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The Palaeolithic of the northern Red Sea — new investigations in Tabuk and Al-Jawf provinces, Saudi Arabia

Robyn H. Inglis, Anthony Sinclair, Abdullah Alsharekh, Christopher Scott & Dhaifullah Al Otaibi

Summary

The land bridge formed by the Sinai Peninsula is one of the major routes proposed for hominin dispersal out of Africa for both *Homo erectus* and *H. sapiens* populations, and its neighbouring regions are, therefore, key to understanding these dispersals. Directly adjacent to the land bridge, the Saudi Arabian northern Red Sea and Gulf of Aqaba coastlines have, until now, been subject to only rapid survey for Palaeolithic archaeology in the 1970s–80s, locating a handful of Palaeolithic artefacts.

A twelve-day reconnaissance survey was undertaken by a Saudi-UK team along the northern Red Sea and Gulf of Aqaba coast in February 2018 for Palaeolithic artefacts, the results of which are presented in this paper. Thirty-four locations were surveyed, across a range of landscape settings, the majority yielding Acheulean and prepared-core technology lithic artefacts, traditionally ascribed to *Homo erectus* and *H. sapiens* populations in Arabia respectively. These observations, while descriptive and necessarily brief, identify a previously undocumented record of Palaeolithic archaeology in a largely unexplored part of Saudi Arabia. The landscape settings in which artefacts were observed provide a geomorphological framework for locating Palaeolithic material in future surveys to realize the potential of the region to understand hominin dispersals from Africa into Arabia and beyond.

Keywords: Palaeolithic, Saudi Arabia, Red Sea, dispersals, geoarchaeology

Introduction

Hominin populations dispersed from Africa into Europe and Asia from at least the beginning of the Pleistocene, with artefacts dated to 2.1 million years ago (mya) in China (Zhu et al. 2018), 1.8 mya in Georgia (Ferring et al. 2011), 1.6 mya in the Levant (Bar-Yosef & Belmaker 2010), 1.5 mya in India (Pappu et al. 2011), and 1.4 mya in Italy and Spain (Arzarello et al. 2007; Toro-Moyano et al. 2013). In this context of dispersal, the Sinai land bridge must always have been important for the movement of people and animals between Africa and Arabia throughout the Late Pleistocene. It has long been considered the primary, and probably the first, route taken by *Homo erectus*, and later *H. sapiens*, populations during their dispersals from Africa (Bar-Yosef & Belfer-Cohen 2013). The Palaeolithic record of this region, therefore, can inform on the routes, timing, and conditions of these first dispersals as well as the subsequent Palaeolithic occupation of Arabia.

A wealth of archaeological evidence deriving from a long history of research in the Levant, Jordan, East Africa, and latterly the interior of the Arabian Peninsula, illustrates the potential richness of the archaeological record of this region, yet some areas close to the route remain under-researched. In particular, while the interior of northern Saudi Arabia has been the subject of research since the Comprehensive Archaeological Survey Program (CASP) in the 1970s and 1980s (Ingraham et al. 1981; Gilmore, Al-Ibrahim & Murad 1982) followed by a programme of recent research associated with former lakes and water courses in the northern interior (see e.g. Breeze et al. 2017; Jennings et al. 2016; Scerri et al. 2015; Shipton et al. 2014; Petraglia et al. 2012), the Saudi Arabian littoral of the northern Red Sea, as well as the Gulf of Aqaba's eastern shoreline, have not been further investigated for Palaeolithic archaeological evidence since the 1980s. This first research in the 1980s identified two Palaeolithic find-spots near Al Muwaylih, but areas further north or along the Gulf of Aqaba were not included in this original survey (Ingraham et al. 1981; Gilmore, Al-Ibrahim & Murad 1982).

This paper reports on the findings of initial, exploratory fieldwork in the region undertaken by a

UK-Saudi team in spring 2018 and presents some initial interpretations. The team investigated thirty-four localities chosen across a range of landscape settings. Nearly all of these localities yielded surface lithic artefacts with Palaeolithic technological characteristics. The necessary speed of fieldwork means that most localities only yielded a small number of lithic artefacts, for which the interpretation remains preliminary. The common presence, however, of Palaeolithic artefacts in the survey region demonstrates that the littoral region of the northern Red Sea and Gulf of Aqaba, like many other under-researched regions, should not be ignored; the environments and resources within the region may have provided a draw for dispersing populations to move along and within, rendering the Red Sea coastline key to understanding the prehistory of the Arabian Peninsula, particularly in the dispersals of *H. sapiens c.*125,000 years ago during Marine Isotope Stage 5 (MIS5; Bailey et al. 2015; Inglis et al. 2018).

Geological setting

The far north-west of Saudi Arabia can be divided into a series of broad landscape zones (Fig. 1). The region is dominated by the Hejaz Mountains, the northernmost extension of the Arabian Escarpment which runs the length of the Red Sea (Vincent 2008). The Hejaz Mountains consist of the faulted and tilted Proterozoic

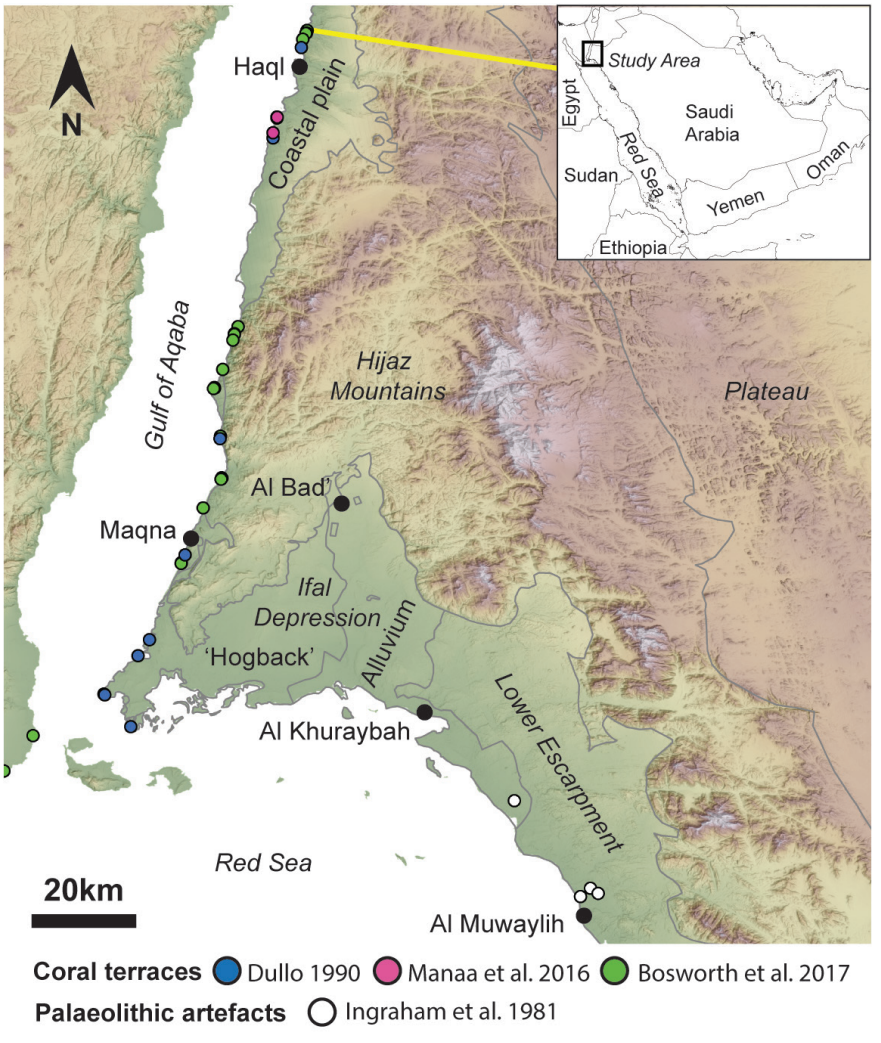

Figure 1. *The study region in north-western Saudi Arabia showing the main landscape zones discussed in the text, the locations of recorded MIS5 coral terraces, and known Palaeolithic find-spots (elevation data © CGIAR-CSI SRTM 90 v4.1 database).*

rocks of the Arabian shield (primarily granitic, but also including mafic plutons and sedimentary-volcaniclastic successions; Johnson 2006) and rise to a height of >2500 m in the study region. They are deeply incised by wadis providing a limited series of constricted routes inland to the Arabian Platform which, to the east of these mountains, broadly slopes eastwards to the Arabian Gulf.

The Gulf of Aqaba, the southern extension of the Aqaba/Dead Sea Transform, is 180 km long and 25 km wide at its widest point, reaching depths of over 1800 m in its centre. Its steep coastal topography is the result of ongoing tectonic uplift recorded in the heights of raised coral terraces (between 3 and 26 m a.s.l.) dated to MIS5e (Bosworth et al. 2017; Taviani et al. 2018; Manaa et al. 2016; Dullo 1990), and continues offshore leaving little by way of a continental shelf. During periods of low sea level therefore, the Gulf's shoreline would not have moved laterally far from its present location. The narrow coastal plain between the Hejaz Mountains and the Gulf (dominated by alluvial sedimentation from wadis draining the mountains) reaches a maximum of *c.*20 km close to Haql, but disappears almost completely in the central and southern Gulf (Bayer et al. 1984).

South-east of the Gulf of Aqaba lies the Ifal Depression, a broadly triangular, low-lying area running for 50 km south from Al Bad' town. It is surrounded on its north, east, and west by the Hejaz Mountains, and on its south by the Red Sea. The Depression, filled with sediments, is a northern extension of the Red Sea graben system, with multiple faults both within and bordering it (Briem & Blümel 1984). Wādī Ifal, the largest wadi draining the Depression, drains a large area of the Hejaz Mountains. Other wadis flow into the Depression forming alluvial fans of varying size, age, and height, particularly to the east where prominent alluvial terraces rising up to 50 m above the present baseline border wadis emerging from a fault scarp. While the northern and eastern parts of the Depression are covered by alluvial deposits, towards the south and east a large area of tilted Tertiary sands and gravels is exposed at the surface, the differential erosion of which has resulted in an undulating 'hogback' topography, with linear bands of gravel of mixed lithologies forming ridges following erosion of interleaved finer sediment bands (Briem & Blümel 1984).

To the south of the Ifal Depression, from Al Khuraybah southwards, the coastal zone of the northern Red Sea consists of a relatively low-lying (*c.*250 m a.s.l.) area of hills 15–25 km wide, dominated by the mafic plutons of the Muwaylih suite and the meta-volcanic and meta-sedimentary Ghawjah formation (Johnson 2006). These 'lower escarpment' hills separate higher mountains to the east from the narrow (*c.*3–7 km) alluvium-dominated coastal plain, and are deeply incised (>100 m in places), containing enclosed basins formed by localized faulting and differential erosion of basement rocks.

No MIS5e coral terraces have been identified on the Red Sea coastline north of Duba (45 km south of Al Muwaylih) where a fossil terrace at *c.*4 m a.s.l. extending for 500 m was dated to MIS5e (Manaa et al. 2016). A major geomorphological feature of the surveyed coastal zone, however, is a thick (up to 50 m) fossil reef complex of unknown and potentially significant age that is preserved at the western, seaward, edge of the lower escarpment hills at up to *c.*70–100 m a.s.l.

The study region is heterogeneous in its landscape history and geology, and in the landscape settings available to Palaeolithic hunter-gatherers. A number of features make it appealing for survey. Firstly, while the region is dominated by granitic rocks not conducive to stone-tool manufacture, substantial exposures of volcanic and metamorphic rocks (e.g. rhyolite, quartzite) would have provided raw material for tool manufacture. Wadis draining the Hejaz mountains would have transported raw materials as clasts from the interior into the coastal regions, increasing the range of accessible lithologies. Secondly, the narrow offshore topography constrains the extent to which late Pleistocene sea-level fluctuations impacted upon the area of terrestrial landscapes available to Palaeolithic populations. Given that coral terraces in the southern Red Sea have yielded Palaeolithic artefacts, the potential for similar finds in the northern Red Sea is high (Zarins, Murad & Al-Yaish 1981; Inglis et al. 2018; Bailey et al. 2015). Thirdly, the diversity of the landforms in the study region present multiple opportunities for the preservation of Late Pleistocene landscape surfaces and deposits where artefacts may have been deposited, preserved, and rendered visible to present-day survey. Particularly key are the coastal and marine terraces, which, if they yield artefacts embedded within them, may provide evidence of coastal occupation and activity.

Previous archaeological survey

Despite its proximity to the rich Palaeolithic record of the Levant (see papers in Enzel & Bar-Yosef 2017), as well as known sites in the Saudi Arabian interior (Breeze et al. 2017; Jennings et al. 2016; Scerri et al. 2015; Petraglia et al. 2012; Groucutt & Petraglia 2012), the study area was last surveyed for Palaeolithic archaeological materials as part of the Comprehensive Archaeological Survey Program (CASP) in the 1970–1980s (Ingraham et al. 1981). This survey identified four locations with Palaeolithic artefacts (as well as circular enclosures) on the coastal plain, all on terraces in wadis north-east of Al Muwaylih (Fig. 1). Unfortunately, the lithics discovered were mostly undiagnostic, aside from a single 'Middle Palaeolithic' transverse scraper found at 204-61 along with large basalt flakes and blades classified as 'probably' Palaeolithic (1981). The authors report no Palaeolithic sites from the Hejaz Mountains, noting that their absence might be attributable to either survey methodology or geomorphological factors including Quaternary sediment cover (1981). It should also be recognized that the CASP did not investigate the 'beach terraces' along this section of the Red Sea coastline even though it was noted by the authors that similar terraces had yielded artefacts in the southern Red Sea (1981).

The extremely limited nature of the previous survey history for this region, when considered alongside the rich finds of Palaeolithic age artefacts in other parts of Arabia, and the geographical proximity of this area to potential dispersal routes for hominins out of Africa highlights the need for further research and sets the context for a new programme of field survey initiated in 2018.

Survey aims and methodology

The 2018 fieldwork aimed to:

a) identify the major geomorphological units in the study region and assess their potential for preserving Palaeolithic artefacts and for informing models of landscape evolution;
a) locate and record Palaeolithic artefacts and their techno-typological affinities to begin to place the Palaeolithic record of the region in its temporal and regional context.

The landscape was assessed prior to survey using methods developed by the authors in the southern Red Sea (Devès et al. 2013; Inglis et al. 2014). Satellite imagery, remote-sensing data, and geological maps were used to build up a broad-scale understanding of landscape zones and the predominant geomorphological conditions within them, followed by more detailed mapping of landforms with apparent suitability for the preservation, exposure, and visibility of Palaeolithic artefacts on the surface. Three main areas were designated for survey: the eastern coastline of the Gulf of Aqaba; the Ifal Depression; and the northern Red Sea coastline between Al Khuraybah and Al Muwaylih. Within each area landscape settings with high potential for Palaeolithic archaeology were targeted (e.g. alluvial terraces), as well as a few settings with lower potential for comparison (wadi beds, sloping jebels).

Survey was carried out in February 2018 with a team of seven archaeologists completing twelve days of survey: three in the Gulf of Aqaba, four in the Ifal Depression, and a further five days around Al Khuraybah/Al Muwaylih. Each location investigated was given a 'locality' number (e.g. L0001) and basic descriptive characteristics were recorded (e.g. local lithology, topography, sediment, and vegetation cover). Survey strategy at each locality consisted of walking short transects, 100–500 m in length according to local conditions. Artefact finds, as well as key geomorphological features and transect ends were assigned 'waypoint' numbers (e.g. WP0001) and recorded using handheld GPS (Garmin GPS 62s). At L0006 (see below), given the quality and density of artefacts, artefact positions were recorded within a defined 10 x 5 m area using a Trimble Geo7X and Zephyr Model 2 external antenna running ArcPad 10, while also noting a wider set of techno-typological characteristics than at other localities.

Artefacts were photographed in the field and recorded with a brief techno-typological description, before being left in place, except for a small number (thirty-eight pieces) that were deposited in the care of the Saudi Commission for Tourism and National Heritage (SCTH), Tabuk. These artefacts were collected, in the absence of other available specimens, to facilitate the display of the region's Palaeolithic archaeology in the regional antiquities museum under construction in Tabuk. They may also serve as comparatives for future scholars.

The typological form of certain diagnostic artefacts has been used to offer a provisional chronological age for the localities. In the study area the presence of hand axes, biface cleavers, and other large flake-based tools are taken as evidence of Acheulean age occupation, while the presence of prepared cores and their prepared-core flake and prepared-core flake-blade products and, occasionally, large blades indicate a later age. Finally, we have recorded a few smaller retouched tools based on blades derived from prismatic cores and often made of raw materials, sometimes chert, that are exotic to the locality. These few blade-based tools are likely to be later in age than artefacts using prepared-core technology. All remaining pieces have been defined for the present as chronologically non-diagnostic.

In broader chronological terms, in the absence of absolute dates as yet, we also chronologically describe Acheulean artefacts as being of Early Stone Age (ESA), and those with prepared core technology as Middle Stone Age (MSA). These terms have been primarily used within an African geographic context, with other researchers in Arabia employing the terminology of Lower and Middle Palaeolithic, originally defined on European materials (Monnier 2006), for these two successive archaeological periods. This specific choice of terminology has been made since a primary question of this research is the identification of hominin dispersals into Arabia. A hypothesis shared among all researchers working in Arabia is that Africa represents the original geographical source of hominin populations bearing first Acheulean and later prepared-core technologies. East Africa is the probable source area for these dispersing hominin populations and here, Early Stone Age and Middle Stone Age are the higher-level chronological terms used pending absolute dates.

Results

Gulf of Aqaba

Survey localities along the Gulf of Aqaba targeted locations with fossil coral terraces preserved above the present-day shoreline, a number of which had been dated to MIS5e in earlier surveys (Manaa et al. 2016; Bosworth et al. 2017; Taviani et al. 2018). These terraces were targeted for two reasons: firstly, similar terraces in the southern Red Sea had yielded Palaeolithic artefacts, some embedded underneath and within marine deposits; secondly, such terraces preserved surfaces of at least MIS5 age where artefacts were likely to be isolated, and therefore preserved from, destruction or burial by wadi action. Nine localities (L0001–9) were surveyed along the Gulf (Fig. 2/a), with Palaeolithic artefacts identified at six of them (Fig. 3).

In the far north of the Gulf, where the coastal plain is relatively wide and covered by alluvium, the MIS5 fossil coral terraces form prominent cliffs standing up to 20 m above the surrounding sabkhas (Fig. 2/b) (Bosworth et al. 2017). Three localities (L0001–3) with coral terraces were investigated, and a total of six artefacts of prepared-core and prismatic blade typologies were recorded (Fig. 3).

In the central part of the Gulf, two localities (L0005 & L0006) were examined on Ras Suwayhil el Kabir, a triangular point extending 3 km into the Gulf from the scarp of the Hejaz Mountains, comprising gently sloping alluvial fan sediments (Fig. 2/a). L0005 is located on a fossil coral terrace capped by alluvium (Fig. 2/c); an exposed profile through this terrace suggests an interleaving of coral, alluvial fan, and shoreline deposits at the alluvial unit's base. No artefacts were recorded. Four kilometres to the south of L0005, a terrace of coral and alluvial fan deposits abutting the edge of the mountains was examined as L0006. This terrace is a major landscape feature, with incisions exposing sediments in cliffs up to 40 m tall. It was surveyed by the Saudi Geological Survey in 2013 and contains fossiliferous sands and coral heads up to 25 m a.s.l. (designated Stations 13 and 14 in Taviani et al. 2018), and while not directly dated, was interpreted as deposited during the MIS5e high sea stand (132–115 ka). The coralline deposit at L0006 is covered by a laminar sand unit (*c.*1 m thick) tilted towards the sea, which itself is overlain by a 2–3 m-thick (at its seaward extent) unit of rounded to angular gravel to cobbles in a sandy matrix (Fig. 4). On the surface of the terrace four Acheulean hand axes were found, as well as one discoidal or possibly prepared core and a range of other artefacts made on a variety of lithologies from quartzite to indurated shale mostly concentrated in one area (Sinclair et al., in preparation). The exceptional and localized nature of this assemblage was recorded by piece plotting of artefacts within a defined 10 x 5 m area, with forty-two artefacts recorded giving a density of 0.8 artefacts/metre.

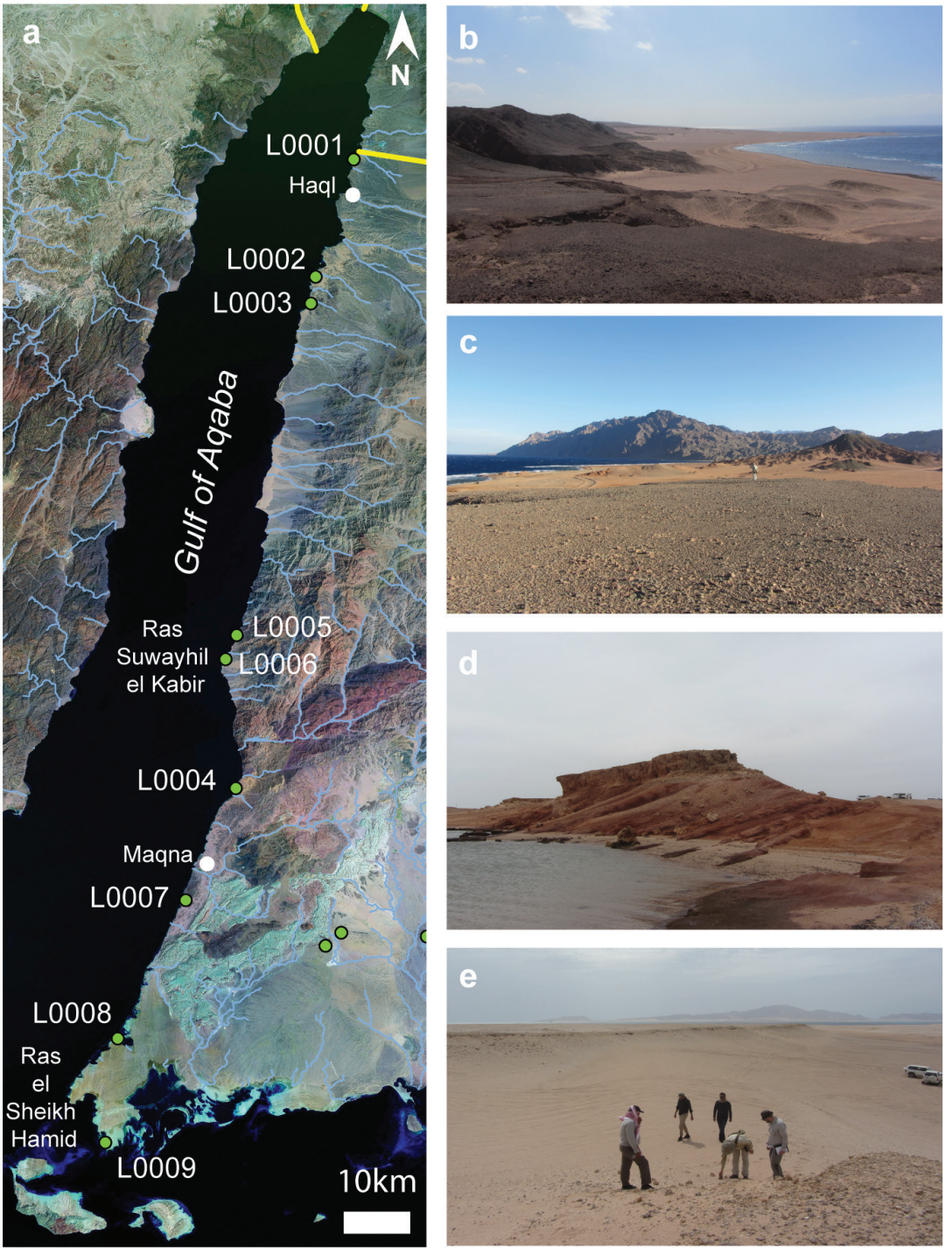

Figure 2. a. *Map and* **b–e.** *general views of localities visited in the Gulf of Aqaba.* **b.** *Coral terraces overlain by colluvial/alluvial deposits adjacent to a bedrock jebel at L0003;* **c.** *the surface of a coral terrace at L0005 showing the Hejaz Mountains forming steep cliffs at the northern end of Ras Suwayhil el Kabir;* **d.** *a coral terrace overlying tilted Tertiary sediments at L0008;* **e.** *a coral terrace above a present-day sabkha at L0009, Ras el Sheikh Hamid (satellite imagery © USGS Landsat ETM+ 2000 Gecover Mosaics; photographs R. Inglis).*

Locality	Coordinates	Landscape type	No. of artefacts recorded	Chronologically diagnostic artefact recorded			
				Acheulean	Prepared-core	Prismatic blade	Small blade / Neolithic
Gulf of Aqaba							
L0001	*N 29°20' 79.6" E 34°57'19.0"*	Coral terrace	2		1		
L0002	*N 29°09'16.1" E 34°53'45.1"*	Coral terrace	3			1	
L0003	*N 29°11'24.4" E 34°54'08.1"*	Coral terrace	1				
L0004	*N 28°30'25.8" E 34°47'45.3"*	Alluvial unit above coral terrace	2				1
L0005	*N 28°42'41.6" E 34°47'48.7"*	Alluvial unit over coral terrace	0				
L0006	*N 28°40'46.5" E 34°46'55.3"*	Alluvial unit over coral terrace	47	11			
L0007	*N 28°21'27.9" E 34°43'44.6"*	Alluvial unit over coral terrace	7	1			
L0008	*N 28°10'23.8" E 34°38'17.3"*	Coral terrace	0				
L0009	*N 28°02'03.3" E 34°37'17.7"*	Coral terrace	0				
Ifal Depression							
L0010	*N 28°17'49.0" E 34°54'55.7"*	Alluvial fan	9		1	4	
L0011	*N 28°18'51.5" E 34°56'11.0"*	Tertiary 'hogback' ridges	20 (3 cobbles with pecked markings)		1	2	
L0012	*N 28°32'53.7" E 35°03'41.6"*	Alluvial fan	0				
L0013	*N 28°25'25.4" E 35°04'12.3"*	Alluvial fan	5 (incl. 1 cobble with pecked marking)	1	1		
L0014	*N 28°27'44.3" E 35°04'57.9"*	Isolated outcrop of sedimentary rock	1				
L0015	*N 28°21'37.1" E 35°05'07.7"*	Alluvial fan	0				
L0016	*N 28°21'09.4" E 35°05 00.2"*	Alluvial fan	4	1	1		1
L0017	*N 28°18'33.2" E 35°03'02.2"*	Alluvial terrace	8		3		
Al Khuraybah to Al Muwaylih							
L0018	*N 28°03'28.9" E 35°17'56.4"*	Jebel of isolated alluvium	1 (incl. 1 cobble with pecked marking)				
L0019	*N 28°03'16.4" E 35°18'09.6"*	Alluvial terrace	9		2		1
L0020	*N 27°40'54.2" E 35°29'25.3"*	Alluvial terrace	9			1	1
L0021	*N 27°40'56.1" E 35°31'14.2"*	Alluvial terrace	2			1	
L0022	*N 27°41'24.4" E 35°32'09.1"*	Alluvial terrace	9	1	3		
L0023	*N 27°58'03.7" E 35°16'38.5"*	Alluvial terrace	23	5	7	1	
L0024	*N 27°51'13.7" E 35°35'00.2"*	Alluvial terrace	0				
L0025	*N 27°51'40.2" E 35°35'13.6"*	Alluvial terrace	12		3		
L0026	*N 27°50'13.2" E 35°36'11.7"*	Jebel of bedrock	0				
L0027	*N 27°48'10.6" E 35°36'08.0"*	Wadi bed	0				
L0028	*N 27°54'09.7" E 35°21'26.3"*	Alluvial terrace	20	2	3		
L0029	*N 27°58'02.3" E 35°16'26.5"*	Alluvial terrace	21	1	4	1	
L0030	*N 27°58'45.9" E 35°15'00.5"*	Fossil corral terrace	1		1		

Figure 3. *Localities and artefacts recorded in the 2018 reconnaissance survey. For diagnostic artefacts recorded: Acheulean includes hand axes and cleavers; prepared-core includes both prepared cores, prepared-core flakes, and flake-blades; small blade/Neolithic includes small blades made on prismatic cores that are similar to artefacts recorded from pre-pottery Neolithic sites in the region. The difference between the total number of artefacts recorded and the diagnostic artefacts is the number of non-diagnostic artefacts.*

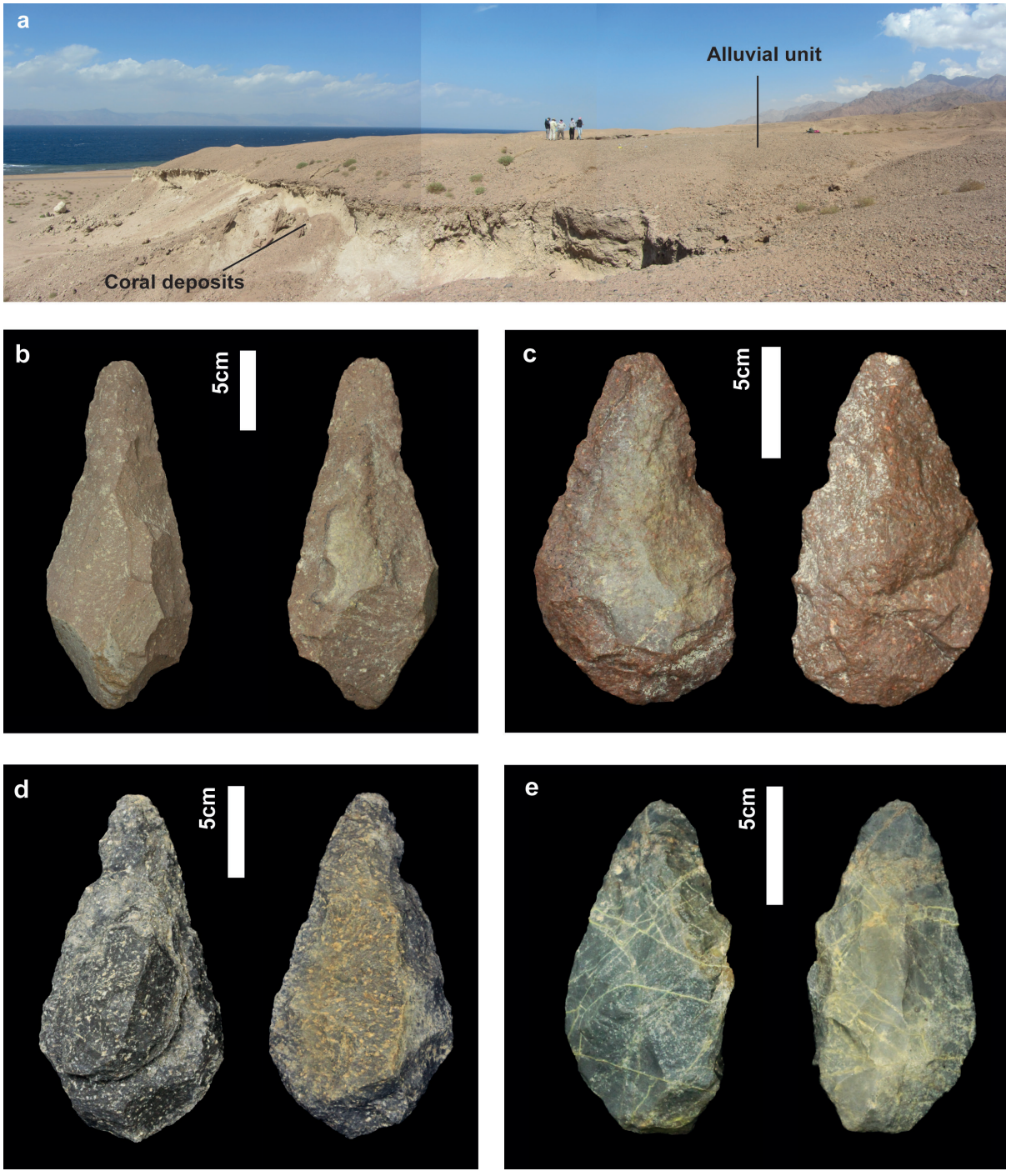

Figure 4. *L0006 geological setting and examples of hand axes from L0006:* **a.** *view of a terrace top formed of coral deposits overlain by a unit of cobbles interpreted as alluvial deposition. People are standing at the location of the detailed artefact recording grid;* **b.** *a large pointed hand axe with careful retouch to define the tip;* **c–e.** *three examples of hand axes made using different raw material. Careful retouch has been used to define one straight lateral cutting edge with the other remaining thicker, presumably for holding in the hand (photographs A. Sinclair).*

These hand axes range in length from 251 to 146 mm and in maximum breadth from 106 to 66 mm. Six have been clearly made on large flake blanks, but from different materials, including basalt, rhyolite, and quartzite, while the seventh may have been made on a naturally exfoliated, angular clast. There is variation in the degree of finishing with greater evidence of retouching of the tip rather than the butt where a possible cortical surface on one, and the original flake blank surface on the others, remain visible; each has a finely prepared cutting edge down one lateral margin.

The artefacts lying on the terrace surface at L0006 were either deposited on, or derived from, an apparently alluvial unit which is undergoing ongoing deflation and erosion; excavation at the locality is necessary to test this hypothesis. Examination of surfaces of the alluvium to the east revealed no further artefacts, suggesting that L0006 represents either a defined locus of activity or a restricted exposure of artefact-bearing sediment. Just beyond the grid, to both the north and the south, three more hand axes were recorded as single finds in gullies that cut through fine-grained, green-grey laminated sediments (indicative of low-energy deposition by water). Since these green sediments are capped by the alluvial unit, it is possible that these isolated hand axes also originate from the same context as those recorded in the grid, and have been washed down into the gullies. Significant questions remain about site stratigraphy and its environmental and taphonomic history, primarily how Acheulean age artefacts along with possible artefacts were made using prepared-core technology to be situated stratigraphically above (and therefore later than) an MIS5e coral terrace, requiring future detailed geomorphological and chronological investigation.

At the southern end of the Gulf of Aqaba, four localities were visited. L0004 and L0007 are both located on coral terrace deposits capped by alluvial deposits similar to the localities surveyed at L0006. At L0004, two artefacts were recorded, one a retouched blade tool made using chert; at L0007, a series of four lightly weathered lithics, including one non-diagnostic bifacial piece, were observed alongside a well-rolled brown quartzite hand axe. The variable condition of these artefacts suggests that pieces had both weathered out from the underlying alluvium (where they may already have been redeposited from their original environment, e.g. the rolled hand axe), as well as being later deposited on the terrace.

L0008 and L0009 are located on the low-lying, undulating hogback landscape of Ras el Sheikh Hamid, ridges that provide a large range of knappable materials. At L0008, where a coral terrace overlay both sandstone bedrock and Tertiary deposits, much of this gravel was thermally shattered. No artefacts were observed on either the coral terrace surface or the surrounding slopes (Fig. 2/d). At L0009 the landscape consists primarily of coralline carbonate rocks, with no obviously knappable materials present. No artefacts were observed.

Ifal Depression

Landscapes within the Ifal Depression can be broadly divided into two types: to the north and east, alluvial terraces border wadis that drain the mountains; to the west and south, low-lying hogback ridges of tilted Tertiary sediments (Briem & Blümel 1984). Localities in both types of landscape were visited, as the two landscapes have different potential for preservation, exposure, and visibility of Palaeolithic archaeology. The hogback landscape is predominantly erosional, and therefore has good potential for the exposure and visibility, but not preservation, of artefacts that may be removed by this erosion. By contrast, the alluvial deposits may conceal artefacts within them, but deflation of these deposits through winnowing of fine material may expose buried artefacts, as well as impacting little on the lateral location of artefacts deposited on top of them. This deflationary environment, and the 'pavement' of clasts it produces, also provide excellent artefact visibility and these alluvial deposits therefore possess potential for locating Palaeolithic artefacts.

Eight localities were examined in the Ifal Depression (Fig. 5), six on alluvial terraces (L0010, L0012, L0013, L0015, L0016, L0017), one on the hogback ridges (L0011), and one on an isolated hill of sedimentary rock to the east of the depression (L0014). No artefacts were observed at L0014, but at L0011, nine Palaeolithic artefacts were found as well as three rounded cobbles bearing pecked designs, possibly Thamudic in age (Fig. 6).

Four localities (L0010, L0013, L0016, and L0017) yielded Acheulean and prepared-core technology artefacts, as well as a number of prismatic blade artefacts that may be younger, and a few of potentially Neolithic age (Fig. 7). All artefacts were weathered and lightly or moderately rolled, and no localized concentrations of

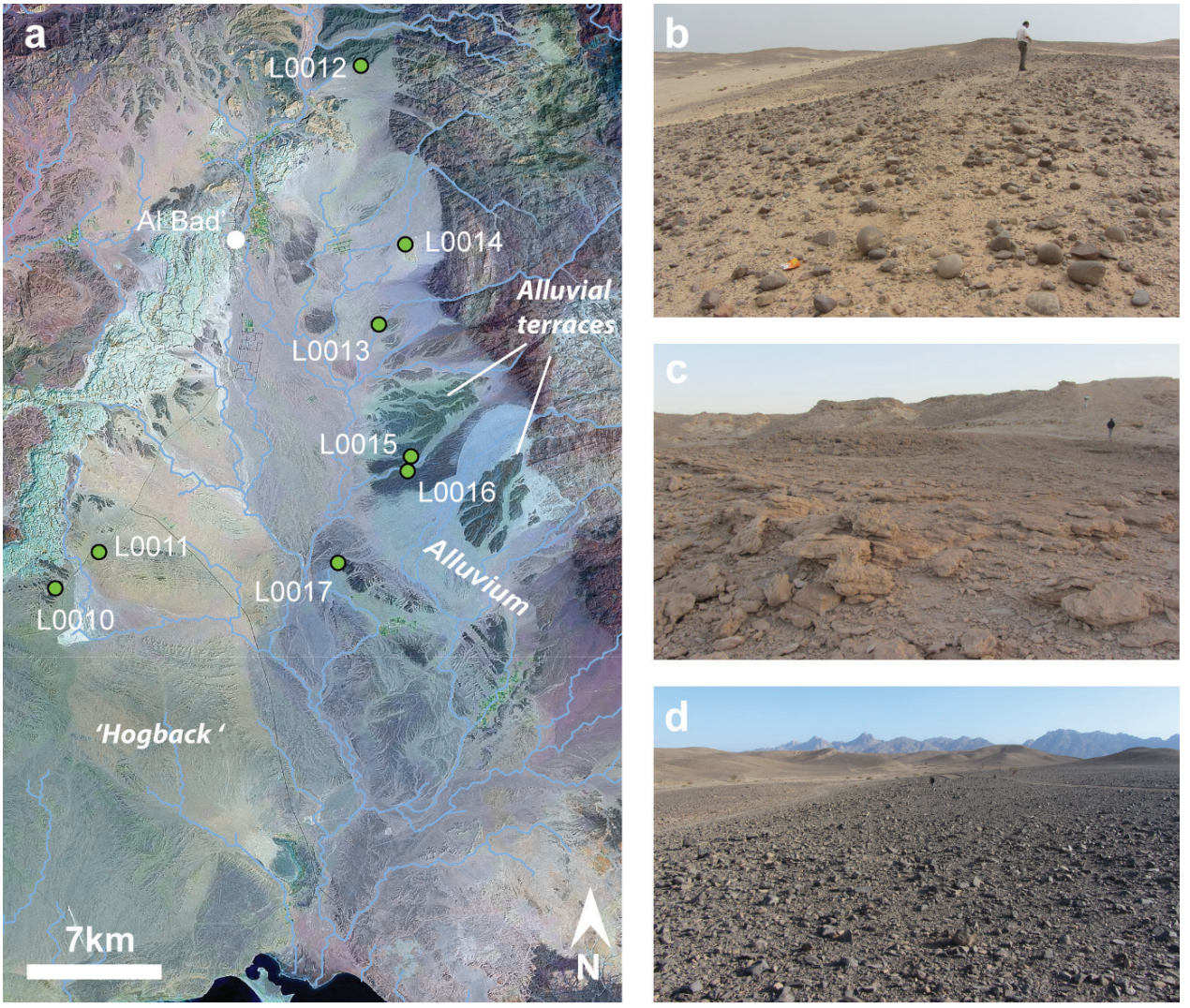

Figure 5. a. *Overview of localities visited in the Ifal Depression;* **b.** *'hogback' topography at L0011;* **c.** *the surface of a hill of sedimentary rock at L0014;* **d.** *the surface of an alluvial terrace at L0016 (satellite imagery © USGS Landsat ETM+ 2000 Gecover Mosaics; photographs R. Inglis).*

artefacts were found at these localities. Furthermore, the condition of the artefacts suggests that they had been moved from an original and different location of manufacture or use. The condition of clasts on the surface of the six alluvial terrace localities showed significant variation in the degree of 'polish' present; while the development of such polish is not a linear process, such variability probably results from multiple phases of alluvial deposition.

Al Khuraybah to Al Muwaylih

The coastline between the towns of Al Khuraybah and Al Muwaylih was a specific focus of investigation as it was the alluvial terraces above Al Muwaylih that had yielded the only reported Palaeolithic artefacts from the region (Ingraham et al. 1981). Due to their favourability for the preservation, exposure, and visibility of lithic artefacts, alluvial terraces were the predominant landscape

Figure 6. *Pecked Thamudic designs on quartzite cobbles at L0011 (photographs A. Sinclair).*

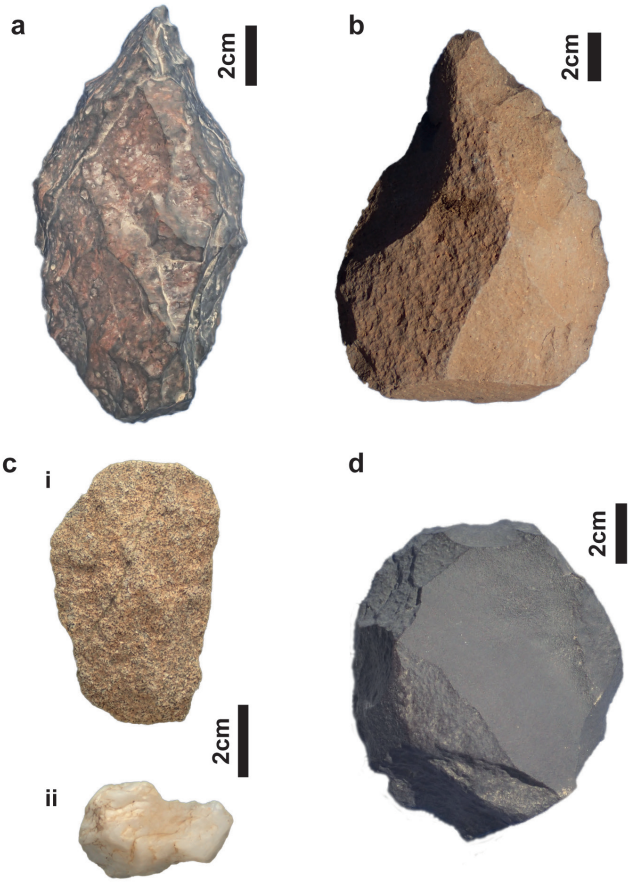

Figure 7. *A series of artefacts recorded from localities in the Ifal Depression:* **a.** *a pic;* **b.** *a large flake with a fine lateral edge created using bifacial retouch;* **c/i.** *a weathered convergent flake with a broken tip;* **c/ii.** *a quartz flake;* **d.** *a horse-hoof shaped core on a round cobble (photographs A. Sinclair).*

setting surveyed in this region, both the large terraces (tens of metres high) along the narrow coastal plain, and smaller alluvial terraces in enclosed basins situated within the lower escarpment area between the coastal plain and the Hejaz Mountains (Fig. 8).

Alluvial terraces

Three localities (L0020, L0021, and L0022) were surveyed on alluvial terraces directly to the south and east of Al Muwaylih, close to sites with Palaeolithic artefacts

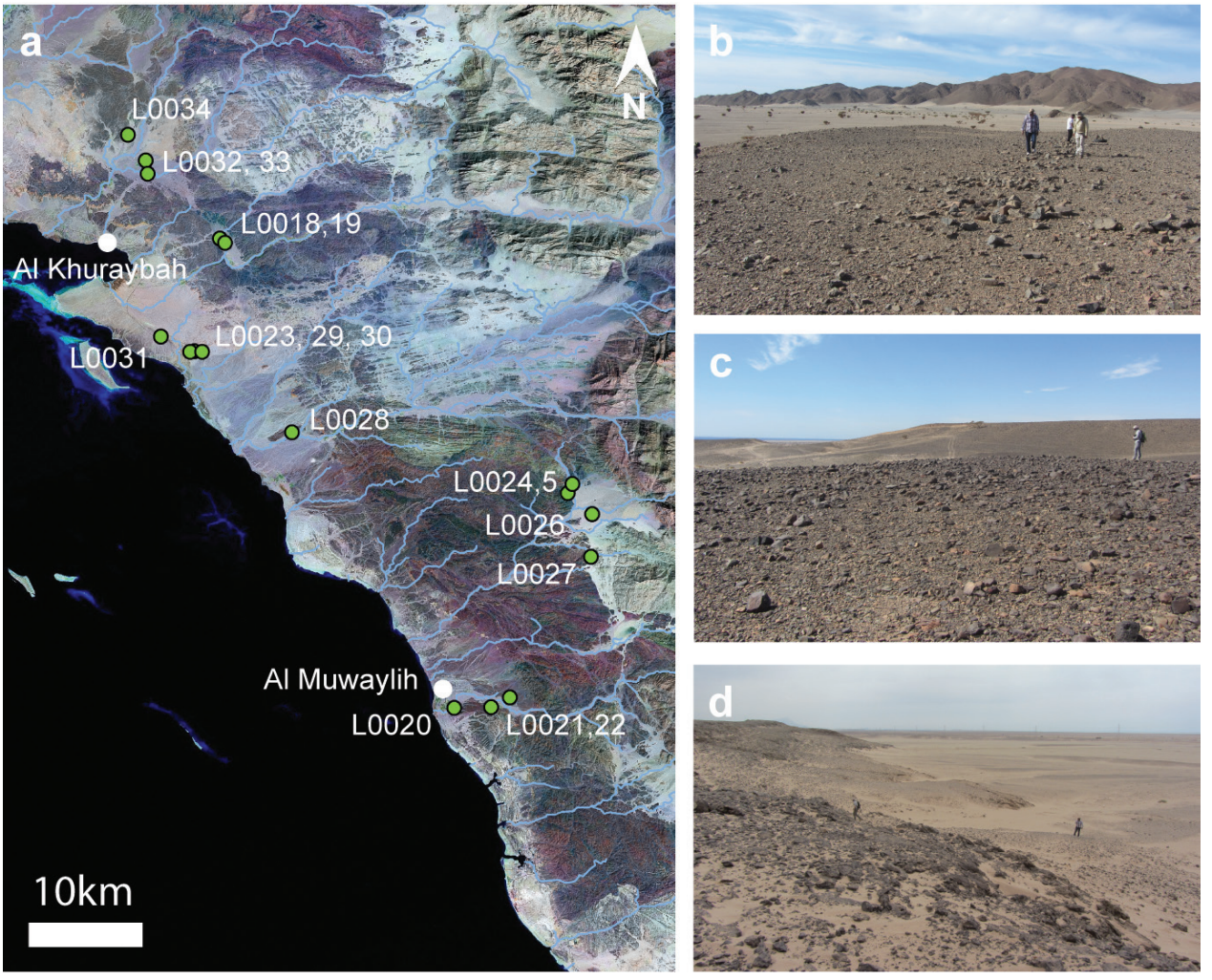

Figure 8. a. *The coastal area between Al Khuraybah and Al Muwaylih showing the localities visited;* **b.** *L0025: a row of funerary cairns on the surface of an alluvial terrace;* **c.** *the surface of an alluvial terrace at L0028;* **d.** *L0031: a fossil coral terrace at the edge of a lower escarpment (satellite imagery © USGS Landsat ETM+ 2000 Gecover Mosaics; photographs R. Inglis).*

discovered by the CASP (204-58, 204-60, and 204-61). The terraces here survive at two levels; a lower terrace (*c.*10 m above the present wadi bed) of clasts and sand with modern funerary cairns, and a higher terrace (*c.*20–30 m above the present wadi bed) consisting of a heavily polished and patinated desert pavement of rounded to sub-angular clasts on a slightly undulating surface. Twenty lithic artefacts were found across all three localities, with prismatic blade-based artefacts of post MSA or Neolithic age at L0020 and L0021 respectively. At L0022, the nine artefacts include Acheulean tools and prepared-core technology artefacts (see Fig. 3). On the north bank of the wadi at L0024, on a *c.*15 m terrace with clasts that are less polished than at the localities on the southern side, twelve artefacts made on a range of lithologies (basalt, schist/shale, quartzite) were observed, a small number are of clear prepared-core typology.

An isolated alluvial terrace 27 km north-west of Al Muwaylih, thought to be equivalent to CASP site 204-78 where undiagnostic Palaeolithic artefacts were observed (Ingraham et al. 1981) was surveyed as L0028. This

terrace stands approximately 20 m high and is roughly rectangular; here, the surface comprises clasts with a moderate degree of polish that retains distinctions in colour between the various lithologies present (basalt, quartzite, shale, etc.). On this terrace, twenty artefacts were recorded with a small number of pieces showing clear Acheulean and prepared-core typology (see Fig. 3).

Seven kilometres south-east of the town of Sharma, a low terrace (*c.*25 m a.s.l.) of alluvium forms a 10 km-long peninsula (mostly now privately enclosed) that has been isolated by present-day wadi beds that flow around its landward edges. The alluvium was probably deposited by Wādī Sharma, with the later change in flow direction and terrace isolation related to tectonic activity or sea-level change. The main terrace was surveyed at L0031, with a second, smaller terrace remnant isolated from the south-eastern extent of the main terrace surveyed at L0023 and L0029. Finally, a transect was surveyed up onto the 70–100 m a.s.l. terrace which is capped by the ancient coral reef (L0030).

The survey localities on the alluvial terrace yielded a wide range of artefact types and lithologies and in places a range of pieces that look like coherent debitage assemblages (see Fig. 3). At L0031, six artefacts were recorded, two made using a prepared-core technology and another on a prismatic blade. At L0023, survey recorded twenty-three Acheulean and prepared-core artefacts as well as one prismatic blade piece (Fig. 9). Survey of the northern part of the alluvial remnant (L0029) confirmed a lower density scatter of artefacts with twenty-one artefacts across the wider surface, including some relatively recent clast reduction assemblages. Finally, at L0030 a single relatively fresh, MSA prepared core was found lying on alluvium and aeolian sand at the base of the terrace made on hornfels.

Enclosed basins

The southernmost surveyed basin, Al Jim, which is around 6 km wide, was investigated at four locations (L0024, L0025, L0026, and L0027). No artefacts were located on surfaces of active sedimentation at the edges of the basin (L0024), in the active wadi bed (L0027), or on top of an isolated hill of bedrock (L0026). At L0025, however, a low-lying alluvial terrace (Fig. 7/b), 400 m in length and *c.*3–4 m above the surrounding landscape, twelve artefacts of different typologies and lithologies (three of MSA type), were recorded as well as a line of funerary cairns along the long axis of the terrace (see Fig. 3).

Wādī Sharma and another, smaller, wadi flow through a roughly rectangular basin, 4.5 x 1 km, 35 km to the north-west of the Al Jim basin. This basin was surveyed at two localities: L0018 was located on a hill of alluvial sediments and bedrock, and L0019 on a low alluvial terrace (2–3 m) in the centre of the basin. No artefacts were found at L0018, although two robbed-out funerary cairns were observed at its top, one accompanied by a Thamudic inscription on a large quartzite clast. On the alluvial terrace, nine artefacts were recorded with two artefacts of prepared-core technology, including a single prepared core and one small prismatic blade.

The northernmost basin that was investigated lies at the foot of Jebel Zehad, north-east of Al Khuraybah. It is bisected by Wādī Ainounah, a major watercourse in the region, which until the 1970s contained perennial flow, indicative of springs in its catchment. Three localities were visited in this basin, all on alluvial terraces. L0032 is situated on a low (3–4 m) terrace in the centre of the basin; L0033 consists of two flat-topped terrace remnants up to 10 m high, the larger of which overlay a vein of caramel-coloured quartz utilized in many of the artefacts recovered from its surface. At L0032, fourteen artefacts were recorded with examples of Acheulean and prepared-core artefacts present; at L0033, ten artefacts were recorded with four diagnostic examples of Acheulean typology.

In the Jebel Zehad basin a final locality, L0034, was examined on the south-eastern edge of a large alluvial terrace that extends 12 km north-east of the Ifal Depression. At the foot of the terrace, three Acheulean hand axes and a cleaver were recovered from the surface. While two hand axes were rolled and weathered, another, with sharp edges and yellowish patina, appears to have emerged recently from the terrace sediment (Fig. 10). This is a distinct possibility since the lower part of the terrace has undergone limited bulldozing. It may also be a separate, lower terrace than the upper surface of the main terrace situated *c.*20 m higher. The clasts on the upper surface of the main terrace were very heavily patinated. Nine artefacts were recorded, with two artefacts made using prepared-core typology and two deriving from a prismatic blade core. Further work to discern the stratigraphy and origin of the lithics particularly in the

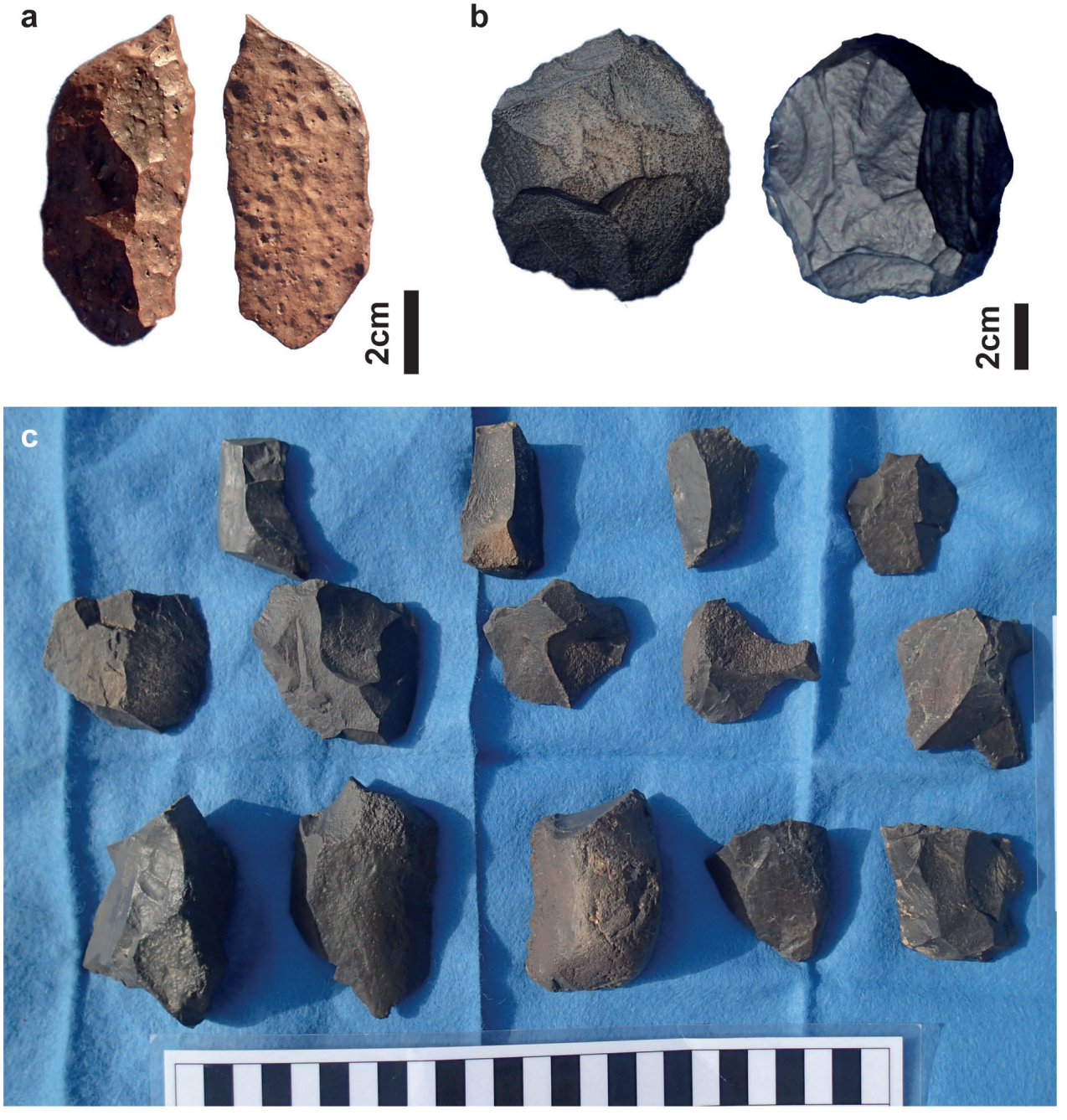

Figure 9. *Exemplar artefacts from L0023:* **a.** *a large piercer made on a heavily weathered chert — note the many instances of pot-lid fractures resulting from thermal damage to the surface;* **b.** *a large discoidal core on a rolled cobble — note the variation in weathering between the two sides of the artefact;* **c.** *a selection of flake debitage resulting from the working of a single rolled cobble (photographs A. Sinclair).*

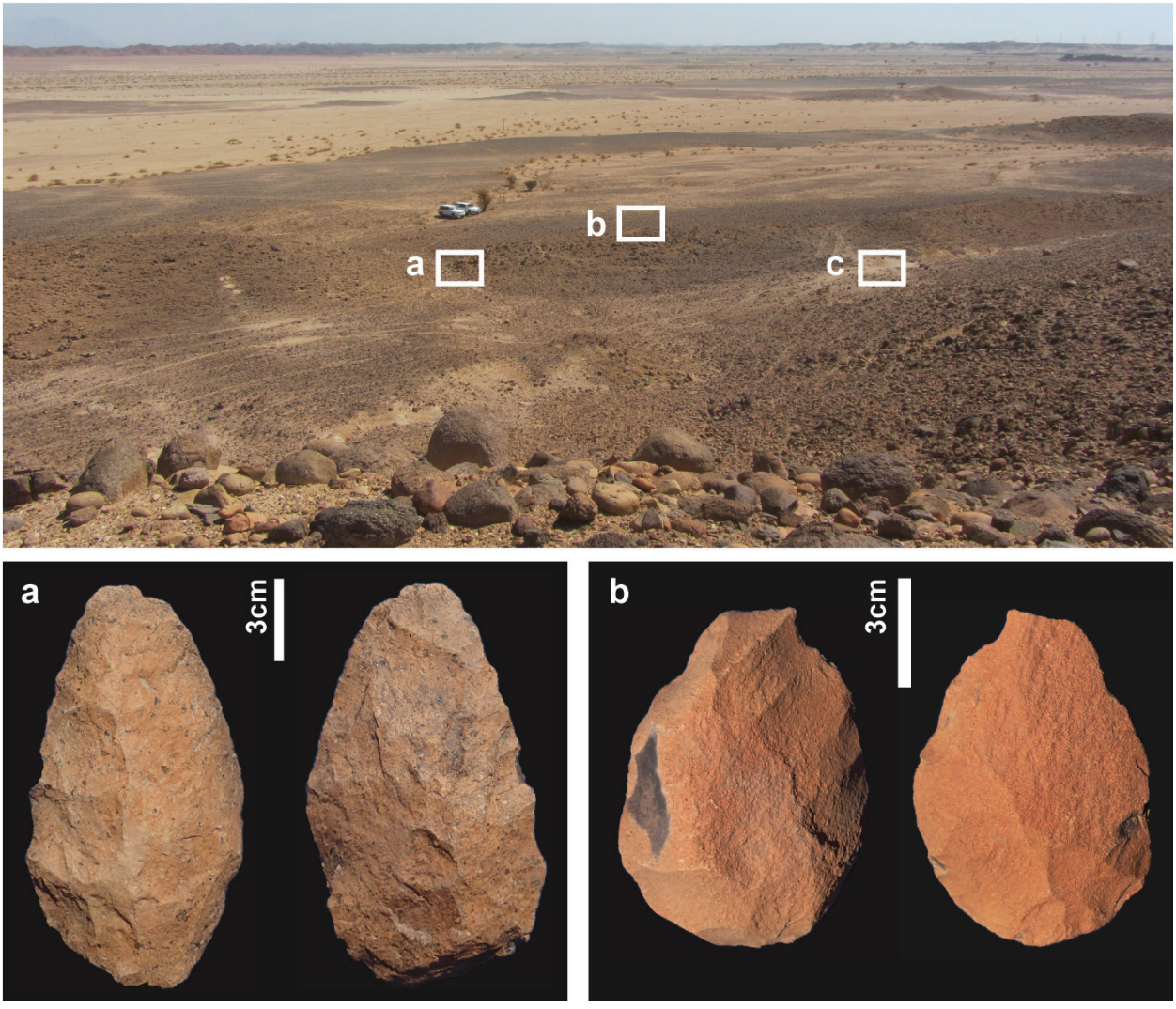

Figure 10. *View to the south-west from the upper alluvial terrace at L0034, looking out over the basin with the ESA find-spots indicated in the upper image including:* **a.** *a biface manufactured on a basalt flake with bifacial retouching used to create a refined lateral cutting edge, found in the side of a small gully;* **b.** *a chert hand axe with yellowish patina suggesting a recent exposure of artefacts — note the modern break damage showing the greyer character of chert underneath;* **c.** *the location of a basalt flake/cleaver from a bulldozed sediment area in gully (photographs R. Inglis).*

lower part of the terrace is a key priority for future survey, given the potential for *in situ* archaeology.

Discussion

The time constraints of a short, exploratory field season necessitated a rapid assessment of a restricted number of localities to evaluate the potential for Palaeolithic artefact-bearing deposits in this important but under-researched region. The restricted time at any one site, along with a policy of leaving artefacts on site for potential future research, also limits the information that could be recorded for any artefact to a brief typological description, some of which is sufficiently diagnostic to generate broad chronological information. The presence of artefacts in particular geomorphological

contexts also helps to understand where, and under what conditions, Palaeolithic artefacts are preserved and accessible to present-day survey in this landscape.

Artefact typology, technology, and regional comparisons

Palaeolithic artefacts have been recorded at almost all the localities visited in all three areas of the survey region. Despite the small numbers of artefacts that could be recorded at any one locality, the presence of artefacts at so many of the localities briefly visited signals a potentially rich Palaeolithic record awaiting further investigation in this region. Artefact typology demonstrates clear evidence of both Acheulean occupation (hand axes and large flake-based tools) and occupation of the area by hominins who used a prepared-core technology for the production of flake and flake-blade tools comparable to other parts of Arabia. The majority of artefacts for both Acheulean and prepared-core technologies were made using basalt, quartzite, or metamorphosed schists and shales, exploited in the form of rolled or angular clasts or large naturally exfoliated flakes. Even though the majority of the artefacts observed cannot be definitively ascribed to a chronological period on the basis of typology alone, the raw materials used suggest that these other artefacts belong to the Acheulean or prepared-core assemblage. Finally, a small number of localities present artefacts made on prismatic blade cores, from apparently non-local materials such as chert. It is very likely that these artefacts will date later than the prepared-core industries, but the small number of such pieces observed to date, and the lack of clear diagnostic retouched types renders the assignment of a broader typological name inappropriate at this moment. These pieces, however, do not appear to be similar in materials used or reduction technique to the blade tools recovered from pre-pottery Neolithic sites in this region, such as Wādī Sharma (Fuji 2018).

Most lithic artefacts observed appear to have been heavily weathered and patinated, as might be expected of surface finds artefacts exposed to the harsh conditions of the Arabian climate. However, there are a small number of artefacts with fresh edges and surfaces (L0006 and L0023), suggesting the possibility for finding buried, *in situ* archaeological deposits.

Of all the localities investigated in 2018, L0006 is the most archaeological significant at this early stage of research and will require further investigation. As noted above, seven hand axes were recorded at this site, along with a range of flakes, some retouched, and simple flake cores with one possible prepared or discoidal core. All artefacts found at the site are in relatively good condition — unrolled with sharp edges to the lateral margins and well-defined ridges between the surface flake scars. While not *in situ* within a sealed stratigraphic context, their condition indicates that the artefacts in this locality have not been moved any significant distance by natural forces, although variation in surface patination between upper and lower surfaces of two hand axes may be indicative of their surface exposure at the current locality for some time.

While there is no absolute date as yet for this locality, the size and form of some of these hand axes allow preliminary comparisons with other Acheulean sites in Arabia and the Levant. A number of hand axes are similar in size, shape, and raw material to examples recorded at the site of Gesher Benet Ya'akov in the Levant (Goren-Inbar et al. 2018; Sharon, Alperson-Afil & Goren-Inbar 2011) and similar to hand axes recorded at Dawadmi in central Saudi Arabia (Petraglia, Drake & Alsharekh 2009) and at Qana 1 in the Nefud desert (Shipton et al. 2014). The Acheulean assemblages at Gesher Benet Ya'akov have been dated to between 800 and 700 kya/MIS20-19 (Goren-Inbar 2017), and signals the appearance of the Large Flake Acheulean (LFA) in the Levant (Sharon 2010; Sharon & Barsky 2015) an industrial complex with claimed African affinity (Sharon 2010), but the situation may be more complicated. There are, as yet, no cleavers recovered at this site, and such tools are common elements at other LFA sites.

Artefact distribution and geomorphology

Geomorphological conditions at each of the localities appear to play a key role in the ability of each landform to preserve, expose, and render visible Palaeolithic artefacts to survey. Localities with unfavourable conditions, such as the highly erosive slope of a steep jebel (L0026) or an active, sediment-rich wadi bed (L0027) did not yield artefacts of any age; even if artefacts were deposited here in the past, they would no longer be accessible to survey due to

their geomorphological setting. In contrast, and as expected from observations in similar environments (Foley & Lahr 2015; Rose et al. 2011), the 'pavement' surface of alluvial terraces and fan remnants proved to be an excellent geomorphological setting for the preservation, exposure, and visibility of lithic artefacts of Palaeolithic age. Some variability was present; on alluvial surfaces where these pavements were less well-developed and where terraces continued to be incised by run-off (e.g. in the alluvial-topped terraces of the Gulf of Aqaba), the lack of Palaeolithic artefacts maybe explained by the less favourable conditions for the preservation and visibility of artefacts. Furthermore, even if all of the alluvial terraces had similarly developed surface conditions, it cannot be assumed that all of the artefacts recorded on the current surface were deposited on the terrace surfaces themselves (Knight & Zerboni 2018). As has been suggested through the variable patinations of the hand axes at L0034, it is possible that artefacts were deposited during alluvial deposition, later becoming exposed and mixed with any material deposited on the surface through deflation. Future work including detailed mapping and absolute dating of terraces coupled with test excavations, will be necessary to provide a framework for understanding the relative age depths of the observed surface assemblages.

Although the observed relationships between landforms and artefact visibility requires systematic testing, our work, alongside that in similar environments, underlines the key role geomorphology plays in shaping lithic artefact distributions and therefore must be integrated into survey strategy, recording, and interpretation (Fanning et al. 2009; Holdaway & Fanning 2014; Inglis et al. 2019).

Hominin activity in the landscape

Given the short period of survey, the dynamism of the region's landscape, and the strong geomorphological controls on artefact distribution, interpretations of hominin landscape use and dispersals from the preliminary observations must remain broad in scale, but still hold important implications for understanding dispersals. Three observations can be made:

1. Palaeolithic artefacts were found in low number throughout the entire study region, documenting the past occupation of the region by hominin populations. This region can therefore no longer be ignored when examining hominin dispersals from Africa into Arabia and beyond.
2. Artefacts were found both along the coastal plain as well as further inland in enclosed basins, suggesting that populations were moving into the hills or into the Arabian interior from the coastal plain (or vice versa) using the basins along the route. This is not surprising since such basins might trap water and attract animals for hunting. As well as preserving artefacts on top of the alluvial terraces, sedimentation in the basins might also have buried Palaeolithic archaeology; this possibility requires future investigation with targeted survey and excavation.
3. No artefacts were found in direct association with marine deposits, and therefore there remains no direct link between immediate shorelines and hominin artefact deposition, such as exists in the Mediterranean (Galili et al. 2018). Yet unlike the southern Red Sea, where the shoreline has shifted laterally tens of kilometres over glacial cycles, the steep offshore topography of the northern Red Sea and Gulf of Aqaba means that even the small numbers of Palaeolithic artefacts observed in the present-day coastal region during this preliminary survey would never have been deposited far from the shoreline, raising the potential that the populations that deposited these artefacts may have been exploiting coastal resources as well as terrestrial ones as they dispersed out of Africa.

Conclusions

The 2018 reconnaissance survey described above has proved the potential of the north-west of Saudi Arabia to inform on ESA, MSA, and later activity in the region, and begins to place the important Palaeolithic record of this region in its cultural context. Its observations make a strong case for the expansion of work in this region to record the rich archaeology potentially associated with the first hominin dispersals out of Africa, but one which, like all others, must be understood in its dynamic geomorphological context.

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References

Arzarello M., Marcolini F., Pavia G., Petronio C., Petrucci M. & Sardella R. 2007. Evidence of earliest human occupation in Europe: The site of Pirro Nord (southern Italy). *Die Naturwissenschaften* 94/2: 107–112.

Bailey G.N., Devès M.H., Inglis R.H., Meredith-Williams M.G., Momber G., Sakellariou D. ... Alsharekh, A. 2015. Blue Arabia: Palaeolithic and underwater survey in SW Saudi Arabia and the role of coasts in Pleistocene dispersals. *Quaternary International* 382: 42–57.

Bar-Yosef O. & Belfer-Cohen A. 2013. Following Pleistocene road signs of human dispersals across Eurasia. *Quaternary International* 285: 30–43.

Bar-Yosef O. & Belmaker M. 2010. Early and Middle Pleistocene faunal and hominins dispersals through southwestern Asia. *Quaternary Science Reviews* 30: 1318–1337.

Bayer H-J., Hötzl H., Jado A.R. & Quiel F. 1984. Midyan region. Pages 27–32 in A.R. Jado & H. Hötzl (eds), *Quaternary Period in Saudi Arabia.* ii. *Sedimentological, hydrogeological, hydrochemical, geomorphological, geochronological and climatological investigations in western Saudi Arabia*. Vienna: Springer-Verlag.

Bosworth W., Montagna P., Pons-Branchu E., Rasul N. & Taviani M. 2017. Seismic hazards implications of uplifted Pleistocene coral terraces in the Gulf of Aqaba. *Scientific Reports* 7: 38.

Breeze P.S., Groucutt H.S., Drake N.A., Louys J., Scerri E.M.L., Armitage S.J. ... Petraglia M.D. 2017. Prehistory and palaeoenvironments of the western Nefud Desert, Saudi Arabia. *Archaeological Research in Asia* 10: 1–16.

Briem E. & Blümel W.D. 1984. Contributions to the Quaternary geomorphology of the Ifal Depression. Pages 47–60 in A.R. Jado & H. Hötzl (eds), *Quaternary Period in Saudi Arabia.* ii. *Sedimentological, hydrogeological, hydrochemical, geomorphological, geochronological and climatological investigations in western Saudi Arabia.* Vienna: Springer-Verlag.

Devès M.H., Inglis R.H., Meredith-Williams M.G., Al Ghamdi S., Alsharekh A. & Bailey G. 2013. Palaeolithic survey in southwest Saudi Arabia: Methodology and preliminary results. *Adumatu* 27: 7–30.

Dullo W-C. 1990. Facies, fossil record, and age of Pleistocene reefs from the Red Sea (Saudi Arabia). *Facies* 22: 1–45.

Enzel Y. & Bar-Yosef O. (eds). 2017. *The Quaternary of the Levant.* Cambridge/New York: Cambridge University Press.

Fanning P.C., Holdaway S.J., Rhodes E.J. & Bryant T.G. 2009. The surface archaeological record in arid Australia: Geomorphic controls on preservation, exposure, and visibility. *Geoarchaeology* 24: 121–146.

Ferring J., Oms O., Agusti J., Berna F., Nioradze M., Sheila T. ... Lordkipanidze D. 2011. Earliest human occupations at Dmanisi (Georgian Caucasus) dated to 1.85–1.78 Ma. *Proceedings of the National Academy of Sciences of the USA* 108/26: 10432–10436.

Foley R.A. & Lahr M.M. 2015. Lithic landscapes: Early human impact from stone tool production on the central Saharan environment. *PLoS One* 10: e0116482.

Fuji S. 2018. Bridging the enclosure and the tower tomb: New insights from the Wādī Sharmā sites,

north-west Arabia. *Proceedings of the Seminar for Arabian Studies* 48: 83–98.

Galili E., Ronen A., Mienis H.K. & Horwitz L.K. 2018. Beach deposits containing Middle Paleolithic archaeological remains from northern Israel. *Quaternary International* 464: 43–57.

Gilmore M., Al-Ibrahim M. & Murad A.S. 1982. Comprehensive Archaeological Survey Program. 1. Preliminary report on the Northwestern and Northern Region survey 1981. *Atlal* 6: 9–23.

Goren-Inbar N. 2017. Gesher Benet Ya'qov. Pages 187–194 in E. Yehouda & O. Bar-Yosef (eds), *Quaternary of the Levant: Environments, climate change and humans.* Cambridge: Cambridge University Press.

Goren-Inbar N., Alperson-Afil N., Sharon G. & Herzlinger G. 2018. *The Acheulian site of Gesher Benot Ya'aqov.* iv. Amsterdam: Springer.

Groucutt H.S. & Petraglia M.D. 2012. The prehistory of the Arabian Peninsula: Deserts, dispersals, and demography. *Evolutionary Anthropology* 21: 113–125.

Holdaway S.J. & Fanning P.C. 2014. *Geoarchaeology of aboriginal landscape use in semi-arid Australia.* Melbourne: CSIRO Publishing.

Inglis R.H., Bosworth W., Bailey G.N. & Rasul N. 2018. Investigating the coastal archaeology and raised coral terraces of the southern Red Sea. Pages 552–582 in N. Rasul & I. Stewart (eds), *Geological setting, palaeoenvironment and archaeology of the Red Sea.* Amsterdam: Springer.

Inglis R.H., Sinclair A., Shuttleworth A., Alsharekh A., Al Ghamdi S., Devès M. ... Bailey G.N. 2014. Investigating the Palaeolithic landscapes and archaeology of the Jizan and Asir regions, south-west Saudi Arabia. *Proceedings of the Seminar for Arabian Studies* 44: 193–212.

Inglis R.H., Fanning P.C., Stone A., Barfod D.N., Chang H-S., Sinclair A. ... Bailey G.N. 2019. Palaeolithic artifact deposits at Wadi Dabsa, Saudi Arabia: A multi-scalar geoarchaeological approach to building an interpretative framework. *Geoarchaeology*. 10.1002/gea.21723

Ingraham M.L., Johnson T.D., Rihani B. & Shatla I. 1981. Saudi Arabia Comprehensive Survey Program: Preliminary report on a reconnaissance survey of the Northwestern province (with a note on a brief survey of the Northern province). *Atlal* 5: 59–84.

Jennings R.P., Parton A., Clark-Balzan L., White T.S., Groucutt H.W., Breeze P.S. ... Petraglia M.D. 2016. Human occupation of the northern Arabian interior during early Marine Isotope Stage 3. *Journal of Quaternary Science* 31: 953–966.

Johnson P.R. 2006. *Explanatory notes to the map of Proterozoic geology of western Saudi Arabia.* (Saudi Geological Survey Technical Reports). Jeddah: Saudi Geological Survey.

Knight J. & Zerboni A. 2018. Formation of desert pavements and the interpretation of lithic-strewn landscapes of the central Sahara. *Journal of Arid Environments* 153: 39–51.

Manaa A.A., Jones B.G., McGregor H.V., Zhao J-X. & Price D.M. 2016. Dating Quaternary raised coral terraces along the Saudi Arabian Red Sea coast. *Marine Geology* 374: 59–72.

Monnier G.F. 2006. The Lower/Middle Paleolithic periodization in Western Europe. *Current Anthropology* 47: 709–744.

Pappu S., Gunnell Y., Akhilesh K., Braucher R., Taieb M., Demory F. & Thouveny N. 2011. Early Pleistocene presence of Acheulian hominins in south India. *Science* 331/6024: 1596–1599.

Petraglia M.D., Drake N. & Alsharekh A. 2009. Acheulean landscapes and large cutting tool assemblages in the Arabian Peninsula. Pages 103–116 in M.D. Petraglia & J.I. Rose (eds), *The evolution of human populations in Arabia: Palaeoenvironments, prehistory and genetics.* Amsterdam: Springer.

Petraglia M.D., Alsharekh A., Breeze P., Clarkson C., Crassard R., Drake N.A. ... Veall M-A. 2012. Hominin dispersal into the Nefud Desert and Middle Palaeolithic settlement along the Jubbah palaeolake, northern Arabia. Ed. F.H. Smith. *PLoS One* 7/11: p.e49840.

Rose J.I., Usik V.I., Marks A.E., Hilbert Y.H, Galletti C.S., Parton A. ... Roberts R.G. 2011. The Nubian complex of Dhofar, Oman: An African Middle Stone Age industry in southern Arabia. *PLoS One* 6: 1–22.

Scerri E.M.L., Breeze P.S., Parton A., Groucutt H.S., White T.S., Stimpson C. ... Petraglia M.D. 2015. Middle to Late Pleistocene human habitation in the western Nefud Desert, Saudi Arabia. *Quaternary International* 382: 200–214.

Sharon G. 2010. Large Flake Acheulian. *Quaternary International* 223–224: 226–233.

Sharon G. & Barsky D. 2015. The emergence of the Acheulian in Europe — A look from the east. *Quaternary International* 411: 25–33.

Sharon G., Alperson-Afil N. & Goren-Inbar N. 2011. Cultural conservatism and variability in the Acheulian sequence of Gesher Benot Ya'aqov. *Journal of Human Evolution* 60/4: 387–397.

Shipton C., Parton A., Breeze P., Jennings R., Groucutt H.S., White T.S. ... Petraglia M.D. 2014. Large flake Acheulean in the Nefud Desert of northern Arabia. *PaleoAnthropology* 2014: 446–462.

Sinclair A., Inglis R.H., Scott C., Alsharekh A. & Othaibi D. (in preparation). The Acheulean in the Red Sea: The handaxes from Ras Suwayhil el Kabir. *Antiquity*.

Taviani M., Montagna P., Rasul N., Angeletti L. & Bosworth W. 2018. Pleistocene coral reef terraces on the Saudi Arabian side of the Gulf of Aqaba, Red Sea. Pages 341–366 in N. Rasul & I.F. Stewart (eds), *Geological setting, palaeoenvironment and archaeology of the Red Sea*. Amsterdam: Springer.

Toro-Moyano I., Martinez-Navaro B., Agusti J., Souday C., Bermudez De Castro J.M., Martinón-Torres M. ... Plamquist P. 2013. The oldest human fossil in Europe, from Orce (Spain). *Journal of Human Evolution* 65/1: 1–9.

Vincent P. 2008. *Saudi Arabia: An environmental overview*. Leiden: Taylor and Francis.

Zarins J., Murad A. & Al-Yaish K. 1981. The second preliminary report on the southwestern Province. *Atlal* 5: 9–42.

Zhu Z., Dennell R., Huang W., Wu Y., Qiu S., Rao Z. ... Ouyang T. 2018. Hominin occupation of the Chinese loess plateau about 2.1 million years ago. *Nature* 559: 608–612.

Authors' addresses

Robyn H. Inglis, (correspondence address) Department of Archaeology, University of York, The King's Manor, Exhibition Square, York, YO1 7EP, UK; Department of Environmental Sciences, Macquarie University, Sydney, Australia.
e-mail robyn.inglis@york.ac.uk

Anthony Sinclair, Department of Archaeology, Classics and Egyptology, University of Liverpool, 12–14 Abercromby Square, Liverpool L69 7WZ, UK.
e-mail A.G.M.Sinclair@liverpool.ac.uk

Abdullah Alsharekh, Department of Archaeology, King Saud University, Riyadh, Kingdom of Saudi Arabia; (correspondence address) PO Box 26395, Riyadh 11486, Saudi Arabia.
e-mail asharekh@hotmail.com

Christopher Scott, Department of Archaeology, Classics and Egyptology, University of Liverpool, 12–14 Abercromby Square, Liverpool L69 7WZ, UK.
e-mail C.B.Scott@liverpool.ac.uk

Dhaifullah Al Otaibi, Saudi Commission for Tourism and National Heritage, PO Box 66680, Riyadh 11586, Kingdom of Saudi Arabia.
e-mail OtaibiD@scth.gov.sa