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Front cover. Block 1000.0049 from Naga (photograph courtesy Karla Kroper).
Above. Pottery jar with decoration of sorghum heads from BMC 60, Berber (photograph courtesy Mahmoud Suliman Bashir).

Archaeological survey in the Melhab basin (Agig district), Red Sea region of Sudan: report on the 2023 field season

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Introduction and overview of previous work

The Western Periphery of the Red Sea (WPRS), to which the entire coastal area of the Sudan is a part, is a key region for investigating hominin (early human) engagement with coastal and near-coastal habitats during varied past climatic conditions (Beyin 2021; Bailey 2009). During humid phases, the numerous coast-bound channels that drain from the eastern slopes of the Red Sea Hills could make the near-coastal plains conducive to hominin adaptation by promoting vegetation cover and freshwater sources. Episodes of sea-level decline during glacial phases (often producing arid climate) are known to promote freshwater springs/oases on those newly exposed coastal gradients where hominin-supporting resources are expected to exist (Faure *et al.* 2002). Such a survival opportunity may have existed for hominins in the WPRS although the associated evidence could be obscured by coastal deposition and erosion. The WPRS features a complex topography (with the addition of a continuous coastline) similar to the fossil-rich inland Rift Valley region of East Africa where hominins lived for millions of years. Hence, it may have posed little survival risk for hominins coming from the interior habitats, and some of the inhabitants may have then easily dispersed toward the Levantine region from there (Beyin 2021).

Despite possessing these ideal eco-geographic characteristics that could have promoted hominin survival, the WPRS had remained a paleoanthropological *terra incognita* throughout the 20th century when many parts of East Africa became hotspots of paleontological and Paleolithic (Stone Age) research. This has hindered accurate appraisal of its contribution to human evolution. Against this backdrop, in 2017, the Red Sea Paleolithic Project was launched,[1] and the same year, the founding team carried out the first Stone Age-focused archaeological fieldwork in the Agig and Khor Baraka districts in the Red Sea State of the Sudan (Beyin *et al.* 2017) (Figure 1). The project's overarching goals include: i) locating Stone Age sites, to be recognised based on stone artefacts referrable to broadly defined prehistoric industries, ii) characterise hominin adaptation and the inhabitant hominin lineages using artefactual and fossil remains, iii) establish the temporal placement and paleoenvironmental contexts of hominin settlements in the region using appropriate proxy geomorphic and isotopic datasets, and iv) elucidate the role of the WPRS in hominin survival and movement out of Africa. Subsequently, in winter 2019-2020, the team carried out a follow-up survey (this time focused on the Agig district), targeting localities that were not explored during the first field season (Beyin *et al.* 2020).

Both field seasons documented a total of nine sites and numerous off-sites (findspots with low-density artefact scatters). The most common archaeological finds during the last two fieldworks were stone artefacts characteristic of the Acheulean technocomplex, notably the handaxe type (Beyin *et al.* 2021). Lithic finds referable to the Middle Stone Age (MSA), such as points, flake blanks and cores reflecting the Nubian and centripetal Levallois methods were also documented but these were less prevalent compared to the Acheulean type. The field activities so far conducted in the area, including the recent one, did not involve formal excavation.

This report concerns the results of a third field season carried out in March 2023 in the Agig district in an

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Figure 1. Location of the Melhab study area with respect to important landmarks.

area called Melhab (Figure 1). The archaeological potential of this area was identified during the final days of the second field season in January 2020. During that visit, the team spotted scatters of stone artefacts and bones on the surfaces of flood plain deposits (silty clay nature) in the area. The stone artefacts here stood out from those we encountered at the other surveyed localities in being characteristically Middle Stone Age, as described below. Also, the deposit appeared promising for fossil preservation. Owing to these observations, we decided to devote the last field season to this area. We sought to characterise the nature of the archaeological traces and identify potential localities for excavation and geomorphic investigations to place past human settlements in the area in their cultural, chronological and paleoenvironmental

contexts. These objectives fit well with the overall mission of the Red Sea Paleolithic Project. The team constituted all four co-authors, a driver and local camp assistants.

The project area

The Melhab study area lies *c.* 40 km as the crow flies from the current coastline and 150–250m above sea level, in a semi-closed basin enclosed by steep hills that form part of the Red Sea Hills. The Red Sea Hills are a chain of mountains that flank the western periphery of the Red Sea from southeastern Eritrea up to eastern Egypt. Melhab is the eponym of the closest village to the archaeology-bearing deposits located in the basin (Figure 2). The village is settled by the Beni Amir ethnic group who practice an agropastoral livelihood. Topographically, the Melhab basin features low-relief floodplain fields parted by conical hills and ridges. The relic and active floodplain zones are dissected by seasonally flooded channels, the largest of which is called Wadi Ararib (*Wadi* means dry river channel in Arabic). Scoured pediments and alluvial fan (lag) deposits are apparent around the foothills, potentially serving as sources of stone raw material that prehistoric people may have exploited. The basin has several kilometre-long catchment area to the south where winding deep valleys cut through cascading hills. This means, the seasonal runoff that flows into the Melhab basin could be vigorous, the expected effect being the formation of a vast and braided floodplain zone (crevasse splay system) downstream. The release of sediment loads on the riverbeds (brought by the runoff) could have forced the channels to change their courses frequently resulting in an extensive relic floodplain zone, such as the one we see now in the Melhab basin (Figures 2 and 3), where early humans could have foraged within the proximity of freshwater sources.

Reflecting such a process, in the Melhab study area, relic flood plain deposits occur as thick outcrops and diffused sediment blanketing low-relief grounds between ridges. They comprise argillaceous (clay enriched) loam. Channel-cut profiles, which are numerous in the area (e.g., Figure 3), reveal pebble and gravel loaded sandy horizons – representing paleo-river courses – interbedding/interfingering with the floodplain deposits. It is also reasonable to speculate that dust blown by wind across the surrounding landscape could have often become imprinted on the floodplain deposits when such places were not flooded, contributing to a build-up of fine sediments, mirroring the formation of loess (Libab Mohamed Ali, chief of the Melhab village, pers. comm.). On the east side of the Wadi Ararib – the area that was the focus of our archaeological survey – the floodplain deposits extend up to 1.0km from the current course of that channel. Ranging in colour from pale brown to white, these beds are scarred by runoff-induced gullies and rill erosion. At several places, they are infused with Ca-carbonate grains/nodules, reflecting active pedogensis in arid to semi-arid settings (Schoeneberger *et al.* 2012). Patches of acacia vegetation line the major channel banks. The existence of vegetation along the channels is indicative of the presence of groundwater. Typically, overbank flooding (and the shifting of the channels' courses) during runoffs is expected to enhance infiltration of water into the ground, thus enriching the underground water table. That, nowadays the locals obtain drinkable water from intermittent streams and boreholes in the riverbeds implies there is groundwater close to the surface. Wetter conditions, such as those that promoted human habitation there in the past, may have amplified the flow of streams from the groundwater.

As noted above, the discovery of artefacts on floodplain deposits in the eastern flank of the Melhab basin during our 2020 field season kindled our interest to further explore the area. From an environmental perspective, given that the area represents a drainage basin fed by numerous tributary channels, one expects it to have been conducive to hominin adaptation, especially during wet phases when recurring runoffs and discharge of springs from groundwater would have promoted vegetation cover, supporting the survival of people and their prey species. Moreover, rapid deposition of fine sediments on the floodplains during intensive runoffs is expected to have facilitated *in situ* burial of artefacts and fossils

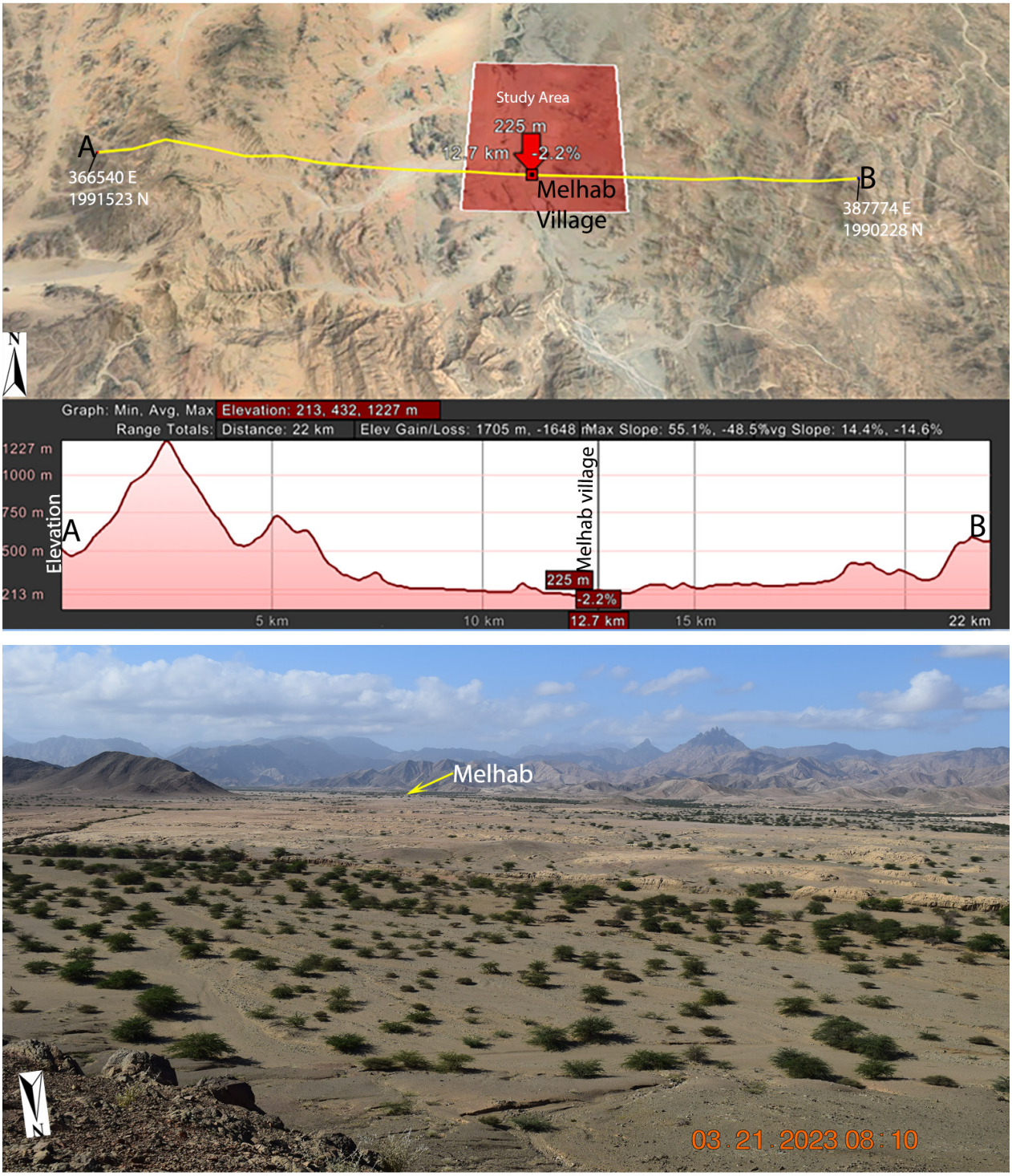


Figure 2. Elevation profile of the study area (top) and south view of the Melhab basin (bottom).

associated with prehistoric human activities. After all, the sheer observation of stone artefacts in the area during our first visit served as unambiguous evidence that prehistoric people lived there. But as is often the case with pioneering fieldworks, detailed field investigation is necessary in order to ascertain the temporal, ecological and cultural contexts of the purported settlements. Hence, the recent exploratory survey the team carried out was a logical step to achieve these goals.

Objectives and methods

The field season was entirely focused on a survey aimed at documenting archaeological sites based, primarily, on surface occurrences/observations. Within this overarching goal, the team sought to

Figure 3. Relevant geomorphic features in the study area: outcrops of floodplain beds scarred by rill erosion (top), channel bank profile showing stratigraphic facies reflecting different depositional processes (a and c = channel laid gravel and pebble; b and d = fine-grained floodplain deposit); X and Y are points where geographic coordinates were taken with a GPS: X = 379328.67 m E, 1994220.96 m N; Y = 379266 m E, 1992077 m N.

characterise the archaeological content and spatial distribution pattern of the sites and their sedimentary contexts as a means of establishing a baseline for future systematic excavation and geomorphic studies. Not all the project members were able to participate in this field season due to differences in academic calendars, thus the visit was intentionally focused on survey (excluding surface collection or excavation) with a plan to run subsequent longer seasons involving excavation, fossil collection, sampling dating sediments and geomorphic work by including experts in each research field.

In selecting target areas for survey, the team employed a judgmental sampling, focusing on localities deemed ideal to preserve archaeological and fossil remains in primary context. Against that framework we directed our field activity to localities bearing fine-grained floodplain deposits (described above), which are more apparent on the east side of the Wadi Ararib trunk channel. Thus, that side was the focal

area of our survey. Such deposits are presumed to preserve artefacts and fossils in a primary context as they represent a depositional setting (as opposed to erosional settings where artefacts could be easily removed by natural processes). At the outset, the presence of these deposits distinguishes the Melhab basin (and its suitability for archaeological investigation) from the other areas the team surveyed in the previous two seasons. Most of the previously surveyed areas, all of which are north of the Melhab basin (toward the coast), feature alluvial fan deposits characterised by deflated lag gravel surfaces where the chance of finding organic remains and artefacts in a primary context is slim.

The team surveyed a *c.* 5km^2 area, stretching *c.* 1kmx5km in a north-south direction (Figure 1). Most of the targeted localities were accessible by vehicle, which allowed efficient use of our time. As was the case with our two previous seasons, the fieldwork involved vehicle assisted foot-survey using systematic and unsystematic approaches. When visiting a locality for the first time, surveyors would walk the area in an unsystematic way, sometimes in a radial manner for a quick reconnaissance to determine the presence of archaeology. If artefacts were observed by team members, the area would be subject to a systematic survey by establishing a transect line-of-sight (a virtual line) directly pointing to a landmark feature on the landscape, such as big trees, a hilltop or a junction of channels. The compass reading of each transect's line-of-sight would be immediately recorded so that surveyors can keep track of their direction while walking the target area. The relatively flat nature of the focal deposits allowed us to maintain nearly uniform transect-widths of 5–10m per person walking in one direction, while the lengths of the transects depended on the nature of the landform. For example, transect lines that traverse hill slopes and riverbeds were adjusted in such a way that surveyors would avoid such landforms as they are unlikely to preserve artefacts and bones in a primary context. The geographic findspots of the artefact findspots and important landmarks were recorded using a Global Positioning System (GPS), which was often operating at a 3m accuracy. The fieldwork did not involve artefact collection or excavation.

Artefact findspots were identified as either 'sites' or 'off-sites' depending on the concentration of artefactual remains on the surface. Following a criterion the team has established in prior field seasons in the area (Beyin 2019; Beyin *et al.* 2020;), findspots containing more than 20 stone artefacts within a 100m^2 area were identified as 'sites'. An exception to this criterion was when fewer than this number but mostly diagnostic stone artefacts were found in a broadly dispersed manner in a discrete part of the landscape, such as an outcrop or a flat field bounded by a channel or a raised ridge, in which case the findspot would be identified as a 'site'. Findspots containing fewer than 20 stone artefacts within 100 m^2 and comprising mostly non-diagnostic types were registered as off-sites. Pottery remains were found at most of the documented sites in close proximity to stone artefacts. Findspots containing only fossil/bone remains were not identified as sites although their GPS locations were recorded because the bones might represent the natural deaths of animals. We note that the team did not include a pottery-expert as we did not expect to find pottery remains in the study area. Thus, this report lacks adequate assessment of the pottery finds from the field season. However, Dr Andrea Manzo of the University of Naples L'Orientale (Italy) has kindly offered professional insights into the cultural and temporal affiliations of some of the pottery finds from pictures we sent to him. We have cited his comments throughout the paper where necessary.

Until we determine the ages of the archaeological occurrences using absolute radiometric dating methods, for the moment, findspots that contain only stone artefacts are considered as representing 'Prehistoric' occupations and those containing pottery and stone artefacts together (or in close association) as 'indeterminate' since we cannot ascertain the cause/source of the association between these artefact types. It is worth noting that, archaeological occurrences containing artefacts of mixed cultural origin – representing prehistoric and historic times – are common throughout the Sudan (Ahmed

Nassr, pers. comm.). Thus, our finds might represent palimpsests of prehistoric and Neolithic occupation episodes. We recognised findspots containing only pottery remains as derived from recent or 'Neolithic' settlements. Stone artefacts are described in terms of the raw material (rock types) they are made from and technotypological aspects, such as mode of reduction (if they are cores), flake scar pattern and shape. For readership's sake, below we provide brief definitions of key terminologies frequently used for describing stone-artefacts throughout the paper.

Middle Stone Age (MSA): Refers to a prehistoric technocomplex or cultural phase characterised, among other things, by what archaeologists commonly call Levallois or prepared core method of flake production whereby cores are exploited from one surface by setting up a single or multiple striking platforms (Boëda 1995). Other characteristic elements of this technology include flakes that usually exhibit a facetted butt and a semi-flat dorsal surface bearing scars, points shaped through lateral retouch, varying frequencies of blades, and other forms of retouched tools, such as scrapers and denticulate (Figures 4 and 5). In Africa, this technological system became predominant from *c.* 300-50ka (ka = 1000 years ago) but has also been documented at younger (*c.* 10ka) sites in West Africa (Scerri *et al.* 2018).

Nubian Levallois: A variant of the Levallois method (and a hallmark of the MSA in many regions) in which the core is set up into a triangular form, allowing the knapper to produce triangular-shaped flakes that have multiple dorsolateral scars from preparatory and prior debitage flaking. Such cores can be shaped into a triangular form by either removing two divergent flakes from the opposite sides of the distal end or through steep flaking of the core's lateral sides to create convergent sides and a central ridge that guides the removal of a triangular flake upon striking the core on the platform (Usik *et al.* 2013). Originally defined in the Sudan and Egyptian Nubia (Guichard and Guichard 1968), the mastering of this technique (and the Levallois method in general) has been associated with advanced hominin motor skills that facilitated controlled knapping and forethought.

Blade core: A stone nodule that was systematically flaked along its longest axes from all sides of its platform/s with the goal of generating elongated and stereotypical flakes which accrue more cutting edge per unit of stone (see Figure 4). Such cores are identified as prismatic or tabular based on their shape and often exhibit parallel running flake scars. When they occur in a size range of *c.* 50–30mm they are called Bladelet cores, and those measuring less than 30mm long are called Microblade cores (Shea 2020, 147).

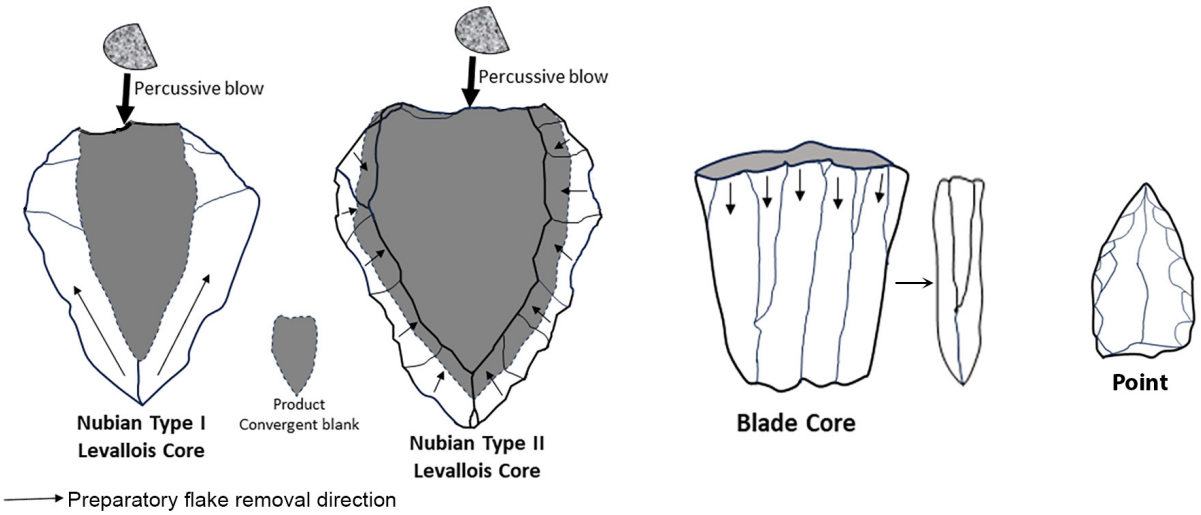


Figure 4. Nubian Levallois and blade core reduction schemes that characterise Middle Stone Age occurrences in many regions of Africa.

Figure 5. Stone tool artefacts representative of the Middle Stone Age technocomplex recorded at various locations in the Melhab study area: A–D) Nubian cores (the white arrows indicate removal direction of preparatory flakes while the black arrows indicate the removal direction of the target blank), E-J) Blade cores, K–P) specialised tools (K, L, M, P = points; N and O = scrapers), Q and S) blade blanks, R and T) convergent (Levallois) flakes. Scale: each bar = 1cm.

Unstandardised/non-diagnostic cores: Cores whose overall form and patterns of fracture scars do not indicate the imposition of a systematic flaking method. Such cores are usually knapped from various directions and lack regularity/consistency in shape and flaking direction.

Convergent flakes. Triangular-shape flakes that indicate systematic/controlled flaking - products of the Nubian Levallois method often fall in this category.

Blades: Flakes whose length is twice (or more) than their width and maintain parallel to semi-parallel lateral sides.

Non-diagnostic flakes: All types of detached pieces produced during stone knapping that do not fall into the definitions of convergent flakes or blades defined above.

Points: Flakes shaped into a pointed (convergent tip) form through secondary retouching.

Scrapers: Flakes that are laterally retouched to create a steep and durable edge.

Perforators: Tools that have pointed tips and are presumed to have served as piercer/borer.

Figure 6. Site ML01 looking west (A), and representative stone artefact finds at the site: B) a point, C–D) blade cores. Scale: each bar = 1cm.

Results

Based on the site definition criteria the team established, eight sites containing stone artefacts and numerous off-sites (those containing isolated or sparse scatters of stone and pottery artefacts) were recorded during the field season within the *c.* 5km^2 area we surveyed (Figure 19). The findspots that were identified as sites were named by the first two consonant letters of the study area, i.e., Melhab, followed by consecutive integer numbers (e.g., ML01, ML02...etc.). Only those off-sites that contained diagnostic artefacts (pottery or stone) were recorded by GPS although isolated finds of all kinds of cultural residues were encountered throughout the surveyed area. When mentioned in this text, the recorded off-sites are identified by the autogenerated identification number of their GPS point (01, 02, 03...etc.). Below we describe the eight documented sites in terms of their artefact contents, general context and tentative

cultural attribution (summarised in Figure 19). Since no systematic collection of artefacts was done, the descriptions of sites and artefacts are necessarily preliminary based on quick field observations.

ML01. This is the findspot of one of the first stone artefacts the team discovered in January 2020 that hinted at the archaeological potential of the area. But that visit was brief, thus we did not have the chance to systematically evaluate the archaeological content of the site. During our recent survey, we documented broadly dispersed stone artefacts, consisting of bifacially shaped points, convergent and blade flakes, blade cores, scrapers, non-diagnostic cores and non-diagnostic flakes knapped from chert, basalt and quartz rocks (Figure 6). These raw materials were probably procured from the nearby channel beds and rocky ridges. The artefact-bearing ground is an infill-bed of the locally conspicuous floodplain deposit that is undergoing extensive erosion by water and wind activities. The artefacts were found around the proximal peripheries of an erosional depression stretching westward toward a channel that runs along the northern margin of the site. This channel is contributing to the instability of the artefact-bearing ground by carrying away sediments as it expands sideways. The site has not yielded pottery and bone/fossil remains and given the presence of stone artefacts referrable to the MSA, it is interpreted as representing a prehistoric (MSA) human occupation.

ML02, another stone artefact findspot registered in 2020, is rendered an off-site due to sparse occurrence of the cultural traces. Among the notable finds are a scraper and a point on chert - a cryptocrystalline sedimentary rock composed mainly of silica (SiO2).

ML03. This is a findspot of stone artefacts and pottery fragments on a semi-flat deflated ground (Figure 7). The artefacts occur in sparsely scattered and clustered distribution patterns. The ground surface features a defused spatter of river-born gravel and pebble sediments (exhibiting rounded and worn surfaces) loosely embedded in the silty clay loam host deposit. The eastern periphery of the site is being dissected by rills that carry runoff water towards a tributary channel connecting to the Wadi Ararib. The stone artefacts encountered here include Levallois, discoid and blade cores, points, blade and convergent flakes, scrapers, non-diagnostic blocky cores (lacking evidence for consistent flaking approach) and non-diagnostic flakes (Figures 7A–F). Most of the cores are of non-diagnostic or unstandardised type. The Levallois approach is mainly inferred from dorsal scar pattern of some diagnostic flakes, but a few such cores (reflecting the 'preferential' removal pattern) were also encountered. Generally, the cores exhibit multiple negative scars, suggesting repeated flake removals. Rock types knapped at the site include fine-grained basalt, chert, quartz and rhyolite, with the first two types being the most dominant. Sources for these rocks are abundant in the nearby riverbeds and rocky ridges, thus they can be considered locally procured. Those identified as chert include mainly an agate-like greenish and banded variant.

Given the non-uniformly dispersed distribution pattern of the artefacts, it was not possible to determine the frequencies of cores, tools, flakes and raw material types represented. Most of the stone artefacts have worn edges due to surface rolling by wind and runoff, although flakes with sharp edge are also represented (Figure 7A). Fragmentary pottery remains, lacking decoration or surface motifs, were observed at the site as isolated and clustered occurrences (Figure 7G). It is unclear if the pottery finds belong to the same human culture/settlement associated with the stone artefacts. Given such associational ambiguity, the site is identified as representing a 'mixed' cultural activity (indeterminate age) until future systematic work ascertains its temporal placement.

ML04. This site contains dispersed flaked stone and pottery artefacts distributed over a clay loam deposit scarred by rill erosion (Figure 8). The ground slopes northward and the artefacts and some randomly distributed rubble and gravel debris occur spattered around the middle section of the gently sloping ground. The stone artefacts include cores (microblade and non-diagnostic blocky types), blade flakes, scrapers and a high frequency of non-diagnostic debitage (knapping debris), all of which are

Figure 7. Archaeological finds at ML03: A) stone tools (x = point, y = scraper on a Levallois flake), B) blade core (bidirectionally flaked); C–D) discoid cores; E) centripetal recurrent Levallois core, F) non-diagnostic core; G) pottery sherds (unknown age). Scale: each bar = 1cm.

primarily made from chert (Figures 8D–E). An interesting observation at this site is the occurrence of a dense cluster of stone debitage, which clearly reflects knapping activity. Core reduction processes involved bidirectional and multidirectional flaking, and the dense occurrence of negative scars on the flakes and cores suggests that cores were repeatedly flaked to obtain serviceable blanks. Supporting this inference is the occurrence of diminutive cores (Figure 8D), which reflects the inhabitants' ability to knap small nodules and a high threshold for core discard (which translates to knapping the cores until they become exhausted). This, in turn, signifies economical use of raw material as a resource maximisation (time minimisation) strategy, such that, people who attempt to extend the use-life of cores by knapping them to their maximum limit would minimise the amount of time they would expend looking for alternative cores. One specimen of pestle (rounded grinding club) was also documented at the site (Figure 8C), which reflects grinding activity/plant food processing.

The pottery artefacts here comprise decorated and non-decorated elements occurring as isolated and clustered finds (Figure 8B). According to Andrea Manzo (pers. comm.), the pottery specimens bears close resemblance to ceramic finds in the Kassala region of eastern Sudan dated to the 1st millennium BC to 1st

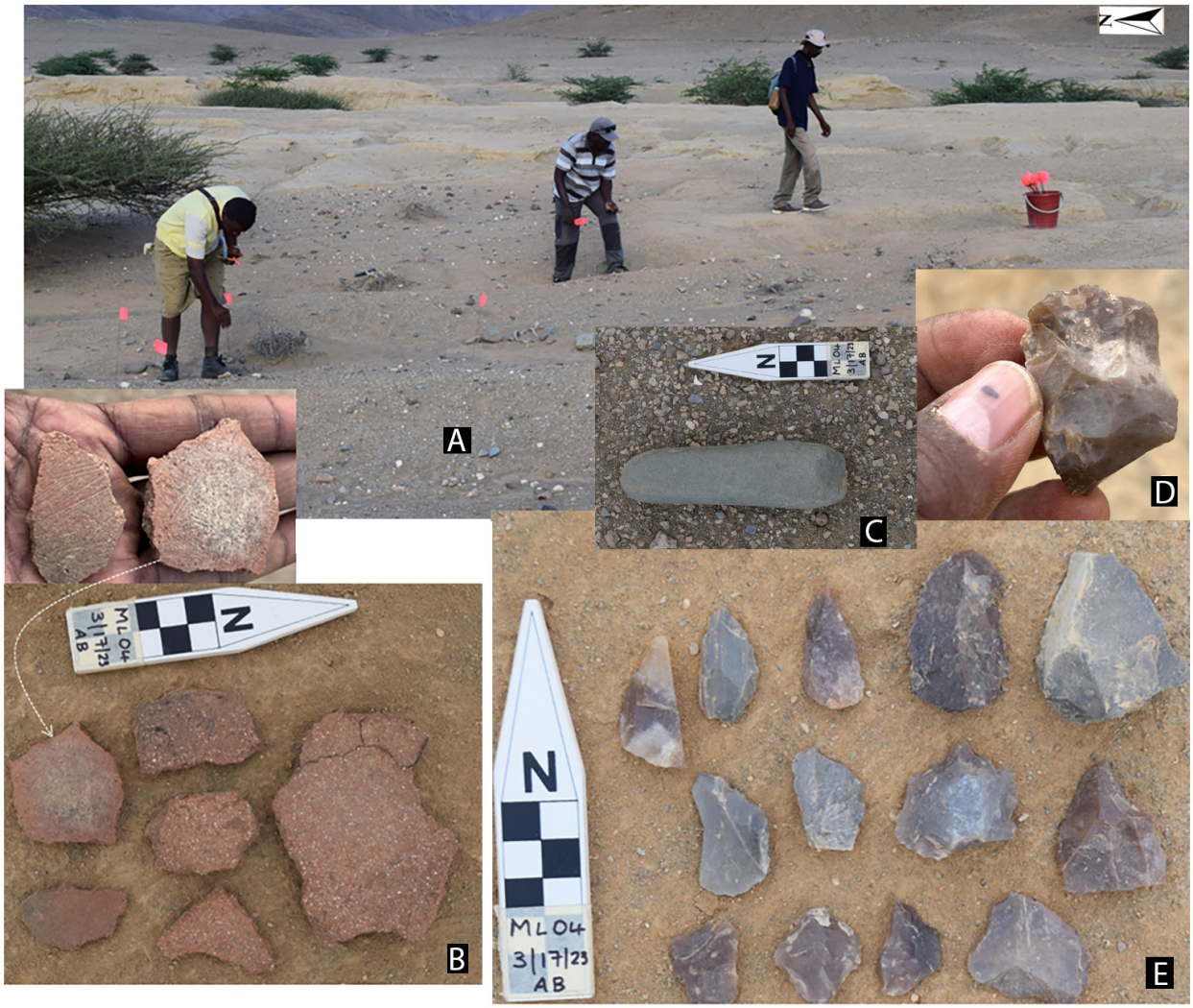


Figure 8. Site ML04 looking east (A), and representative archaeological finds at the site: B) pottery sherds, C) ground stone (pestle), D) a dimunitive core, E) stone artefacts of assorted size and type indicative of knapping activity. Scale: each bar = 1cm. According to Andrea Manzo (pers. comm.), the pottery from the site (plate B) may date to the 1st millennium BC to 1st millennium AD.

millennium AD. Future research with the help of pottery specialists will clarify the function and cultural provenance of these finds, and by extension, the temporal placement of the site. Given the presence of stone and pottery artefacts coupled with the discovery of a ground stone, tentatively, the site can be identified as representing a Neolithic or agropastoral occupation, of indeterminate age.

ML05. Lying about 500m northwest of ML04, this site revealed blades, non-diagnostic flakes and cores in a subsurface context, as well as a grinding stone (flat mortar) and pottery remains with some diagnostic body parts (e.g., handles) that were encountered on the surface (Figure 9). The ground slopes gently eastward from a north-south extending rocky ridge that flanks the northern side of the site. As a result, the surface is covered by a dark, gravelly, slope-wash debris-sheet, giving the surface an overall dark expression (Figure 9A). The pottery specimens were found in the southern section of the site; and according to Andrea Manzo (pers. comm.), reflect the same tradition recorded at ML04, dating to the 1st millennium BC to 1st millennium AD. The stone artefacts (mainly cores of chert material) were documented in the northern part of the site near the base of the rocky ridge. The cores occur cropping out of a *c.* 700mm deep profile of silty clay loam bed cleaved by a rill erosion (Figure 9C). The team lightly scraped off the profile for up to 0.5m sideways around the cropping-out stone artefacts to assess their

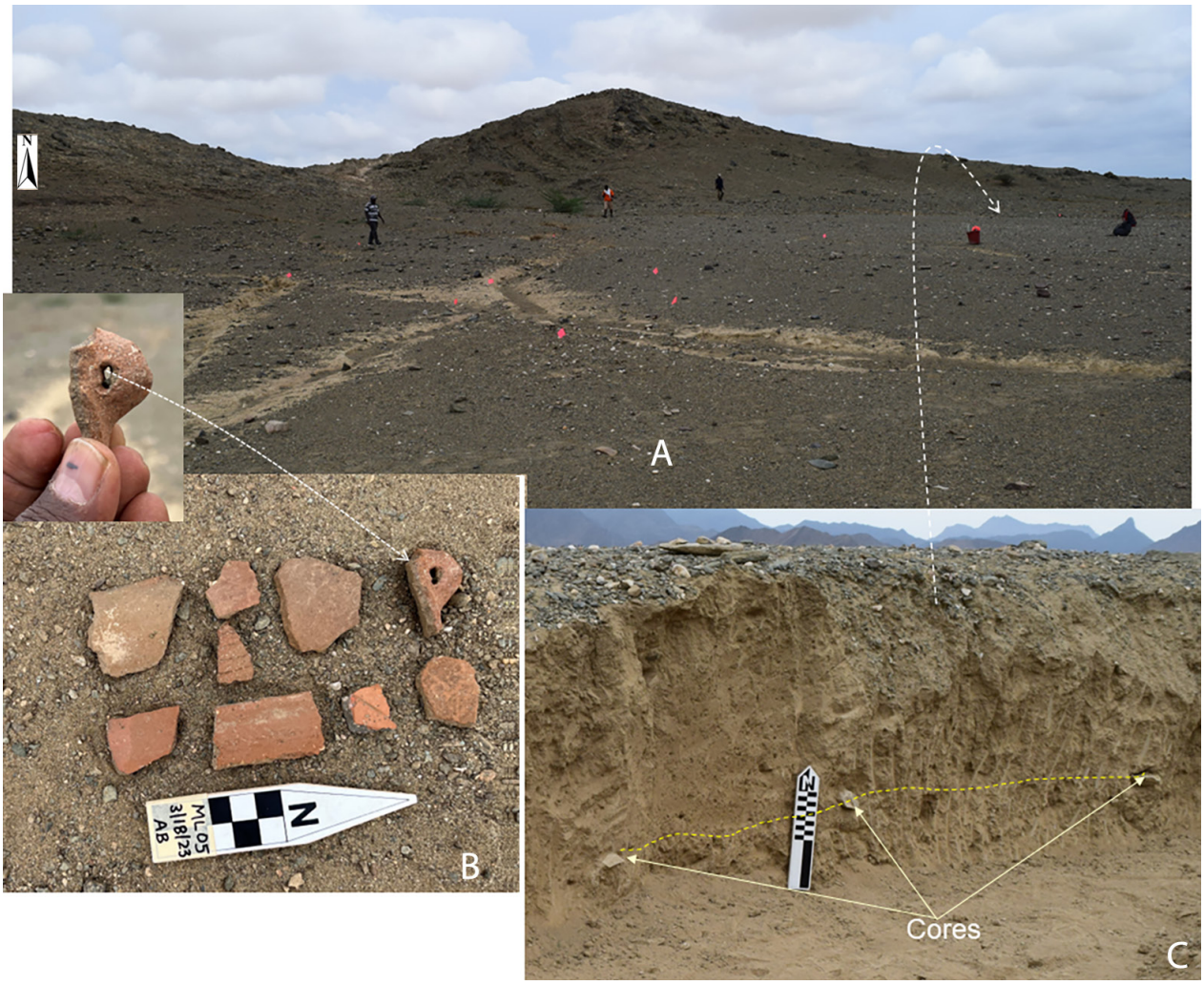


Figure 9. Site ML05 looking north (A) recent slope-washed gravelly debris-sheet overlaying silty clay bed, B) pottery finds at the site, C) a channel-cut profile containing cores (the team lightly scrapped off the profile to expose the cores for photos, but the artefacts were left *in situ* except one that was collected after it fell from the wall). Scale: each bar = 1cm. According to Andrea Manzo (pers. comm.), the pottery may date to the 1st millennium BC to 1st millennium AD, and is possibly a part of the tradition recorded at ML04.

condition and expose them for photography.

While the number of stone artefacts so far observed is small (five cores and a few flakes), the mere discovery of diagnostic stone artefact in a subsurface context (but not pottery remains) at the site is noteworthy for two reasons: i) it implies the presence of two settlement phases, one associated with the stone artefacts (a Stone Age occupation) and a younger one associated with the pottery finds on the surface in the southern section of the site, ii) there is the prospect of dating the burial age of the artefact-bearing deposit using Optically Stimulated Luminescence (OSL) method, which can give us a minimum age of human activity associated with the stone artefacts. To that end we collected one OSL sample from a spot adjacent to one of the cores on the wall, 480mm below the surface. The majority of the *in situ* finds occur at 450–520mm below the surface, suggesting their broad contemporaneity. The OSL sample was left at the National Corporation for Antiquities and Museum in Khartoum due to a delay in export permit processing, but we hope that we will be able to export it for dating in our next visit. A few flakes and one of the cores that were deemed to be in an unstable condition were collected. The team also diverted the course of the rill to prevent the artefacts left there from being eroded before we recover them through

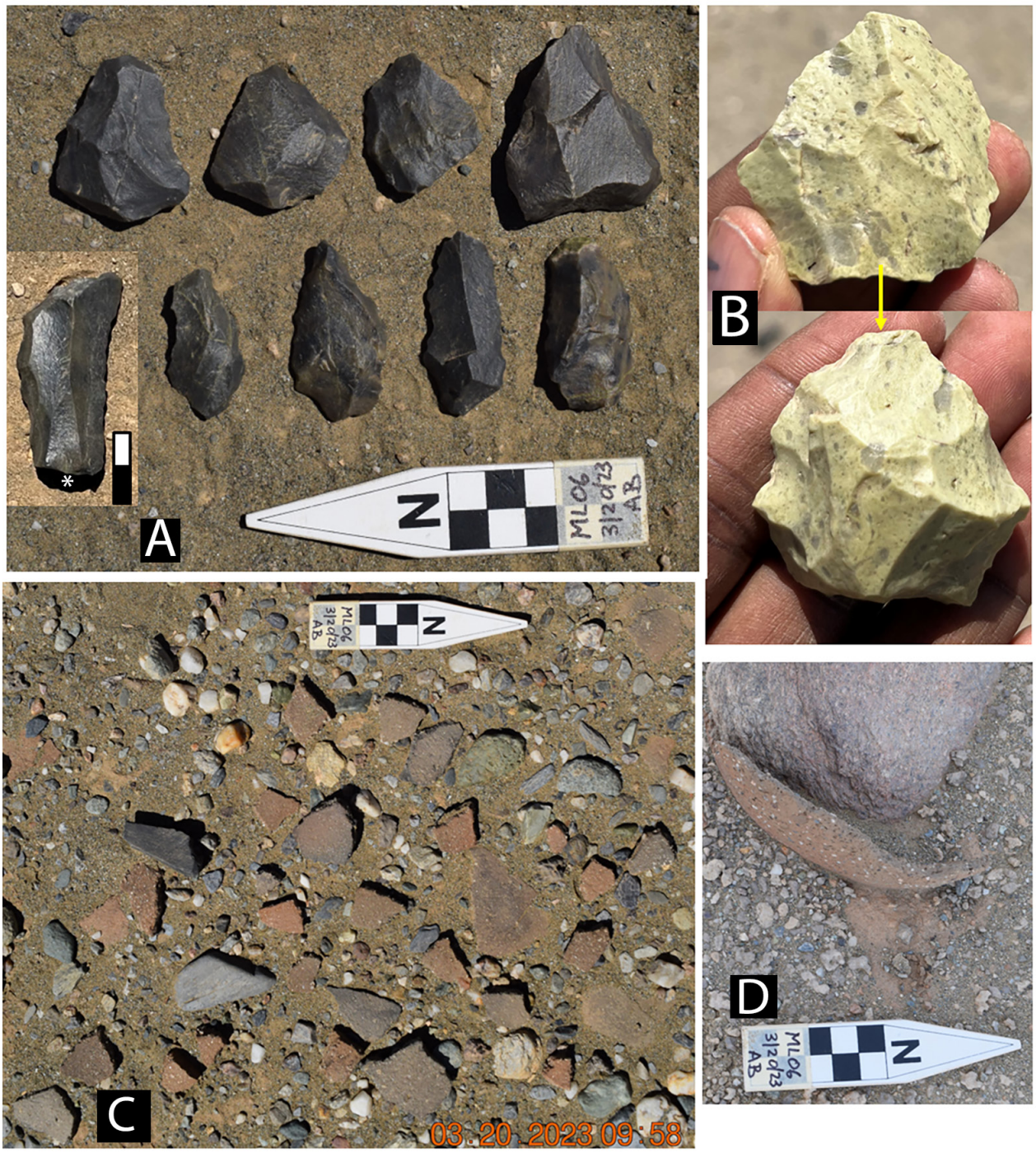


Figure 10. ML06 finds: A) stone artefacts (* = a blade with an expanding distal end and semi-convex backed edge), B) discoid core, C–D) pottery sherds (unknown age). The fact that specimen 'D' is sticking out from the ground may suggest a primary context- the spot where it was originally discarded. Scale: each bar = 1cm.

formal excavation, which we plan to do on our next visit.

ML06. This site produced stone artefacts and pottery remains in close proximity on a flat deflated surface covered by gravel lag. The stone artefacts comprise scrapers, points, discoid and non-diagnostic cores and flakes primarily knapped from chert with fine-grained basalt being the second most prevalent raw material (Figure 10A–B). Among the diagnostic stone artefacts, scrapers make up a higher percentage and consist of the end and side-scraper types. The dorsal negative scars on the flakes suggest a systematic core reduction, with some bearing scars resulting from the removal of blade blanks and possibly using the Levallois method. While the intentional edge retouches (occurring over specific regions of the edge

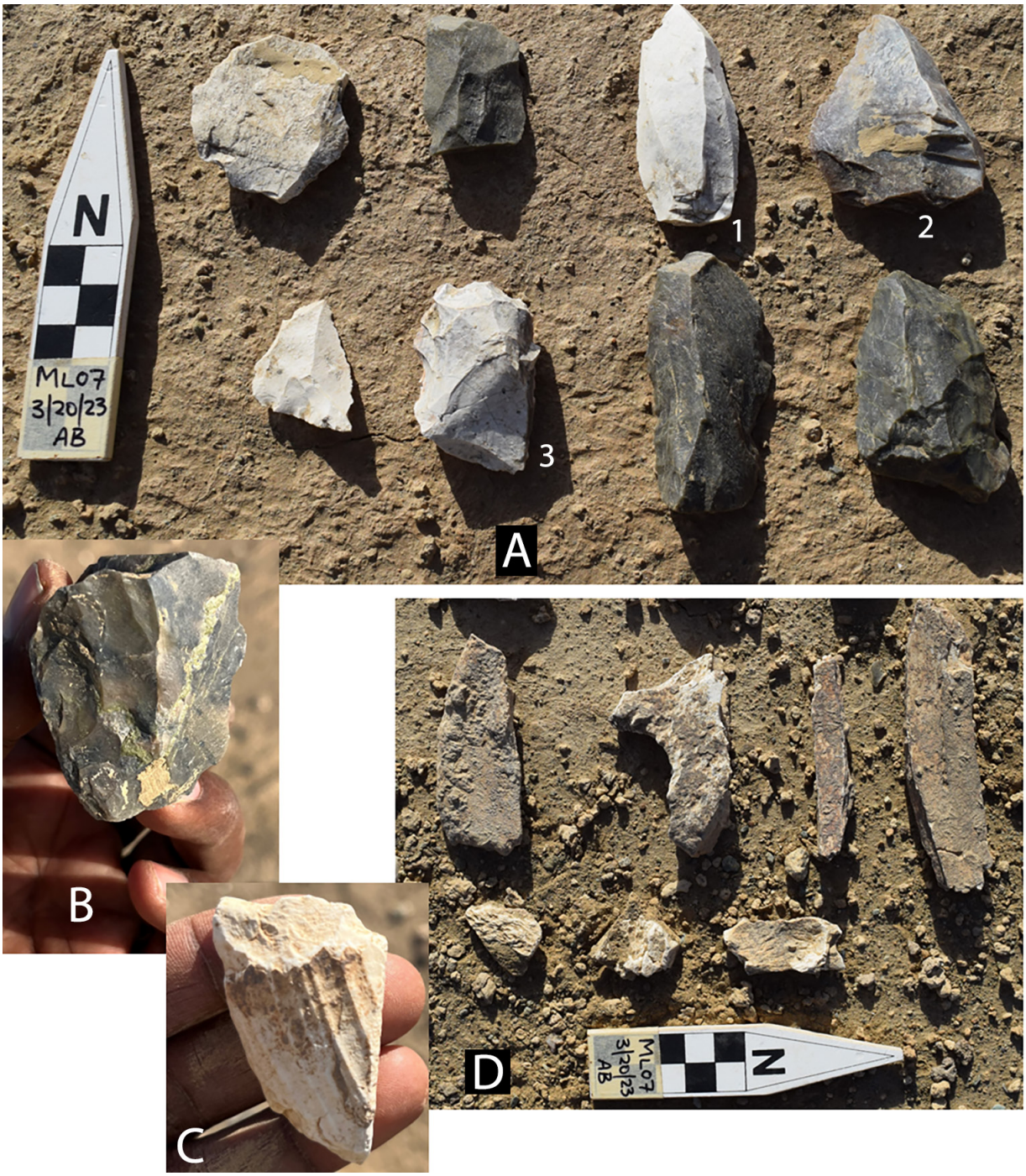


Figure 11. ML07 finds: A) stone artefacts (1 = blade, 2 = Levallois point-flake, 3 = scraper), B) a chert core flaked in multiple directions, C) a tusk, probably from a warthhog, D) bone fragments of terrestrial fauna.

section of the southern slope enclosing the depression. The presence of cores, flakes and retouched tools (sign of maintenance) hints at a habitation site, although no bones were documented to ascertain the subsistence behaviour of the inhabitants. No pottery or ground stone remains were found at the site, which suggests it is Stone Age, possibly that of a MSA occupation.

Off-site finds

In addition to the above discussed archaeological occurrences, isolated and thinly scattered stone and pottery artefacts, ground stone tools, faunal bone/fossil remains and graves were encountered throughout the surveyed landscape in varying frequencies and contexts (Figures 14–18). Isolated finds

Figure 11 (cont.). E–G) pottery sherds (* = ground stone). Scale: each bar = 1cm. According to Andrea Manzo (pers. comm.), specimen 'E' may date to 1st millennium BC–1st millennium AD, and the two big holes are proposed to have been used for fixing a horizontal loop handle or for hanging. Manzo also notes that the decoration style of this specimen bears close resemblance to pottery finds in the Eastern Desert of Sudan dating to the first half of the 1st millennium AD. Specimen 'F' bears characteristic features of ceramics associated with the Butana and Gash Groups known in eastern Sudan between the Atbara and Gash rivers, *c.* 3rd–2nd millennium BC (Manzo, pers. comm.). The age of the specimens in Place 'G' is proposed to be 1st millennium BC–1st millennium AD (Manzo, pers. comm.).

in a patterned manner) are discernible on the scrapers and points, most of them retain polished/glossy surface expression due to desert varnish. Irregular edge-breakages and dulling were observed on most of the stone tools, possibly caused by post-depositional weathering (Figure 10A). The pottery remains occur as isolated pieces and thinly scattered groups and comprise decorated and undecorated elements (Figure 10C). Of a noteworthy observation was a large, curved sherd sticking out of the ground (Figure 10D),

indicating that the inhabitants produced large pots. Given the existence of both pottery and stone artefacts in proximity, the site is tentatively interpreted as representing a mixed occupation of indeterminate age.

ML07. This is the findspot of stone and pottery artefacts, and bone remains in close proximity on a flat surface of the silty clay loam floodplain deposits (Figure 11). The stone artefact class comprises scrapers, convergent and blade flakes, and microblade cores primarily knapped from chert (Figures 11A–B). Although we did not find cores indicative of a specific reduction process (possibly due to being transported by the inhabitants for flaking at other locations), the shapes of the blanks and the configuration of flaking scars on them point to the application of the Levallois and blade reduction schemes for the production of triangular and elongated blanks. Dense step microscars on the proximodorsal edges of the blanks reflect efforts by the knappers at creating stable striking platform by chipping off weak extremities so as to be able to detach flakes in a predictable manner. This is to emphasise that stone knapping at the site involved careful core management and the application of efficient flake production methods, thereby signifying stone tools were valued in the culture.

The pottery finds at the site include rims and body parts, some with imposing decorative motifs, including alternate oblique parallel lines (Figure 11E) and surface treatment/scraping (Figure 11G). We were able to refit a few pieces based on their decorative patterns. According to Andrea Manzo (pers. comm.), the decoration style of one of the pottery specimens that we showed him a picture of bears close resemblance to finds in the Eastern Desert of Sudan dating to the first half of the 1st millennium AD, while another specimen bears characteristic features of ceramics associated with the Butana and Gash Groups known in eastern Sudan between Atbara and Gash rivers, *c.* 3rd–2nd millennium BC. Obviously, direct observation of the specimens by experts is necessary in order to accurately ascertain their age and cultural affiliation, but these picture-based observations highlight the mosaic nature of the cultural record in the study area. A tusk-like white piece was also found at the site (Figure 11C), possibly derived from warthog as this animal exists in the region today.

The discovery of bones at the site, albeit fragmentary (Figure 11D), is interesting, and reveals the prospect of being able to determine the subsistence behaviour of the inhabitants through systematic recovery of identifiable specimens in future fieldwork. While the stone artefacts clearly suggest an MSA technological repertoire (represented by the Levallois and blade blanks), their association with pottery makes their attribution to prehistory uncertain.

ML08. Located about 270m north of ML06, this site revealed broadly dispersed stone artefacts and pottery remains on a flat surface (Figure 12). The most diagnostic entity in the stone artefact class is a scraper, mainly an end scraper variant. Other represented stone artefacts include perforators, non-diagnostic cores and non-diagnostic flakes. Chert is the preferred raw material. Two tabular stones with horizontally etched parallel lines were discovered at the site- one is flat elongated and another semi-circular in shape (Figures 12A–B,1–2). The lines circle all sides of both items with a precise geometric alignment, suggesting they may have been intended for placing strings to facilitate hanging them as body adornments or for another utilitarian purpose in the culture. The pottery finds are fragmentary and coarse in texture and consist of decorated and non-decorated elements (Figure 12C–D). Although containing pottery and stone artefacts, the cultural foundation of the site remains unclear (indeterminate age), although the pottery and ground stone finds point to a possible Neolithic (agropastoral) occupation.

ML09. This site has produced stone artefacts characterised by Nubian Levallois cores, convergent flakes, points and scrapers as well as expedient cores and non-diagnostic flakes (Figure 13). The knapped rocks include chert, basalt, rhyolite and quartz. The findspot lies *c.* 600 m south of ML01 in an erosional depression sloping westward flanked by an overhanging ledge of the floodplain deposit to the south. Most of the stone artefacts occur among diffused volcanic clasts and channel-born gravels on the middle

Figure 12. ML08 finds: A–B) stone artefacts (x = discoid cores, + = scrapers, * = perforators, 1 and 2 = stone artefacts with horizontally etched geometric lines representing a symbolic meaning or specialised function), C–D) pottery sherds. Scale: each bar = 1cm.

of pottery and astone artefacts were particularly numerous. According to the picture-based assessment of representative pottery specimens from the study area by Andrea Manzo (pers. comm.), the majority of the ceramics appear to date to 1st millennium BC–1st millennium AD, same as those observed at the sites. A noteworthy find was a piece of bivalve seashell (Figure 16) found near potsherds and stone artefacts (GPS: 379268 E, 1992492 N), which signifies intentional human transportation of marine organisms for symbolic or dietary purposes. Such an activity would have entailed logistical trips to the coast or inter-group exchange system as the shoreline would not have been less than 25km from Melhab in the past even during episodes of high sea level, far enough to have necessitated special trips to the coast.

Elaborately designed ground stone tools (Figure 15) were encountered as isolated finds and some were

Figure 13. Site ML09 finds: A) stone artefacts (* = points, + = end scraper, x = flakes), B–D) Nubian Levllois cores (the solid-line arrows on specimen 'D' indicate the removal direction of preparatory flakes while the dashed black arrow on the same indicates the removal direction of the target blank). Scale: each bar = 1cm.

near pottery scatters. It is reasonable to associate such items with grinding of plants for food. Most of the encountered faunal fossils were heavily weathered, thus it was difficult to determine their taxonomic identity in the field; that is awaiting future visits by an expert. The graves, which occur in diverse landscape settings (foothills, ridge tops and flat fields) appear to represent the pre-Islamic period due to the lack of domed tombs and complex funerary structures that characterise the Islamic period (Manzo 2017). These off-site finds expand our understanding of the scope and nature of human activity in the study area beyond what we have been able to infer from the sites described above.

Figure 14 (A-C). Pottery sherds from off-site findspots in the study area. Scale: each bar = 1cm. According to Andrea Manzo (pers. comm.), the specimens are believed to date to the 1st millennium BC–1st millennium AD (except speciment 'B', which may be younger).

Discussion. Significance of the finds, emerging questions and future directions

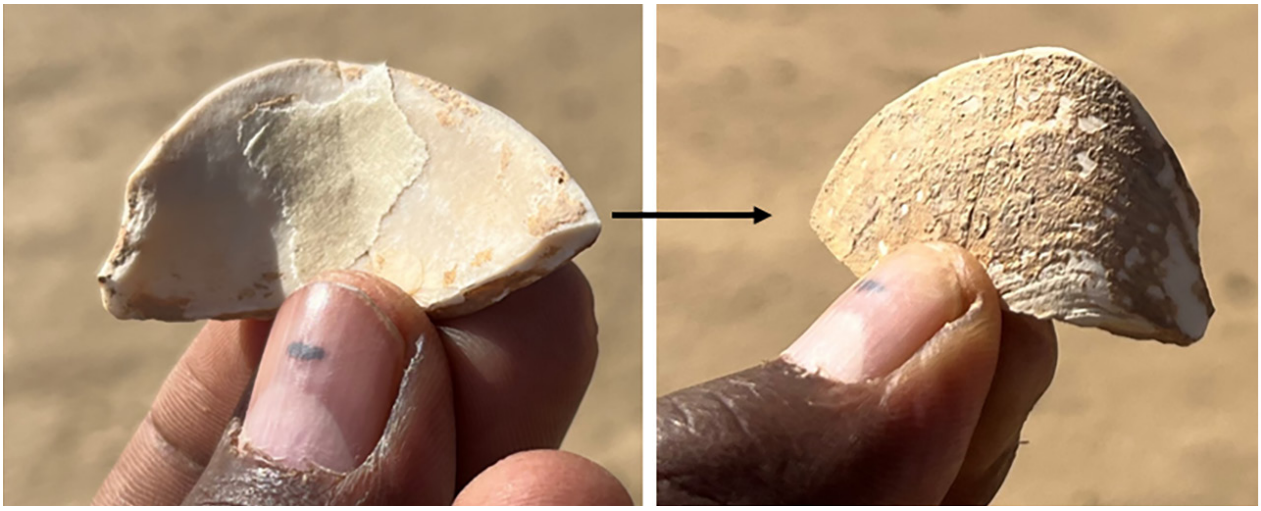
The fieldwork in the Melhab basin was successful in revealing the presence of a rich record of past human habitation in an area that was not previously known to the archaeological community. Two previous field seasons by the team in the Agig district (mainly to the north of Melhab) have documented sites dating to the Acheulean and MSA technocomplexes roughly representing Early and Late Pleistocene hominin occupations. The finds from the Melhab area expand the spatial breadth and nature of the archaeological record in the Red Sea coastal region of the Sudan. At the outset, the presence of sites with pottery, ground stone tools and faunal bone/fossil remains distinguishes this study area from those the team explored in previous seasons. The pottery remains and ground stone tools reflect domestic activities, such as plant food processing (e.g., cereal grinding and cooking), serving and storage, which can be linked to sedentary to semi-sedentary agropastoral groups (Garcea 2006; Manzo 2017). The discovery of faunal bones associated with artefactual remains demonstrates that the inhabitants exploited animals, but whether these animals were wild or domesticate remains to be determined by future investigations of systematically collected zooarchaeological samples from the sites. Some of the faunal bones seem to represent size 2 terrestrial

Figure 14 (cont., D-G). Pottery sherds from off-site findspots in the study area. Scale: each bar = 1cm.

animals (gazelle/sheep type), signifying that the area may have featured a steppe landscape ideal for such herbivores contemporary with the settlements affiliated with the artefacts.

Stone tools characteristic of the MSA are prevalent at the Melhab sites- represented by Levallois and blade cores and blanks derived from them, points and scrapers (Figure 5). Similar artefacts were documented at the hitherto explored localities to the north. In this study area, chert (a microcrystalline rock, ideal for flaking) was the preferred raw material whereas the Acheulean finds were mainly knapped from basalt and rhyolite. The technical execution and quality of raw material used to make them demonstrate that the makers possessed well-developed knapping skills. The range of functions for these artefacts would have been diverse, including as tips for projectile armatures, knives, scraping tools, etc. Making stone tools that have played such important roles in the inhabitants' lives may have necessitated acquiring proficient knapping skills. Interestingly, neither large cutting tools (e.g., handaxes- characteristic of the older Acheulean sites) nor geometric microliths (characteristic of later prehistoric hunter-gatherer stone tool technology) are represented in the Melhab study area. The question then is, do the stone artefacts

Figure 15. Ground stone artefacts from off-site findspots in the study area.



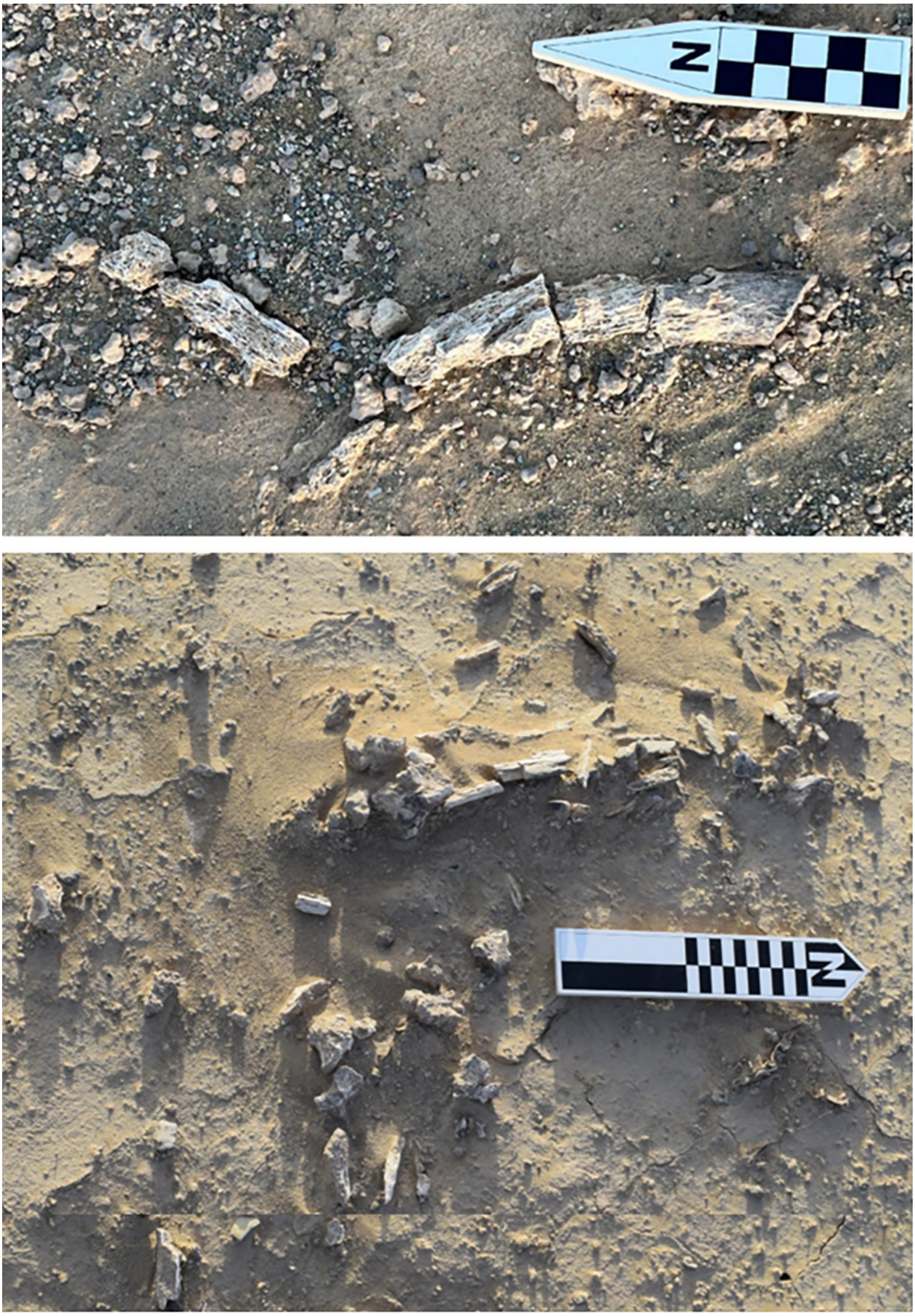


Figure 17. Bones of terrestrial faunal remains from off-site findspots in the study area.

Figure 18. Representatives of the graves observed in the study area. According to Andrea Manzo (pers. comm.), the one on the left resembles graves at Mahal Teglinos, near Kasala, dating to the early 3rd to early 2nd millennium BC, which is suggested to have been associated with settlements in the Eastern Desert since the 5th millennium BC.

that show MSA affinity and the other cultural residues, such as pottery and ground stone tools belong to the same culture and settlement phase or are we seeing a palimpsest (mix) of different human occupation phases? The presence of sites that contain only stone tools seems to suggest the existence in the study area of distinct (successive) settlement phases - an older one associated with the MSA and a younger occurrence associated with making pottery and ground stone tools.

The presence of younger settlements (post-MSA) is obvious from the discovery of pottery remains that bear resemblance to finds in Eastern Sudan dated to the 1st millennium BC to 1st millennium AD (Andrea Manzo, pers. comm.). It is unclear if an MSA-affiliated older human settlement had existed. Determining the nature, age, and durations (recurring vs a single episode) of human settlement history in the study area will require targeted excavation of representative sites to recover artefactual and organic materials *in situ* and collect dating samples from secure contexts. It is only on establishing reliable age and geomorphic controls for the sites and acquiring sufficient behavioral data from the artefactual and organic residues that we will be able to confidently place the finds in their proper temporal and paleoclimatic contexts. Our future work will address these questions.

The widespread occurrence of traces of human activity in the study area attests that all the different units of the landscape bore cultural meaning, ranging from economic (where subsistence and tool manufacturing activities occurred) to ritualistic and social (e.g., graves). It is clear from the documented evidence that in the past the Melhab area hosted abundant resources that sustained human groups. Among other things, its setting as a drainage basin could have made it appealing for human settlement, in part due to the availability of freshwater and vegetation for terrestrial prey animals around the Wadi Ararib trunk channel and the numerous tributary water courses that traverse the area. It is also worth noting that the spectacular mountain peaks surrounding the Melhab basin may have held some symbolic or spiritual significance, thereby promoting a stable social community tied by common beliefs and cultural norms. That the Melhab basin is surrounded by a terraneous landform, the inhabiting groups had probably remained insulated from external influences during the interval of time they stayed there.

Site	Provenience		Lithics								Pottery		Gr. s.	Bones	Cultural Attribution
	East	North	Raw Material	Points	Levallois/ Nubian cores	Convergent flakes	Blade cores	Blade flakes	Scr.	Other	Decorated	Undecorated			
ML01	379272	1994825	ch, b, q	x		x	x	x	x	ndc, ndf					MSA
ML03	378976	1991596	b, ch, q, r,	x	x	x	x	x	x	ndc, ndf		x			Indeterminate (mix)
ML04	379191	1991956	ch					x	x	ndc, mb, ndf	x	x	x		Indeterminate (mix)
ML05	378772	1992258	ch							ndc, ndf	x	x	x		Indeterminate (mix)
ML06	378974	1993262	b, ch, r, ind.			x		x	x	ndf, ndc	x	x			Indeterminate (mix)
ML07	379481.6	1993403	ch			x		x	x	mb	x	x	x	x	Indeterminate (mix)
ML08	378862	1993494	ch, b						x	pf, ndc, ndf, sel*	x	x			Indeterminate (mix)
ML09	379159	1994520	b, ch, q, r,	x	x	x			x	ndc, ndf					MSA

Key

b = basalt, ch = chert, q = quartz, r = rhyolite, mb = microblade, ndc = non-diagnostic core, ndf = non-diagnostic flake, pf = perforator, scr. = scraper, gr.s. = ground stone, sel* = stones with horizontally etched lines

Figure 19. Details of sites and artefacts in the study area.

Conditions like today or drier would have made the basin unconducive to hunter-gatherer groups as the area is arid (especially during summer months) and almost devoid of wild game. Thus, hunting and gathering-dependent human settlement must have occurred during wet phases.

Despite many lingering questions regarding the chronological placement of the sites and cultural identity of the inhabitants, the Melhab finds demonstrate that the Red Sea region of the Sudan holds great potential for investigating various scenarios about past human settlement history in the western periphery of the Red Sea. Documenting the presence of human settlements in this region in itself is a vital contribution to the archaeological heritage of the Sudan and the African side of the Red Sea basin. Encouraged by the emerging finds, the team will continue to study the localities so far identified in the study area to collect high-resolution archaeological, fossil, paleoclimatic and geochronological datasets. The area is rich in sedimentary deposits featuring stratigraphic facies that reflect past climate changes. Systematic investigation of such deposits will allow us to clarify the climatic contexts of human occupation; for example, it will be possible to determine the vegetation and rainfall patterns that characterised the area in the past, which can then allow the modelling of human subsistence and land-use strategies. On the archaeology side, the team plans to conduct targeted excavations to recover artefactual and organic remains from secure contexts. Dating the sites using applicable radiometric methods (e. g., radiocarbon dating and luminescence) will constitute a vital part of our future endeavor.

To accomplish these goals, we plan to involve experts in geomorphology, proteomics (the study of proteins from food-related chemical residues trapped in pottery matrix), and pottery and zooarchaeological analyses, that will complement the existing small pool of personnel involved in the project (the PIs' expertise lies in stone artefact analysis). We hope that such a collaborative endeavor will facilitate the generation of critical data related to the temporal placement of the sites, paleoenvironmental history of the region and the cultural affiliations of the inhabitants.

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