

## Research Note



# Gold Miners on the Trail of the Earliest Humans in Eastern Saharan Africa. Investigating the Acheulean and Middle Stone Age in Sudanese Nubia

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## Abstract

This research note presents evidence for the oldest Middle Pleistocene Eastern Saharan human activity from the area referred to as the Eastern Desert Atbara River (EDAR), Sudan, which is currently threatened by gold mining. Preliminary results of multifaceted analyses indicate the activity of *Homo sapiens* during MIS 5 as well as *Homo erectus* during MIS 7–11 or earlier.

## Keywords

Sudan – EDAR – Pleistocene – Acheulean – MSA – OSL

## 1 Introduction

Although the search for gold in the Sahara has a long history, beginning as early as 4000 BC (Klemm & Klemm 2013), North African countries have recently experienced a new gold rush. This new gold mining devastates the desert landscape. In countless shafts, sunk to the depth of several dozen meters, miners use mechanical equipment to search for gold particles in quartz. One of these miners noticed stone tools in the walls of a mine in the Sudanese Eastern Desert, a discovery which provided evidence of *Homo erectus* and *Homo sapiens* groups subsisting in the Sahara during periods of favourable climatic conditions in the Pleistocene. The research initiated by the discovery has revealed numerous traces of hominin activity. These

hominins inhabited an ancient savannah landscape, using the resources provided by its meagre braided streams. During the research it became apparent that in addition to Acheulean handaxes and choppers and Middle Stone Age (MSA) stone artefacts the remains of encampments can be found in the mining zone. The discovered Palaeolithic sites are located on a potential dispersion route of early hominins towards Eurasia and deposited in stratigraphic sequences that can be directly dated (Masojć et al. 2019).

The study area (Fig. 1), named the Eastern Desert Atbara River (EDAR), is composed of several Palaeolithic sites located in the Eastern Desert, between the Nile valley in the west and the Atbara river valley in the south (17°39' N, 34°46' E; about 70 km to the east of the town Atbara) within the large Wadi el Arab stretching from the Red Sea Mountains to the Atbara river. The present landscape of the desert surrounding the EDAR area is a vast, flat plain. Although some EDAR sites are eroded to the modern desert surface, the majority of them were found in the stratigraphical context of exposed areas and in profiles of abandoned gold mines/shafts.

## 2 Gold Mining in Sudan

Numerous archaeological studies have revealed that gold was a pillar of economy in ancient Nile Valley civilizations (Klemm & Klemm 2013). It has long been assumed that gold in ancient Egypt came from the south and was extracted largely, if not entirely, by the process of panning (Meyer et al. 2003). The power of the Kingdom of

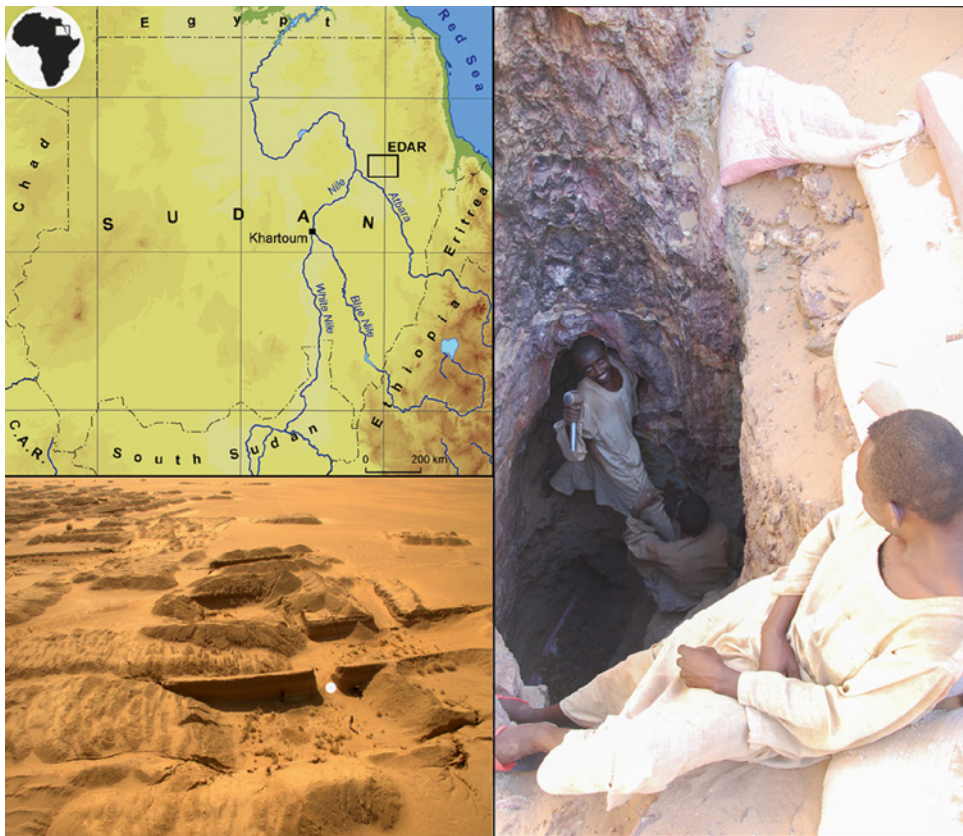


FIGURE 1 Location of the EDAR area in the Sudanese Eastern Desert (top left), gold mining activities (right), and the excavation area (3 m × 3 m) at the EDAR 7 site (white dot)

Kush, for instance, rested in part on its ability to extract gold from the sands and gravels of the Nile valley. The gold from Kush was sent as tribute to the pharaohs, as seen in the painted scenes from the walls of the tomb of Huy, the Egyptian governor of Kush during the New Kingdom, ~ 1330 BC (Emberling 2009). Another example from a much later period is the most complete evidence for the complicated, multi-stage processes of gold mining, ore reduction, and smelting dated to the 5th–6th centuries AD from Bir Umm Fawakhir in the Egyptian Eastern Desert (Meyer et al. 2003).

Gold mining is also a historical activity in the Sudan (Ille 2011). Recently, the loss of oil revenues from South Sudan, which became independent in 2011, led to a renewed interest in gold mining on the part of the Khartoum government. Today, about fifteen international companies and a little more than a hundred domestic companies have obtained industrial production licenses. According to Chevrillon-Guibert (2016), they probably employ more than half a million people, not counting artisanal and informal gold miners, which would considerably increase this count. Most gold mines are located in outlying Sudanese areas, some in regions currently torn by conflict (Darfur, South Kordofan). It is thought that Sudan shares

third place in gold production with Mali, after Ghana and South Africa (Chevrillon-Guibert 2016).

The Sudanese Eastern Desert of the Atbara River (EDAR) area has been intensively used for semi-mechanized artisanal and informal gold mining since 2010. Gold miners initially exploited the area on a small scale. In recent years private mining companies have intensified their activity around the areas of Jebel al-Grain, Wadi Hudi, Wadi al-Oshar, Wadi el Arab up to the Egyptian border and the Red Sea Mountains. Their mining activities are destructively affecting archaeological sites and devastating the natural landscape, especially the areas situated far from settlements. Vast places in the EDAR area are covered by mines with shafts up to 20 meters deep (Fig. 1).

### 3 Materials and Methods

All necessary permits were obtained for the study in the EDAR area. Permissions were issued by the Director General of the Sudanese National Corporation for Antiquities and Museums (NCAM). The research was carried out by the Institute of Archaeology, University of Wrocław (Poland) together with the Department of Archaeology & Tourism,

Al Neelain University (Khartoum, Sudan), the Korea Institute of Geoscience and Mineral Resources (KIGAM; Republic of Korea), the Research Institute of Natural Science of the Gyeongsang National University (Republic of Korea), and Royal Holloway, University of London (United Kingdom). During the duration of the project, archaeological artefacts were stored at Al Neelain University. After completion of field work all materials were transferred for permanent storage to the National Museum in Khartoum.

The taxonomic affiliation of archaeological horizons from EDAR was based on the presence of characteristic lithic artefacts: Large Cutting Tools (LCTs) typical of the Early Stone Age (ESA) Acheulean, and Levallois products attributed to the Middle Stone Age (MSA). A Microsoft Access database was designed to record the lithic inventories from each excavated EDAR site. Spatial analyses, based on data from artefact plotting, were conducted using ArcGis (Desktop 10.6). Use-wear analyses were conducted for selected artefacts. Only the forms classified as tools during the technological analysis were included. All artefacts were observed under a NIKON Eclipse LV 100 microscope with magnifications between 200× and 500×. Where evidence for use wear was found, it was documented with a HIROX RH-2000 digital microscope. The LCTs from the EDAR sites (EDAR 7, 133) were subjected to a morphometric analysis together with analysis of published drawings and photographs of assemblages from several Eastern Saharan Acheulean sites: the Dakhla Oasis (Schild & Wendorf 1977), Kharga Oasis (Caton-Thompson 1952) and Bir Sahara 14 (Schild & Wendorf 1981). The geometric-morphometric approach to analysing 2D images was aimed at determining the differences between the assemblages of Acheulean artefacts. Our analysis implemented a pattern similar to that used by Costa (2010), which consists of the 2D analysis of semi-landmarks superimposed on the outlines of artefacts, allowing comparisons between stone artefacts using comparative points and identifying differences between given samples.

Stratigraphic sections were exposed above the weathered rhyolite bedrock. Geological samples were collected from stratigraphic trenches and the associated archaeological excavations. Sedimentological data were collected following facies analysis and included observations such as the thickness of units, dominant colour, cementation, presence of carbonate, bedding, structures, and artefact content. The chronology of the studied succession relies primarily on artefacts, sedimentary studies and luminescence dating. Sediment samples for optically stimulated luminescence (OSL) dating were collected in opaque

metal tubes hammered into the face of a cleaned section. The samples were then processed in the laboratories of the Korea Institute of Geoscience and Mineral Resources (KIGAM) and the Gliwice Absolute Dating Method Centre in Poland (GADAM) under subdued red light. At KIGAM, measurements were carried out using a Freiberg Instruments Lexsyg Smart system TL/OSL reader equipped with a Hamamatsu bi-alkaline photomultiplier tube (H7360-02), while at GADAM measurements were performed on a Daybreak Model 2200 reader. The OSL characteristics of the quartz from the EDAR area show a rapidly decaying signal and continuously growing dose response curve which makes it well-suited for application of the SAR protocol used (see Masojć et al. 2019 for details on the method). So far, 28 samples from the EDAR area were OSL dated.

To provide additional relative dating information and paleoclimatic data, atmospheric cosmogenic nuclides were measured. Major element and beryllium (Be-10 and Be-9) concentrations were measured in samples obtained from EDAR 135 sediment profiles. The cosmogenic nuclide Be-9 falls down to the ground with precipitation. Atmospheric beryllium-10 and terrigenous beryllium-9, which are produced in the upper atmosphere by the interaction between the cosmic rays and atmospheric components such as nitrogen, oxygen, and carbon, etc., can be used for relative dating with other proxies such as oxygen isotopes and paleomagnetic intensity and paleoclimatic signals at the sampling site (McHargue & Donahue 2005). Chemistry of samples was performed at the KIGAM laboratory.

#### 4 Results

Archaeological survey resulted in the discovery of Acheulean and MSA sites. Selected sites have been excavated (Table 1). Quartz and greenish rhyolite, both available in the vicinity of the sites, were almost exclusively used as raw materials for stone tools. EDAR 6, an Acheulean site where lithic materials are scattered on the surface over an area exceeding forty hectares, constitutes a central place in the EDAR area. Acheulean stone artefacts appear there mostly subaerially on the landscape surface after long periods of erosion processes since the Middle Pleistocene. Within the lithic inventory production of cleavers from massive flakes has been observed. Additionally, some of the flake cleavers display the evidence of use of the Kombewa technology – a specific way of acquiring flakes from big flakes detached from giant

TABLE 1 Characterisation of the main EDAR sites excavated. The inventory of EDAR 6 comes from two trenches and the surface collection

Site number	Cultural affiliation	Stratigraphical position	Depth in m (approx.)	Age based on OSL	Lithic inventory	Excavated area (m <sup>2</sup> )
EDAR 6	Acheulean	I or IIA	1.5	MIS ≤ 7	164	20
EDAR 7	Acheulean	IA	3.2	MIS ≤ 11	918	9
EDAR 133	Acheulean	I or IIA	1–1.5	MIS 7–9	371	~ 20
EDAR 134	MSA	III	0.5–1	MIS 5	379	16
EDAR 135 lev. 1	MSA	IIB	1.6–2.0	MIS 5	1211	3.5
EDAR 135 lev. 2	Acheulean	IIA	2.8	MIS 7/6	737	5.1
EDAR 155	MSA	IIIB-C	0.4–0.6	MIS 5	1111	~ 20

cores, which provided flake blanks of appropriate shape and size lending themselves to further production of cleavers requiring minimum effort. The presence of the Kombewa method was so far virtually absent at Nubian Acheulean sites (Haynes et al. 1997).

Amongst the excavated Acheulean sites, two deserve special attention. Firstly, the Acheulean horizon at EDAR 135, which yielded a small assemblage (more than 700 artefacts), was dated to ~200 ka (Unit-II A), making it one of the youngest assemblages of this techno-complex in the world. This inventory is characterized by the presence of flake tools (scrapers, perforators, denticulate) and only few LCTs. Secondly, an older Acheulean horizon with nearly one thousand artefacts deposited at a depth of more than 3 m (Unit-I A) was excavated at EDAR 7 (Fig. 3). The artefact positioning indicates that the excavated area represents a buried Acheulean inventory in secondary position, a possible *Homo erectus* stone knapping dump. It is characterized by an abundance of cleavers and the use of the Kombewa method. Such developed Acheulean technologies of large flake production and high values of standardized made-on-large-flake cleavers and handaxes first appear in Africa around 1.0 Ma continuing up to the Middle Pleistocene and are labelled as “Large Flake Acheulean” stage (Sharon 2007). This relatively well-preserved assemblage is overlain by a carbonate cemented sand dated to 280±27 ka, providing a minimum age. However, the base of the carbonate cemented sand in nearby EDAR 135 is dated to 391±30 ka, potentially suggesting that the EDAR 7 tools are older than this. While 391±30 ka is young for the Acheulean in the African Rift, this age would make EDAR 7 the oldest encampment/activity area remains found in Eastern Saharan Africa. The morphometric analysis shows similarities between the EDAR 7 assemblage and Site 14 in the Bir Sahara depression (Schild & Wendorf 1981).

A deep sedimentary sequence spanning a Pleistocene to Holocene succession is exposed in mines in the EDAR area. A simplified representation of the EDAR sedimentary deposits (Fig. 2) shows a Pleistocene succession over 5 m thick and divided into three units (Units I–III) bounded by erosional surfaces, with a well-established chronology based on optically stimulated luminescence (OSL) dating (Fig. 2). EDAR 135, which has the most complete sedimentary sequence is described below. Unit I (~ 400–200 ka, MIS 11–8) consists of stratified pebble gravel at the base (Unit-I A), overlain by massive sand with abundant calcrete nodules (Unit-I B), suggesting sediment deposition in braided streams followed by carbonate precipitation under arid climatic conditions. Unit II (~ 200–130 ka, MIS 7–6) comprises planar to cross-stratified pebble gravel (Unit-II A) overlain by a metre-thick, massive and carbonate-cemented sand (Unit-II B), indicating another episode of fluvial incision and sediment deposition, followed by carbonate precipitation under arid climatic conditions. Unit II is overlain by a thin and continuous gravel layer, interpreted as a desert pavement produced by winnowing and intermittent rain. The overlying Unit III (~ 130–10 ka, MIS 5–1) comprises soil which can be divided into three subunits based on subtle changes in grain size and sediment colour. The unit is structureless but contains rare pebbles and tubular voids interpreted as the molds of plant roots. The entire sequence shows multiple transitions from fluvial to aeolian sediments, i.e. from wet to arid conditions.

Younger archaeological horizons from several sites belong generally to MIS 5 (~ 130–70 ka), representing a Middle Stone Age phase. The oldest among them, the MSA horizon from EDAR 135 (upper layer), is dated to ~ 120 ka (MIS 5 d–e). The analyses revealed several characteristics that seem to set this inventory apart from other MSA Northeast African inventories. Among these, the

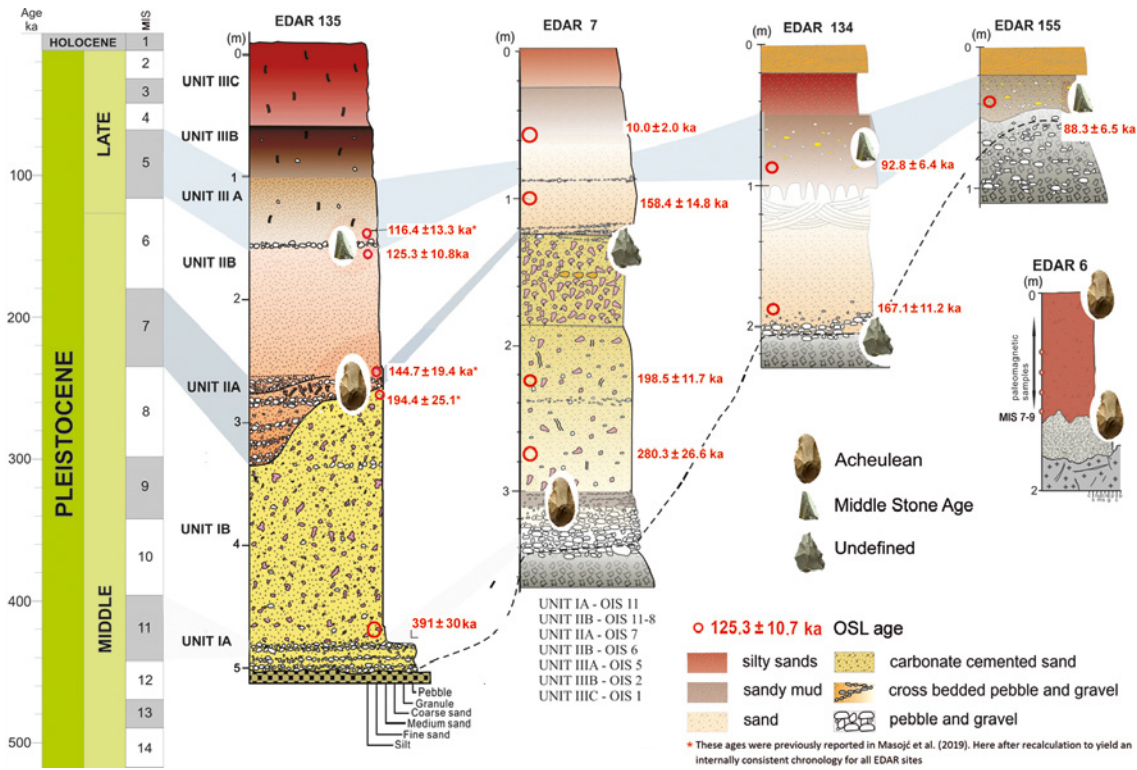


FIGURE 2 Summarized geology and archaeology of the EDAR area

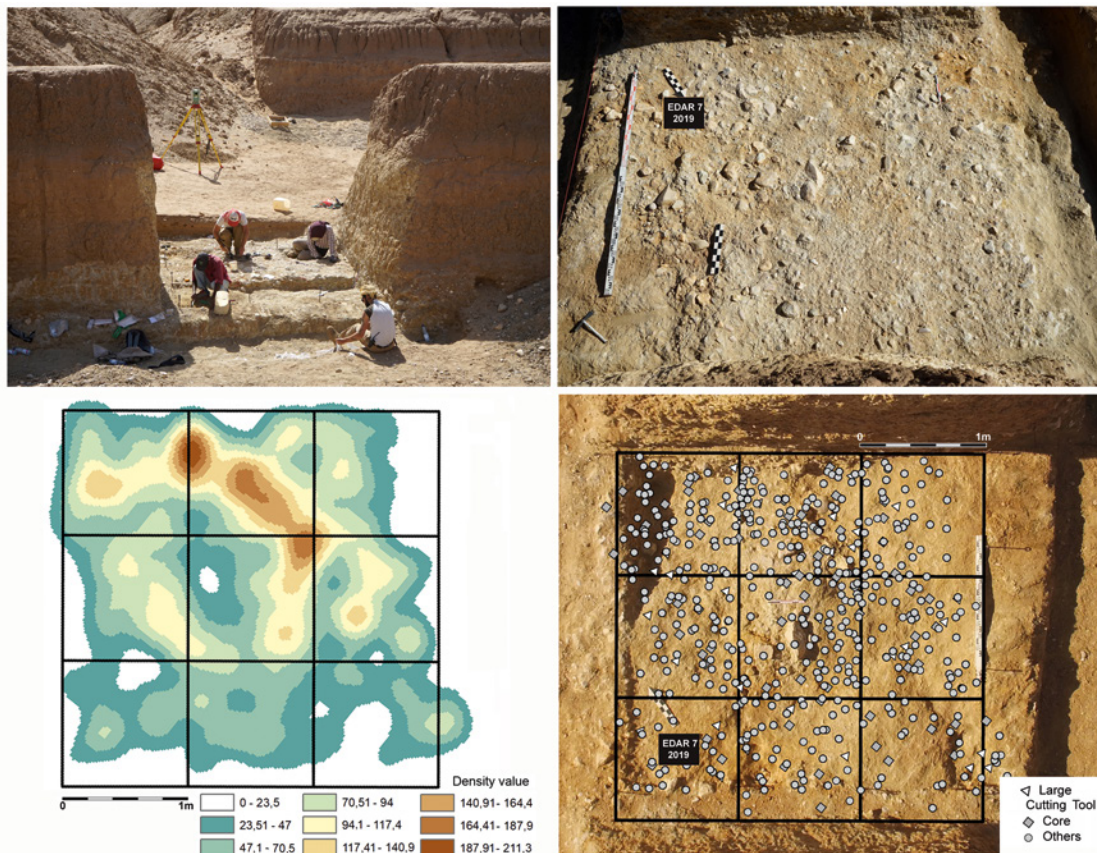


FIGURE 3 Acheulean horizon excavated at EDAR 7 (top left). Undisturbed area (3 m × 3 m) within the mine being excavated – top of the Acheulean horizon (top right), density map (bottom left) and scatter pattern (bottom right) of artefacts



FIGURE 4 Selected Acheulean artefacts: rhyolite handaxe (a), cleaver (b), chopping tool made on chert (c) and quartz (d), quartz handaxe (e), cleaver (f)

dominance of simple, non-predetermined core reduction strategies and expedient tool types, coupled with the lack of traces of Nubian Levallois technique, are the most conspicuous. Two younger horizons from EDAR 134 and EDAR 155 are dated to later phases of MIS 5, approx. to 90 ka, and are characterized predominantly by centripetal Levallois technology. MSA horizons end the Palaeolithic sequence in the EDAR area. Besides these characteristic assemblages excavated at EDAR sites there are also undiagnostic inventories, containing mostly debitage, for which attributions are impossible (Fig. 2). This is the case for EDAR 7 where several artefacts were found at a depth of 1.2 m in sediment dated to older than 158 ka and also for EDAR 134 where a group of several flakes was found at a depth of ~ 2 m just below the sediment dated to 167 ka. Taking into consideration the very young chronology of the Acheulean horizon from EDAR 135, these two small inventories could be affiliated either with the Acheulean or MSA. There are no younger Late Palaeolithic or Mesolithic inventories.

The EDAR sites differ from the Eastern Saharan African Acheulean in several respects, notably the constant presence of cleavers among bifacial tools and the production of bifacial tools on flakes (Fig. 4). The presence of the

Kombewa method is yet another difference, as well as the co-occurrence of two main methods of tool production in the assemblages (EDAR 7, 135): one geared towards the production of large cutting tools, the other focused on flake tools (perforators, endscrapers, composite tools, etc.) based on small debitage (Fig. 5). Use-wear studies of the latter showed traces of work in soft and hard materials, including wood and bones (Fig. 5f). The measurement of atmospheric cosmogenic nuclides shows that below a depth of 160 cm, the Be-10/Be-9 ratio and concentrations of elements such as Ba, Sr, Mg and Mn display repeated pronounced fluctuation (Fig. 6). Several cycles are visible, implying repeated variations in the relative intensity of soil-sedimentary moisture (pluvial) and aridity (interpluvial). These fluctuations are presumed to be amplified by hydroclimatic changes, regionally representing relatively warm and cold climate in Northeast Africa. In particular, since late MIS 7 (~200 ka) until early MIS 5 (~120 ka), hominin occupations are evidenced at EDAR 135. Carbonate nodules and cementations were ubiquitously formed during the relatively arid periods, and the period of cyclic variations in mineral composition is ~25 ka, implying that it is driven by axial precession.

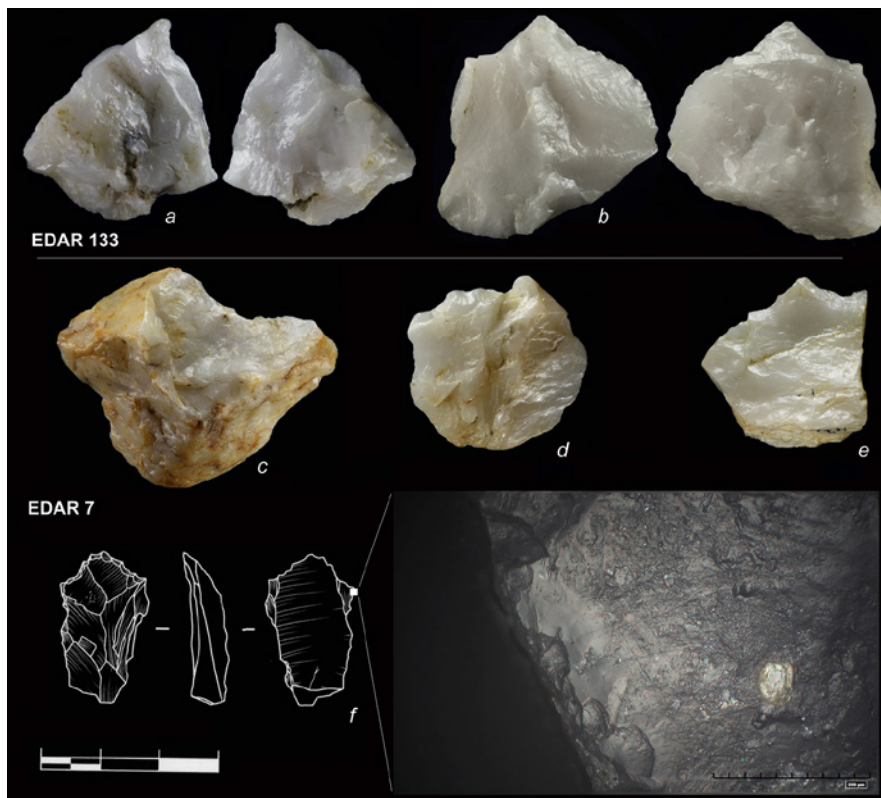


FIGURE 5 Acheulean flake tools. Perforators (a–b, e), notch (c), denticulate (d). Use wear identified as produced by cutting bone (f)

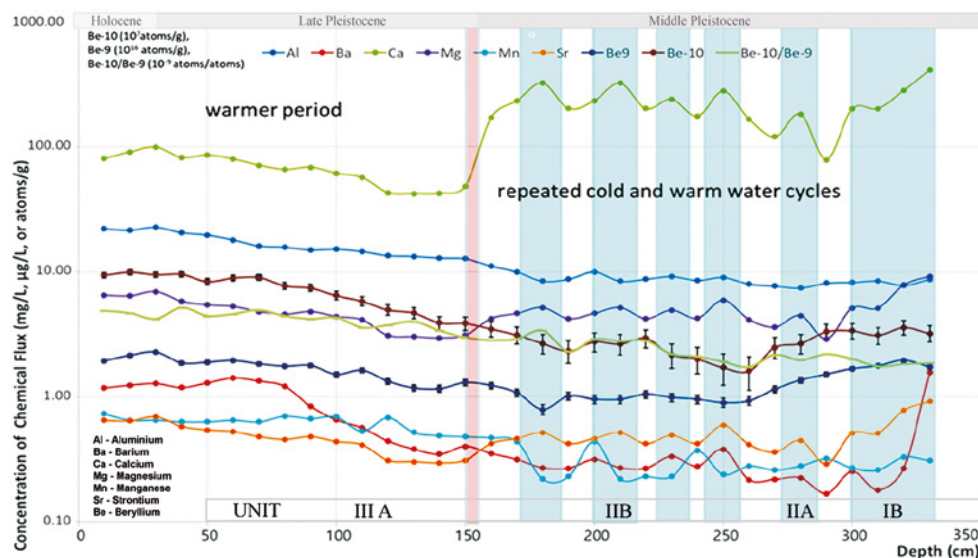


FIGURE 6 EDAR 135. Element compositions and Beryllium ratio showing cyclic climatic variations

## 5 Conclusions

There are few homogenous and datable Palaeolithic assemblages in the north-eastern part of Africa (Usai 2019; Garcea 2020; Masojć 2020). Besides the sites situated in the Nile valley (Wendorf 1968; Veermersch 2000; Van Peer et al. 2003) and the Egyptian oases (Caton-Thompson

1952; Wendorf et al. 1993), cave sites in the Red Sea Mountains (Kindermann et al. 2013; Schmidt et al. 2015) and individual open-air sites in the desert (Masojć et al. 2017) have been recorded. While sites representing the Levallois tradition and the late Palaeolithic of the Nile valley (Vermeersch 1992; Wendorf & Schild 1992; Schild & Wendorf 2010) are to a certain extent represented, the



oldest cultural episodes are absent or limited to a few sites only, as is the case of the Acheulean handaxe tradition (Arkell 1949; Caton-Thompson 1952; Schild & Wendorf 1977; Vermeersch et al. 2000). The Acheulean and MSA sites in the Eastern Desert (EDAR) studied in this project provide new information about the Saharan Palaeolithic. Within the EDAR area there are archaeological remains represented by the Middle Stone Age Levallois technology of *Homo sapiens* activity (Stewart & Jones 2016), dated generally here to MIS 5, and *Homo erectus* presence manifested by handaxes and cleavers (Sahnouni et al. 2013), dated to the time span between MIS 7–MIS 11 (although we suggest that the Acheulean horizon from EDAR 7 could be much older than 391 ka (MIS 11)). The chronology of the EDAR Acheulean sites puts them on one hand within the oldest Acheulean phase in Eastern Saharan Africa (MIS 9, MIS 11<) and on the other hand amongst the latest Acheulean representations worldwide (late MIS 7, ~ 200 ka).

The archaeological record in the EDAR area, under constant threat from mining, is of considerable importance for understanding the earliest prehistory of Eastern Saharan Africa. The evidence at EDAR confirms the intensity of human occupation of the desert when the Sahara was periodically habitable during Middle and Late Pleistocene humid periods. It is also of special interest because the area could play an important part in the dispersion of early hominins towards Eurasia, demonstrating that habitable corridors existed between the Ethiopian Highlands, the Nile and the Red Sea coast, allowing population dispersals across the continent and out of it. The results highlight the importance of studying ancient watercourses, far from the coast, oases and the Nile valley (Drake et al. 2011).

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