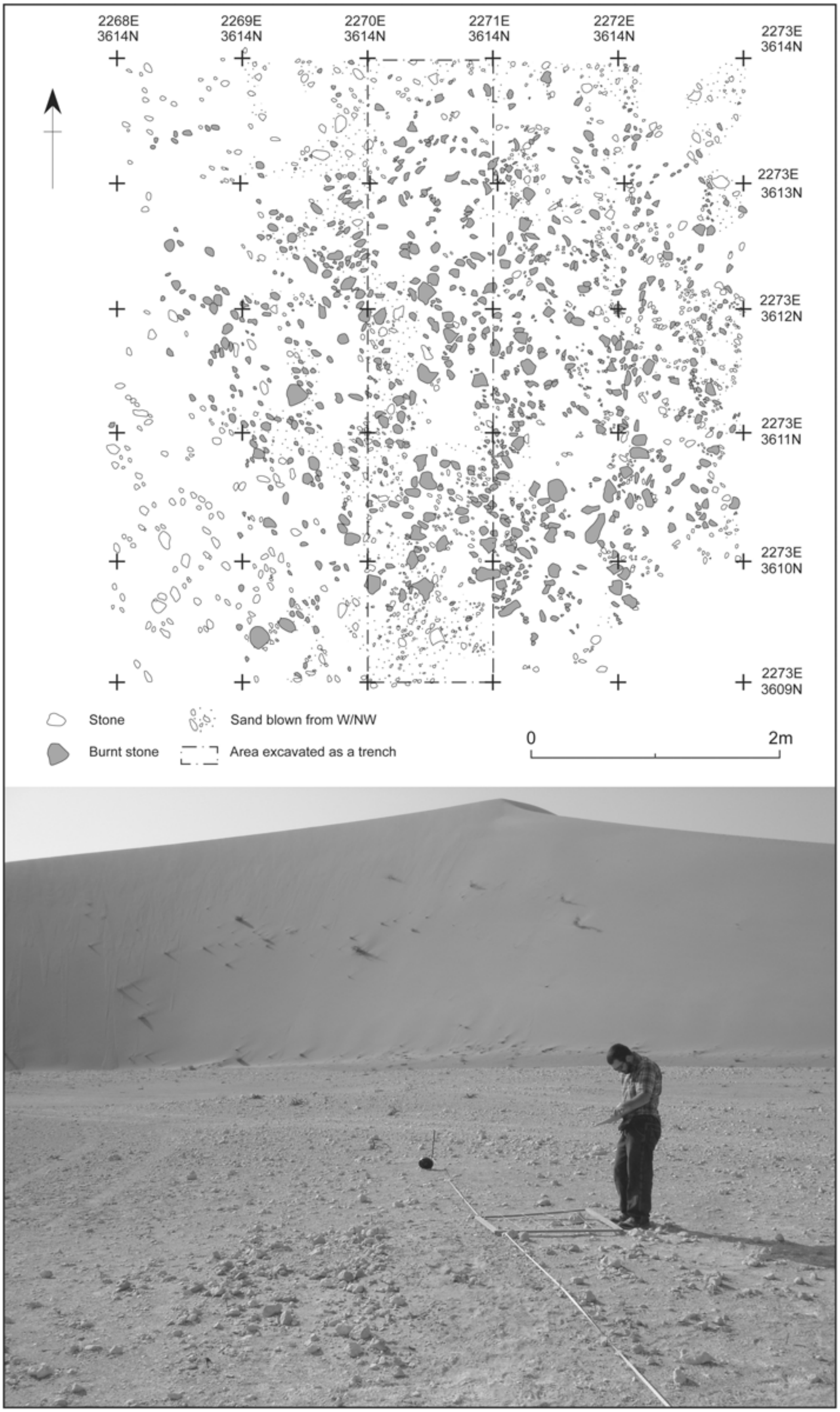

FIGURE 5. *A plan and a photograph of "burnt mound" No 1, with a 70 m-high barchan dune to the south.*

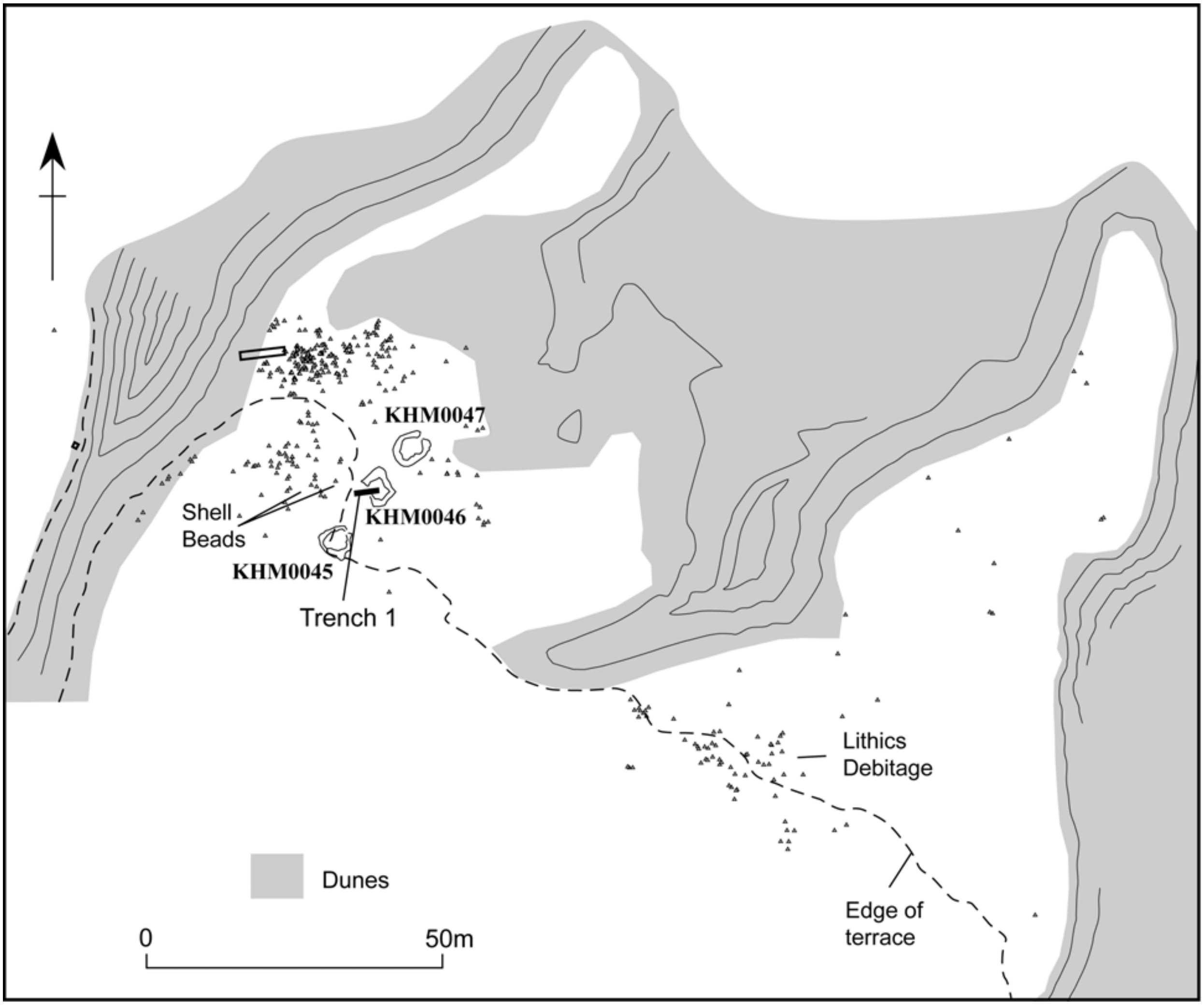

FIGURE 6. *Kharimat Khor al-Manāhil lithics scatter.*

gypsum (resulting from precipitation) it was considered that the rubble might be the remains of up to five building structures (KAM0003–KAM0007; cf. Kallweit, Beech & Al-Tikriti 2005). The recovery of a limestone mortar (KAM0008) from the immediate vicinity suggested domestic activities took place in the vicinity. However, a single 1 x 5 m trench, excavated across one of the spreads to a depth of 0.3 m, demonstrated that the rubble was of natural origin.

The "burnt mounds" (Figs 2 and 5)

Three "burnt mounds" were located to the south-east of the site, and comprised circular concentrations of burnt limestone. The largest mound (No 1) measured 4.5 m in diameter and about 15 cm in height. Its surface was littered with grey limestone fragments, each no larger than 20 cm, which give the impression of having been burnt. Close observation of the surface of these limestone fragments revealed a consistent pattern of weathering from the prevailing north wind, which may imply some antiquity.

About 7 m to the south a second, less-well preserved "burnt mound" (No 2) was clearly more deflated, the stones being dispersed over a flat area about 3 m in diameter. A third and much smaller concentration of burnt stones (No 3) was recorded 70 m to the south, and was only 1.5 m in diameter. The original sediments associated with both "burnt mounds" (Nos 2 and 3) were completely eroded. The best-preserved mound (No 1) was excavated in the hope that samples of ash or charcoal might be obtained for radiocarbon dating.

A north–south trench measuring 5 x 1 m across was excavated through the centre of the mound exposing the natural bedrock at a depth of approximately 0.32 m. This was sealed by a layer of small limestone fragments cemented with coarse sand in a hard gypsum-rich layer measuring approximately 0.3 m in depth (the deflated land surface). The "burnt" limestone fragments lay directly on this surface. Recent aeolian sand 0.02 m in depth lay between the "burnt" stones, having probably been immobilized by the heavier fragments. Unfortunately there were no traces of ash, charcoal, or any archaeological finds, as erosion and weathering were responsible for the deflation of the mound.

Certainly a recent date cannot be excluded for the "burnt mounds" at the southern extent of KAM, but the consistent weathering from the prevailing north wind does suggest that these features are of some antiquity. All three mounds are situated in close proximity on the surface of an exposed limestone outcrop, possibly a relic lake shoreline. The choice of areas close to water for cooking and processing would have been a natural option and it is possible that they may represent ancient hearths.

Kharimat Khor al-Manāhil (KHM)

Work at KHM concentrated on three low mounds, each with a central shallow sub-circular depression and what appeared to be vertically set limestone. An initial test trench (Trench 1, Fig. 6) excavated through KHM0046 suggested that these might be the remains of some form of house-type structures (Kallweit, Beech & Al-Tikriti 2005) or even tombs (Beech *et al.* 2006). Further excavation of KHM0045 and KHM0046 during the January 2007 season revealed the presence of a borehole, 4 m deep and approximately 0.15 m wide, in the middle of each of the depressions. Limestone fragments in both depressions were found to be angled downwards towards the apex at the centre of the depression where the borehole was located. The features are without doubt the result of seismic studies undertaken for the purpose of oil exploration in the early to mid-1960s. Fragments of limestone were forced into a vertical position when the charge at the base of the borehole was detonated. Small metal and wire fragments adhering to limestone fragments were discovered in the centre of each depression. Each of the boreholes contained water, and a sample was taken for further analysis. Dr Mike Brook, a hydrologist at the Abu Dhabi Environment Agency reported that the water was slightly salty and that it was within the typical regional range, having a salinity measurement of 17,200 mg/litre and a PH of 7.6. This would not be considered suitable for human consumption, watering animals, and/or for agriculture at the present time.

Lithics collection at KHM sites

A concentration of lithics was recorded to the north-west of the three depressions (KHM0045–KHM0047, cf. Fig. 6), and a second some 60 m to the south-east. A total of 388 lithics find spots were collected and mapped during the 2005–2006 season, including debitage as well as completed and semi-completed artefacts and projectile points. Other tool types included retouched flakes and blades, retouched pieces of debris, chisels, scrapers, awls, a knife, and one axe.

Shell beads

Surface finds also included two shell beads approximately 5 and 10 m west of KHM0046 (Fig. 6; cf. Beech *et al.* 2006: 24, fig. 9). The first example was a typical flat, round disc-bead, about 7 mm in diameter, with a hole about 2 mm in diameter drilled through it. It had been manufactured from a marine bivalve shell, possibly from a species like Cardiidae *Acrosterigma maculosa*, as traces of its distinctive parallel grooves were still visible on its uppermost surface. This species is present in both the Arabian Gulf and the Gulf of Oman in sandy offshore habitats (Dance 1995: 246, no.1090). The second example was an almost complete small marine gastropod, Olividae *Ancilla* cf. *farsiana*, whose apex had been cut off to facilitate it being threaded as a bead. This species is present in both the Arabian Gulf and the Gulf of Oman in intertidal habitats as well as sandy offshore habitats (Dance 1995: 145, no 604).

Dating the dunes

The problem of absolute dating of Neolithic sites within inland desert environments is the absence of associated suitable organic matter for radiocarbon dating. This is also the case for the lithic scatters at KAM and KHM. For this reason dating was carried out using Optically Stimulated Luminescence (OSL) on quartz grains within layers above and below the flint horizon. Luminescence dating methods determine the time elapsed since a radiation-produced charge in natural minerals was last reset by sunlight (for comprehensive overviews of luminescence dating techniques see Wintle 1997; Aitken 1998; Stokes 1999; Murray & Wintle 2000).

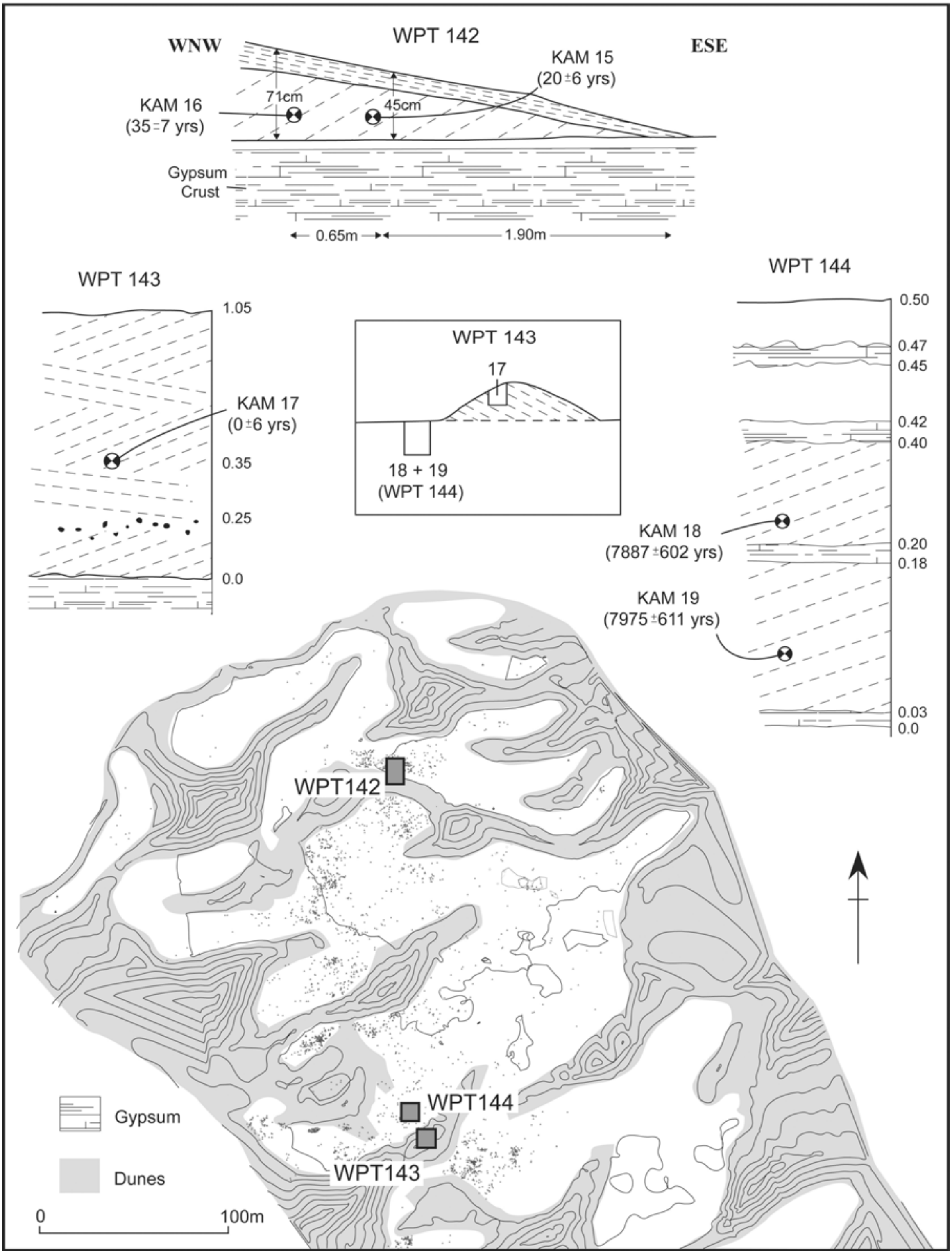

FIGURE 7. *Location of OSL dating trenches at Khor al-Manāhīl.*

OSL sample site	Sample No	Lab. No	Description	Equivalent dose (Gy) 2σ	Qz-SAR-Age (a)	Dose rate (µGY / a)
WPT 142	15	MR0471	Dune above northern extent of lithic scatter, Fig. 7	0.03 ± 0.01	20 ± 6	1464 ± 75
WPT 142	16	MR0472	Dune above northern extent of lithic scatter, Fig. 7	0.05 ± 0.01	35 ± 7	1430 ± 68
WPT 143	17	MR0473	Dune above southern extent of lithic scatter, Fig. 7	0.00 ± 0.01	0 ± 6	1435 ± 74
WPT 144	18	MR0474	Beneath lithic scatter towards southern extent of site, Fig. 7	10.24 ± 0.39	**7887 ± 602**	1298 ± 86
WPT 144	19	MR0475	Beneath lithic scatter towards southern extent of site, Fig. 7	10.82 ± 0.43	**7975 ± 611**	1357 ± 89

FIGURE 8. *OSL dating at Khor al-Manāhil.*

OSL sample site	Sample No	Lab. No	Assumed water cont. (GEW. -%)	Uranium (ppm)	Thorium (ppm)	Potassium (ppm)	Cosmic dose (µGy / a)
WPT 142	15	MR0471	5 ± 3	0.69 ± 0.03	1.45 ± 0.07	1.13 ± 0.06	170.2 ± 8.5
WPT 142	16	MR0472	5 ± 3	0.74 ± 0.04	1.39 ± 0.07	1.09 ± 0.05	167.2 ± 8.4
WPT 143	17	MR0473	5 ± 3	0.62 ± 0.03	1.3 ± 0.07	1.13 ± 0.06	167.3 ± 8.4
WPT 144	18	MR0474	8 ± 5	0.62 ± 0.03	1.35 ± 0.07	1.02 ± 0.05	172.7 ± 8.6
WPT 144	19	MR0475	8 ± 5	0.65 ± 0.03	1.36 ± 0.07	1.08 ± 0.05	170.8 ± 8.5

FIGURE 9. *Uranium, thorium, and potassium determined by gamma spectrometry, assuming 5% error, at Khor al-Manāhil.*

Method and protocol

OSL measurements on coarse grain quartz (150–200 µm) were taken with an automated Risø TL–DA 15 reader using blue (470 ± 30 nm) stimulation and a 7.5 mm Hoya U340 detection filter (280–380 nm). Equivalent dose (ED) measurements were performed using the single-aliquot regenerative-dose protocol on twenty-four aliquots per sample. OSL was measured for 40 s at 125°C with a 10 s preheat at 240°C and a cut heat of 200°C. The integrated signal of the first 0.5 s shine down were used to calculate the ED. Radionuclide analysis for dose rate determination was performed by high-resolution gamma spectrometry using a 20% p-type HPGe detector (Preusser & Kasper 2001). The age of each sample was then calculated from the average and given in years (Figs 8 and 12).

Luminescence dating results

Khor al-Manāhil

A test trench (WPT144, Fig. 7) was excavated at the southern extent of the debitage spread in Area 9, and a sample of the laminated palaeodune, taken at a depth of 0.50 m (KAM–19), was dated to 7975 ± 611 years ago. This was sealed by gypsum and then a laminated, partly cemented, sediment (KAM–18) lying immediately below the lithics horizon, which provided a date of 7887 ± 602 years ago (Figs 8 and 9). Two further trenches (WPT142 and WPT143, Fig. 7) were excavated into the dunes overlying the flint debitage. Three samples (KAM–15 to KAM–17) from these dunes showed that the dunes were deposited within the past fifty years (Fig. 8).

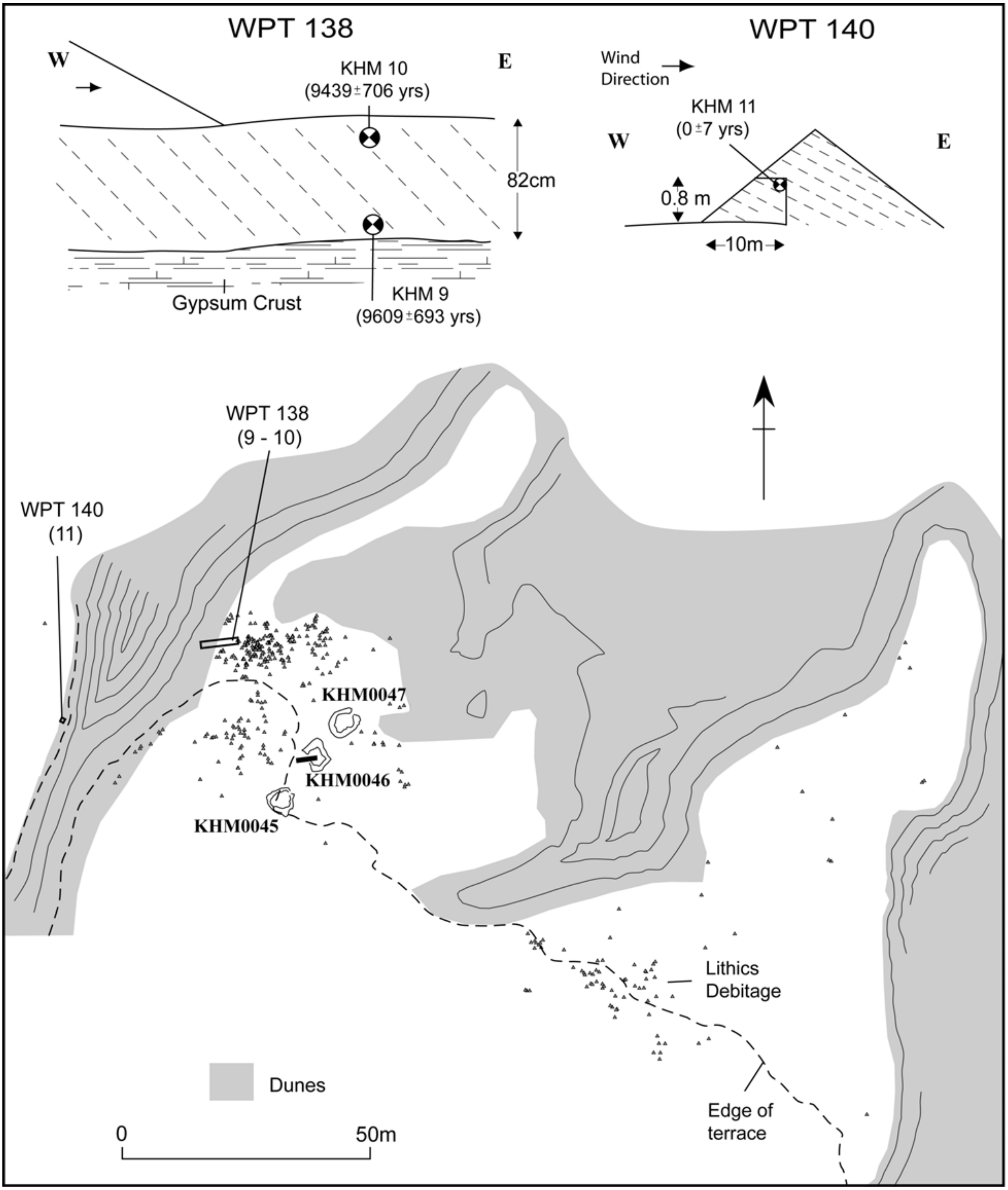

FIGURE 10. *Location of OSL trenches at Kharimat Khor al-Manāhil KHM0046.*

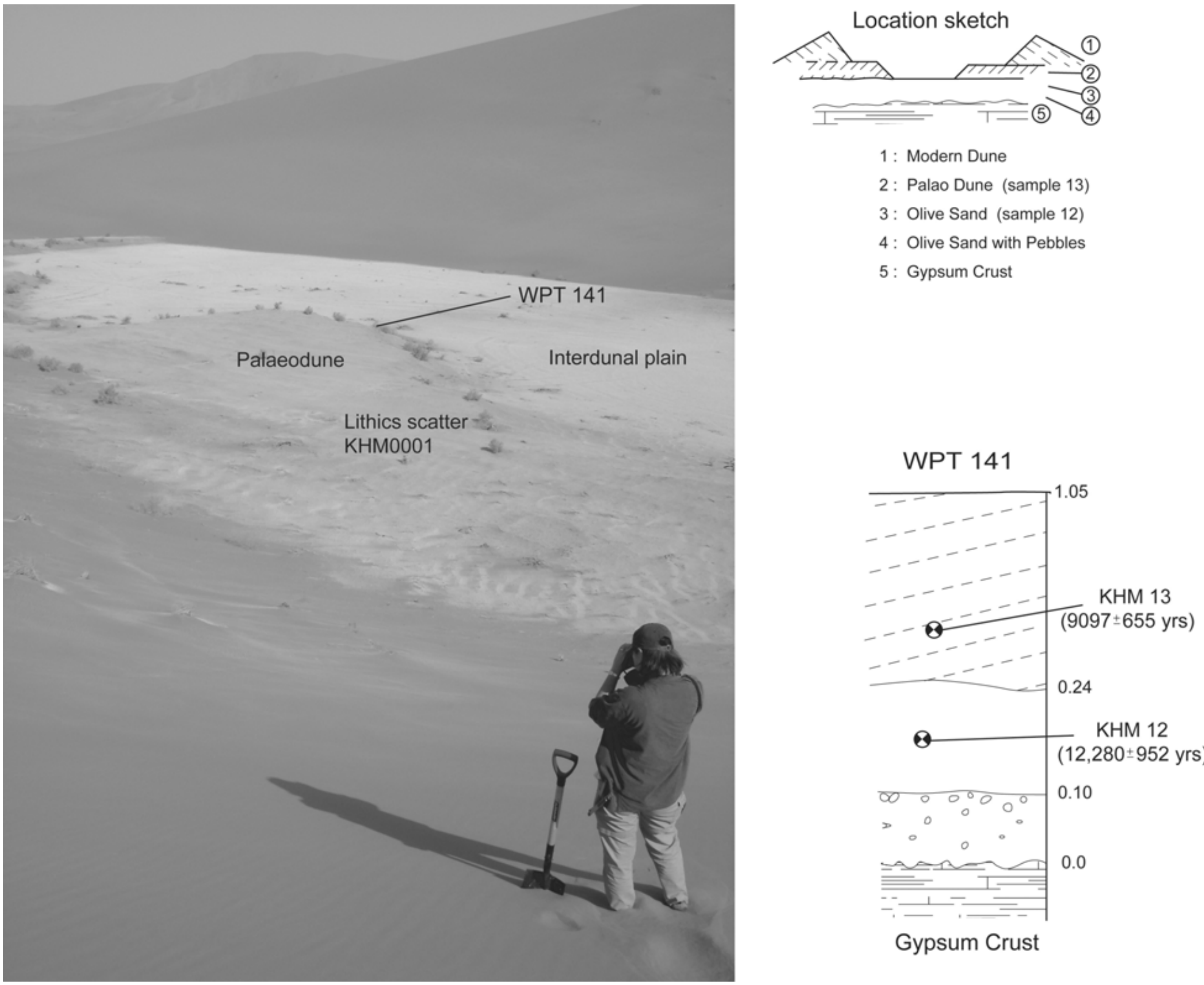

FIGURE 11. *The location of OSL trenches at Kharimat Khor al-Manāhil KHM0001.*

Kharimat Khor al-Manāhil

KHM0045

A trench excavated into the terrace to the north-west of KHM0047 (WPT 138, Fig. 10) provided a sample at a depth of 0.82 m, which dated the sediments to 9609 ± 693 years ago (KAM–9). Sediments at a depth of 0.25 m below the flint scatter provided a date of 9439 ± 706 years ago (KHM–10, Figs 12 and 13). A sample from the dune to the west, which overlay the terrace and flint debitage, suggested that the dune had accumulated within the past ten years (WPT140, KHM–11).

KHM0001

The site of KHM0001 is an interdunal depression approximately 1 km to the west of KHM00046 (Figs 1 and 11). A trench (WPT 141) was excavated below the palaeodune and samples taken from the sediments beneath the flint scatter. The earlier palaeodune material (KHM–12) was dated to 12,280 ± 952 years ago and the sediments immediately below the flint scatter (KHM–13) to 9097 ± 655 years ago (Figs 12 and 13).

Site code	OSL sample site	Sample No	Lab. No	Description	Equivalent dose (Gy) 2σ	Qz-SAR-Age (a)	Dose rate (μGY / a)
KHM0001	WPT 141	12	MR0469	Beneath the lithic scatter at edge of terraced area (lower sample), Fig. 11	17.88 ± 0.75	**12280 ± 952**	1456 ± 95
KHM0001	WPT 141	13	MR0470	Beneath lithic scatter at edge of terraced area (upper sample), Fig. 11	12.64 ± 0.38	**9097 ± 655**	1389 ± 91
KHM0045–7	WPT 138	9	MR0466	Beneath the lithic scatter and associated structures (lower sample), Fig. 10	12.74 ± 0.36	**9609 ± 693**	1326 ± 88
KHM0045–7	WPT 138	10	MR0467	Beneath the lithic scatter and associated structures (upper sample), Fig. 10	11.18 ± 0.36	**9439 ± 706**	1184 ± 80
KHM0045–7	WPT 140	11	MR0468	Sand dune above the lithic scatter and associated structures, Fig. 10	minus 0.03 ± 0.01	0 ± 7	1387 ± 73

FIGURE 12. *OSL dating at Kharimat Khor al-Manāhil, KHM0001 and KHM0045–7.*

Site code	OSL sample site	Sample No	Lab. No	Assumed water cont. (GEW. -%)	Uranium (ppm)	Thorium (ppm)	Potassium (ppm)	Cosmic dose (μGy / a)
KHM0001	WPT 141	12	MR0469	8 ± 5	1.08 ± 0.05	1.99 ± 0.1	1.05 ± 0.05	165.0 ± 8.2
KHM0001	WPT 141	13	MR0470	8 ± 5	0.74 ± 0.04	1.47 ± 0.07	1.09 ± 0.05	168.5 ± 8.4
KHM0045–7	WPT 138	9	MR0466	8 ± 5	0.71 ± 0.04	1.29 ± 0.06	1.04 ± 0.05	167.6 ± 8.4
KHM0045–7	WPT 138	10	MR0467	8 ± 5	0.55 ± 0.03	1.06 ± 0.05	0.93 ± 0.05	172.7 ± 8.6
KHM0045–7	WPT 140	11	MR0468	5 ± 3	0.52 ± 0.03	1.11 ± 0.06	1.11 ± 0.06	172.0 ± 8.6

FIGURE 13. *Uranium, Thorium and Potassium determined by Gamma spectrometry, assuming 5% error at Kharimat Khor al-Manāhil, KHM0001 and KHM0045-7.*

Discussion

The discovery of flint sites in the Rubᶜ al-Khālī over the past fifty years has altered our perception of a seemingly barren and inhospitable landscape. The flint scatters at Khor al-Manāhil and Kharimat Khor al-Manāhil, combine with other sites within the Rubᶜ al-Khālī, including Yaw Sahhab in the Liwa Oasis (Harris 1998; Kallweit 2001) and Bidaᶜ al-Mutawaᶜ in western Abu Dhabi (Crombé 2000), to add significantly to our assessment of the exploitation of resources in the Rubᶜ al-Khālī, particularly in an environment where lithics provide the main and often only source of evidence for Neolithic habitation.

The surface assemblages can be dated to around 7500–6000 BP, as the tools all belong typologically to the so-called "Arabian Bifacial Tradition" (ABT) or more closely to the "Rubᶜ al-Khālī Neolithic", as first defined by Christopher Edens (1982). Unusual tool types within the assemblage, for example the concave side scrapers, can provide techno-typological comparisons with other Neolithic assemblages within the Rubᶜ al-Khālī. Both assemblages, with their emphasis on weaponry (arrowheads and large projectile points) rather than domestic tools, suggest the scatters result from temporary or seasonal camps. Future work will focus on the spatial distribution of debitage and tools, as well as provide comparative analysis with other sites from the Rubᶜ al-Khālī.

The two shell beads found on the surface of KHM may have originally been produced by a community exploiting coastal resources, and brought into the desert interior via a trade network as part of seasonal migration. Marine shells have been recorded at a number of Neolithic sites in the Rubᶜ al-Khālī and various parts of inland Arabia. Whether the beads were produced at coastal workshops or were simply carried as whole shells into the interior and then worked, is not clear. Archaeological evidence demonstrates that a good number of the beads could have been produced in coastal workshops.

Identical examples of both types of bead are known from the Neolithic cemetery of Jebel Al-Buhais 18, located in Sharjah emirate in the UAE (Kiesewetter, Uerpmann & Jasim 2000: 140, fig. 3; 142, 144, fig. 10 and table 1). Grave EE contained a 30–35-year-old woman with a loincloth around her waist decorated with many *Ancilla* cf. *farsiana* shells (2000: 142). Graves FO, GG, AL, AK and GI, contained five adults buried close together, partly in each other's arms. Pierced *Ancilla* shells were used as decoration on the headband of a man (grave FO). The man also had on his right wrist a bracelet with disc-beads, alternating black and white tubular beads, and pierced *Ancilla* shells, similar to the ones found on the other two women and men. Grave GI was also adorned with *Ancilla* shells, which probably are the remains of cloth decoration (2000: 142). More than 24,000 objects of presumed ornamental purpose were recorded during the Buhais excavations, the largest assemblage of Neolithic jewellery known from the region (Beauclair, Jasim & Uerpmann 2006).

What was the regional environmental context to these sites? Recent work on deflated megalinear sand dunes at Awafi in Ras Al-Khaimah, showed that around 10,000 years ago these dunes accumulated very rapidly, caused by winds blowing from south-west to north-east (Goudie *et al.* 2000: 1011). Cores from the Arabian Sea suggest changes in the Indian Ocean Monsoon resulted in higher precipitation over the Arabian Peninsula between 10,000 and 6000 years ago (Preusser, Radies & Matter 2002). A shift in the Inner Tropical Convergence Zone (ITCZ) may have resulted in the development of lacustrine, arid, and steppe conditions, with vegetation more akin to savannah (Van Campo, Duplessy & Rossignol-Strick 1982) across parts of the Rubᶜ al-Khālī. Former lacustrine deposits in the Ayn al-Faydah region (Gebel *et al.* 1989) seem to confirm this, with sediments from a dry interdunal lake basin at Awafi also indicating grassland with a strong woody element between 8300 and 6000 cal. yr. BP (Parker *et al.* 2004: 673). Radiocarbon dating of fossil lake beds in the Rubᶜ al-Khālī confirms lakes lasting from a few years to several hundred years between 10,000 and 6000 cal. yr BP (McClure 1988). Terracing within some of the interdunal plains may reflect the former shorelines of these ancient lakes (United Arab Emirates University 1993; Glennie 2005: 142, 144, fig. 9/27), which may have also held water, at least seasonally, during humid periods.

The time period of 9500 cal. yr. BP for dune development at Kharimat Khor al-Manāhil fits well with the expected age range, as does the lowermost greyish sand, which provided dates of around 12,000 years (possibly corresponding to the Younger Dryas in Europe). However, the second period of around 8000 years ago for the dune mobilization at Khor al-Manāhil is well into the climatic optimum, when precipitation should be sufficient to prevent aeolian dune reactivation.

This period corresponds with a rapid cooling and drying of parts of the earth's climate system at around 8200 BP, as recorded in temperature records derived from central Greenland ice cores (Rohling & Pälike 2005). High-resolution speleotherm records from Qunf Cave in Dhofar suggests this dune remobilization may coincide with a temporary weakening of the monsoon around 8400–8200 cal. yr. BP (Fleitmann *et al*. 2003). The flint assemblages post-date this event, once vegetation cover and palaeosoils had become established on the cemented aeolian carbonate dune sands.

At Awafi in Ras Al-Khaimah the dune megaridges are overlain by patterns caused by north-west "Shamal" winds (Parker *et al.* 2004: 667), with a shift once more in the Indian Ocean Monsoon, and aeolian dune reactivation occurring once more towards the end of the climatic optimum (Bray & Stokes 2003; Parker *et al.* 2004: 673). Gradual drying out of the soil and reduced vegetation around 6000 years ago (certainly through a reduced rainfall but possibly also due to over-grazing) would have caused soils to mobilize leaving the assemblage as a scatter on the surface of the palaeodunes. The flint assemblages all lay within a matrix of large particles within the upper 2 cm of the surface, which sealed sterile fine sand. The larger, heavier particles on the surface (including flint debitage) would seem to be the result of deflated palaeosoils, which served to prevent further aeolian deflation of the underlying deposits of fine sand. Sediments immediately below the lithics scatters provide us with a *terminus post quem* for the debitage at the two sites (less than 9500 years at Kharimat Khor al-Manāhil and 8000 years at Khor al-Manāhil). As the overlying dunes provide a modern date, no *terminus ante quem* for the assemblages can be determined. The dunes above the flint horizons at both sites ranged from 0 ± 6 years ago to 35 ± 7 years ago and the OSL dates clearly demonstrate the mobility of some of the smaller-sized dunes in both areas, which seem less stable than their larger counterparts.

An appreciation of the earth's climate system during the Holocene is key to understanding how nomadic Neolithic communities exploited the Rub[c] al-Khālī, how these groups responded to both minor fluctuations and long-term environmental change; and how they developed under favourable lacustrine, savannah conditions, and their response to gradual desertification. In such a marginal environment minor fluctuations in the climate must have had a major impact on resources, and it is no surprise that flint assemblages are associated with lacustrine deposits. Furthermore, fluctuations in the climate may have caused enforced migration of communities living in the Rub[c] al-Khālī, not only within the early Holocene, but possibly during other periods. Clearly climate was a crucial mechanism in determining the level of resources available to Neolithic groups in the Rub[c] al-Khālī. Further work still has to resolve fundamental questions regarding migration patterns, and how these communities adapted to the onset of a hyper-arid environment. Future seasons of the project will be conducted under the auspices of the new Abu Dhabi Authority for Culture and Heritage (ADACH) with the University of Birmingham (UK) as a collaborating partner.

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References

Aitken M.J.
1998. *An Introduction to Optical Dating*. Oxford: Oxford University Press.

Beauclair R. de, Jasim S.A. & Uerpmann H-P.
2006. New results on the Neolithic jewellery from al-Buhais 18, UAE. *Proceedings of the Seminar for Arabian Studies* 36: 175–187.

Beech M., Kallweit H., Cuttler R. & Al-Tikriti W.Y.
2006. Neolithic sites in Umm az-Zamul. *Bulletin of the Society for Arabian Studies* 11: 17–26.

Bray H.E. & Stokes S.
2003. Chronologies for Late Quaternary barchan dune reactivation in the southeastern Arabian Peninsula. *Quaternary Science Reviews* 22/10: 1027–1033.

Crombé P.

2000. A Neolithic site at Bida Al Mitawaa in Western Abu Dhabi (U.A.E.). *Arabian Archaeology and Epigraphy* 11: 9–14.

Dance S.P. (ed.)

1995. *Seashells of Eastern Arabia*. Dubai: Motivate.

Edens C.

1982. Towards a Definition of the Western ar-Rub[c] al-Khālī Neolithic. *Atlal* 6/3: 109–124.

Fleitmann D., Burns S.J., Mudelsee M., Neff U., Kramers J., Mangini A. & Matter A.

2003. Holocene forcing of the Indian Monsoon recorded in a stalactite from Southern Oman. *Science* 200: 1737–1739.

Gebel H.G., Hanss C., Liebau A. & Raehle W.

1989. The Late Quaternary Environments of 'Ain al-Faidha (Al Ain, Abu Dhabi). *Archaeology in the United Arab Emirates* 5: 9–48.

Glennie K.W.

2001. Evolution of the Emirates land surface: an introduction. Pages 9–27 in I. Al Abed & P. Hellyer (eds), *United Arab Emirates: A New Perspective*. London: Trident Press.

2005. *The Desert of Southeast Arabia*. Bahrain: Gulf PetroLink.

Goudie A.S., Colls A., Stokes S., Parker A., White K. & Al-Farraj A.

2000. Latest Pleistocene and Holocene dune construction at the north-eastern edge of the United Arab Emirates. *Sedimentology* 47: 1011–1021.

Harris A.

1998. A Late Stone Age site south of the Liwa Oasis. *Tribulus (Journal of the Emirates Natural History Group)* 8/2: 24–27.

Kallweit H.

2001. Remarks on the Late Stone Age in the UAE. Pages 55–63 in D.T. Potts, H. Al Naboodah & P. Hellyer (eds), *First International Conference on the Archaeology of the United Arab Emirates, Abu Dhabi*. London: Trident Press.

2006. A new Tool Type from Umm az-Zamul Neolithic sites, United Arab Emirates. *Tribulus (Journal of the Emirates Natural History Group)* 16/1: 14–15.

(forthcoming). The lithics assemblage. In E. Popescu & M.J. Beech (eds), *Excavations at an Ubaid coastal settlement on Dalma island, Abu Dhabi, UAE*. (British Archaeological Reports, International Series). Oxford: Archaeopress.

Kallweit H., Beech M. & Al-Tikriti W.Y.

2005. Kharimat Khor al-Manāhil and Khor al-Manāhil — New Neolithic sites in the south-eastern desert of the UAE. *Proceedings of the Seminar for Arabian Studies* 35: 97–113.

Kiesewetter H., Uerpmann H-P. & Jasim S.A.

2000. Neolithic jewellery from Jebel al-Buhais 18. *Proceedings of the Seminar for Arabian Studies* 30: 137–146.

McClure H.A.

1988. Late Quaternary Palaeography and Landscape Evolution of the Rub[c] al-Khālī. Pages 9–13 in D.T. Potts (ed.), *Araby the Blest. Studies in Arabian Archaeology* (Carsten Niebuhr Institute Publications, 7). Copenhagen: Museum Tusculanum.

Murray A.S. & Wintle A.G.

2000. Luminescence dating of quartz using an improved single-aliquot regenerative-dose protocol. *Radiation Measurements* 32: 57–73.

Parker A.G., Davies C. & Wilkinson T.

2006. The early to mid-Holocene moist period in Arabia: some recent evidence from lacustrine sequences in eastern and south-western Arabia. *Proceedings of the Seminar for Arabian Studies* 36: 243–255.

Parker A.G., Eckersley L., Smith M.M., Goudie A.S., Stokes S., Ward S., White K. & Hodson M.J.

2004. Holocene vegetation dynamics in the northeastern Rub[c] al-Khālī desert, Arabian Peninsula: a phytolith, pollen and carbon isotope study. *Journal of Quaternary Science* 19/7: 665–676.

Preusser F. & Kasper H.U.
2001. Comparison of dose rate determination using high-resolution gamma spectrometry and inductively coupled plasma-mass spectrometry. *Ancient TL* 19/1: 19–23.

Preusser F., Radies D. & Matter A.
2002. A 160,000-Year Record of Dune Development and Atmospheric Circulation in Southern Arabia. *Science* 296: 2018–2020.

Rohling E.J. & Pälike H.
2005. Centennial-scale climate cooling with a sudden cold event around 8,200 years ago. *Nature* 434: 975–979.

Stokes S.
1999. Luminescence dating applications in geomorphological research. *Geomorphology* 29: 153–171.

United Arab Emirates University
1993. *National Atlas of the United Arab Emirates*. Reading: GEOProjects (UK) Ltd.

Van Campo E., Duplessy J.C. & Rossignol-Strick M.
1982. Climatic conditions deduced from a 150-kyr oxygen isotope-pollen record from the Arabian Sea. *Nature* 296: 56–59.

Wintle A.G.
1997. Luminescence dating: Laboratory procedures and protocols. *Radiation Measurements* 27: 769–817.

Zarins J., Murad A. & Al-Yaish K.H.
1981. The Second Preliminary Report on the Southwestern Province. *Atlal* 5/1: 9–43.

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