Age and formation processes of an Acheulean site with extensive accumulation of large cutting tools: Garba I (Melka Kunture, Upper Awash, Ethiopia)

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Abstract

The paper provides new data on the age and formation processes of Garba I (Melka Kunture, Upper Awash, Ethiopia). The site, one of the largest handaxe accumulations of the African Acheulean, was extensively excavated in the Sixties of the last century by J. Chavaillon but left largely unpublished. The chronology was also poorly constricted. Quartz grains dated through electron spin resonance (ESR) spectrometry now provide a minimum age of 538 ka for the archaeological layer. In addition, we make available new data allowing an updated interpretation of the stratigraphic sequence and spatial distribution, as well as a detailed taphonomic study of the lithic assemblage. Additional information on the archaeozoological and palaeobotanical record are integrated in the discussion. We conclude that the extensive accumulation of large cuttings tools (LCTs) is not the result of major sedimentary disturbance processes but rather the outcome of a distinct hominin behaviour, which possibly was not focused on the processing and consumption of large mammals. New research at Garba I allows new insights on the

Acheulean sites with similar large accumulations of handaxes. Additionally, it contributes to a better understanding of the early Middle Pleistocene in Africa, an under-researched period of the Early Stone Age.

Keywords

Acheulean, Garba I, Melka Kunture, Middle Pleistocene, electron spin resonance (ESR) dating, site formation processes, site taphonomy.

1. Introduction

The Acheulean is longest and most largely widespread prehistoric techno-culture. Traditionally, it is defined by the emergence of the capability of detaching large flakes and shaping large cutting tools (LCTs) (i.e., handaxes, massive flake tools or cleavers) (Clark 1994; Díez-Martín and Eren 2012; de la Torre, 2016; Gallotti and Mussi 2018b).

The characteristic of several Acheulean sites is the extensive accumulations of LCTs. Such sites have been identified in Africa (e.g., Isaac 1977; Gowlett 1978; Roche *et al.*, 1988), Middle East (Clark 1967, 1968; Goren-Inbar and Saragusti 1996; Petraglia 2003; Petraglia and Shipton, 2008) and Europe (Roberts and Parfitt 1999; Méndez-Quintas *et al.* 2018). They are considered a classic feature of the Acheulean of Africa, where such iconic archaeological complexes were discovered and excavated during the 20th century. Olorgesailie (Isaac, 1977), Isenya (Kenya) (Roche *et al.* 1988), Kariandusi (Shipton, 2011) and Kalambo Falls (Zambia) (Clark, 2001) are some of the main Acheulean sites that have built the African prehistory. They are usually associated to channelled fluvial deposits and accordingly interpreted as resulting from extensive sedimentary disturbance processes, with the redeposition of mixed archaeological assemblages. Only few like Isenya have been considered to be *in situ* (Roche *et al.* 1988). However detailed publications are rare (Schick 1986; Schick 1992; Shipton, 2011; Walter and Trauth 2013). In-deep geoarchaeological and taphonomic approaches are needed, as well as a better chronological constriction. Today, new fieldwork and taphonomic methods are developed to revaluate the degree of sedimentary disturbance of classic -already excavated- sites (Benito-Calvo and de la Torre 2011; Duller *et al.* 2015; de la Torre *et al.* 2017; Méndez-Quintas *et al.* 2019). This allows to evaluate the accuracy of the original data from these sites and eventually to better understand hominin behaviour and patterns landscape occupation.

The Melka Kunture complex (MK) provides one of the longest and most complete sequences documenting the Acheulean Techno-complex in Africa, from its emergence to the transition into the Middle Stone Age (Gallotti and Mussi 2018a). It is located on the banks of the upper Awash River, on the Ethiopian highlands, ~ 2000 m above sea level (**Fig. 1**). After surveys by L. Balout in 1963-1964, proper fieldwork was started in 1965 by a French Mission led by Jean Chavaillon. From 1999 onwards the responsibility for investigations has been held by the Italian Archaeological Mission at Melka Kunture and Balchit, first directed by Marcello Piperno and now by Margherita Mussi as the head of a joint Italo-Spanish Archaeological Mission. Tens of sites, often multi-layered, have been excavated over the past 60 years in the gullies and valleys of the Awash tributaries (**Fig. 1**), providing rich and complex archaeological, paleontological, paleoanthropological, ichnological and paleoenvironmental evidence. Over the last decades, the early Acheulean sites have been extensively investigated in order to explore the emergence of this techno-complex in the Ethiopian highlands (Gallotti 2013; Gallotti and Mussi 2017; Gallotti and Mussi 2018a; Mussi *et al.* 2021). The focus has now turned to the Middle Pleistocene occupations and human behaviour during this age-range (Altamura *et al.* 2017; Altamura *et al.* 2018; Altamura *et al.* 2020a; Mussi *et al*. 2016).

In this paper we provide a multidisciplinary approach to Garba I, a site which was so far frequently mentioned in the scientific literature but left unpublished. Garba I is one of the largest and most extensively excavated accumulations of LCTs at MK and in Africa. The research aims at understanding the environment and depositional dynamics, and the age and impact of sedimentary processes on the archaeological record. Following this interdisciplinary approach, this research combines with new stratigraphic data a detailed taphonomic analysis of the lithic artefacts and the analysis of the orientation and density patterns of natural and anthropogenic remains. This allows to discuss the formation and integrity of the archaeological record. We provide an accurate chronology for the hominin activities at ~600 ka and highlight the value of the archaeological assemblage for understanding hominin behaviour during the early Middle Pleistocene. In addition, we explore a site of the so-called African "late Acheulean". The lack of well-dated sites with large assemblages in this age range does not allow to fully understand them (see Gilbert *et al.*, 2016). Still, the emergence, in the paleoanthropological record, of new hominins with brains larger than those of *Homo erectus*, makes this period quite relevant for the study the human evolution eventually leading to the origin of *Homo sapiens* (McBrearty and Brooks 2000; Rightmire 2009). At MK there is indirect evidence that Garba I formed at the time of *Homo heidelbergensis* (Profico *et al.* 2016).

2. The Acheulean site of Garba I

2.1. Research history and previous studies

Garba I is located at 2012 m asl on the right bank of the upper Awash River, along the Garba gully **(Fig. 1).** It was one of the first archaeological sites discovered at MK. Designated originally as Godetti, it was found in 1964 by G. Bailloud when he surveyed the area of Melka Kunture (Bailloud 1965). A relevant number of large tools (cleavers, handaxes, etc.) was eroding from a thin layer visible on a natural section. G. Bailloud initially named it "level C" but J. Chavaillon later referred to it as "level B" (Chavaillon 1967). Fieldwork was carried out by J. Chavaillon from 1965 to 1971 (**Fig. 2-3**). This was the time of the VII Panafrican Congress in Addis Ababa, whose participants visited MK and Garba I, where a large area of the excavation had been left in full view with the aim of establishing and open-air museum. After an interruption, a last field season took place in 1975. During Chavaillon's research, each bone and lithic remain was recorded using a detailed grid (**Fig. 2c**) and marked with a number. The sediment was systematically sieved and pieces under 1 cm were stored in bags with reference to the square meter. Several altimetric measurements were recorded for each piece during the 1975 campaign, but unfortunately this information was not kept in the archives. The archaeological collections are now stored in Addis Ababa in the National Museum.

At Garba I, 243 m^2 were excavated down to level B, the main level discussed here, where some 12.000 artefacts were discovered (**Fig. 2-3**). Because of the size of the excavation and the amount of lithic industry, the importance of Garba I has been underlined ever since 1971 and the VII Panafrican Congress on Prehistory (Chavaillon 1976). However, the assemblage and the rich and complex documentation only underwent preliminary publication. Excavation reports and non-detailed articles provide general information of the fieldwork and some preliminary interpretations (Chavaillon 1967, 1970, 1978; Chavaillon *et al.* 1979).

Overlying the main excavated level, level B (henceforward Garba IB), level A was found to be much disturbed. Underlying level C was just tested. Level B was embedded in fluvial sediments including a relevant number of pebbles and large stones (Chavaillon 1967) (**Fig. 2**). Until 1974 various hypotheses were put forward concerning the anthropic or natural origin of this accumulation. A detailed analysis carried out by M. Taieb confirmed the natural origin of the pebbles (pebble lag) on top of which laid the archaeological material (Taieb 1974). According to Chavaillon (1976), Garba I exemplified the remains of campsites established on top of a pebble lag. In his opinion multiple occupations happened during a relatively short period, although they were interrupted by the seasonal flooding of the paleo-Awash.

Following his preliminary analysis of the assemblage, Chavaillon interpreted Garba IB as a home-site where a wide range of activities took place, as cooking and butchering (Chavaillon 1970). He also mentioned rocks supposedly used to wedge a stake and a heated stone possibly related to a small hearth, but this is not documented with any supporting information (Chavaillon 1978). Finally, the extremely fragmentated faunal remains were seen as evidence of the intentional crushing of bones. However, in his last publication, with Arlette Berthelet, Chavaillon modified this interpretation, rather relating them to post-depositional processes (Chavaillon and Berthelet 2004).

In Chavaillon's times, the age of the deposit was based on the relative chronology and on lithic typology. He had established all over the area of MK a sequence of volcanic tuffs that he tried to correlate from site to site, naming them with a capital letter in alphabetical order, from the earliest to the latest. Following this scheme, Garba I was first put between tuffs D and E – namely 3 meters above tuff D - and later above tuff E. This changed when geochemical, K/Ar and palaeomagnetism analysis became available. The Matuyama-Brunhes boundary, ~ 0.78 million-years ago -Ma- (but at the time dated at 0.73 Ma), was identified along the gully 7 meters beneath level B. This suggested that the archaeological layer accumulated between 350-400 ka (Chavaillon and Chavaillon 1980), later recalculated as 400-500 ka (Piperno, 2001). A last chronological notation was published in 2004 (Chavaillon and Berthelet 2004, p.60): "The underlying fluvial deposits seal a sequence of volcanic layers. The latter are contemporary with a sequence on the Gombore II site which seals the hippopotamus "Butchery site", this last dated to 0.7 Ma."

2.2. The archaeological assemblage

Garba I is one of the largest assemblages of MK. More than 12,000 lithic elements had been retrieved and kept by Chavaillon. However, as in other sites (Mussi *et al*. 2021), the re-examination of the originally labelled "percussion material" identified many unworked elements that we now classify as natural and non-anthropic material (n = 1377). The assemblage studied here is composed of 7227 lithic elements, 828 bifacially shaped tools (handaxes and cleavers, *sensu* Tixier 1956), 1154 retouched pieces, 3216 flakes, 393 cores and core fragments and 144 pounding tools which includes polyhedral and spheroidal pieces (**Table 1; Fig. 4**). The remaining are ambiguous or badly weathered pieces with low informative value (henceforward LIV). Furthermore, 29,835 small fragments <20 mm have been retrieved, which is the sieve material. Various types of porphyritic and aphyric basalts and lavas were used, but the obsidian alone represents 57.11% of the knapped material. The detailed features of the lithic material will be discussed in a publication under preparation. Contrarily to other sites of MK, at Garba I the bone remains are rare. Furthermore they are very fragmentary. Only 156 bone, teeth and horn-core fragments are listed in the inventories.

3. The geological and geomorphological setting of Melka Kunture

MK developed within a closed basin on the eastern edge of the NW Ethiopia Plateau, in the upper Awash valley on the western margin of the Main Ethiopian Rift. The area is characterized by a half-graben structure-oriented NE-SW according to the Rift pattern. The general scheme is complicated by the effect of tectonics, where the oldest faults, WE-oriented, are cut by NW–SE faults that control the incision of the Awash River gorge (Raynal and Kieffer 2004; Salvini *et al.* 2012).

During the Plio-Pleistocene the basin was mainly affected by volcanic deposits and by fluvial aggradation and erosion (Kieffer *et al.* 2002, 2004; Raynal and Kieffer 2004). The basin stratigraphy consists of a sequence of primary (fall and flow) volcanic deposits interbedded with reworked sediments emplaced in a floodplain environment (Chavaillon and Taieb 1968; Taieb 1974; Raynal and Kieffer 2004). The volcano-sedimentary sequence of MK hosts the numerous fossils and archaeological remains of Early, Middle and Upper Pleistocene age.

Correlations among localities are often difficult to establish, due to lateral variations of facies and tephra geochemistry (Raynal and Kieffer 2004). However, volcanic deposits allowed radiometric dating and correlations among archaeological horizons found in the complex sequences, either in the gullies or along the river (Morgan *et al.* 2012). Paleomagnetism was also investigated (Tamrat *et al.* 2014).

The geomorphologic evolution of the landscape has been strongly affected by Plio-Pleistocene volcanism and tectonics, as well as by fluvial processes and climate change (Chavaillon and Taieb 1968; Taieb 1974; Bonnefille 1976; Raynal and Kieffer 2004; Maerker *et al.* 2019; Mussi *et al.* 2016; Mussi *et al.* 2021). The dynamic nature of the landscape with alternating phases of fluvial aggradation and erosion differentially affected the archaeological levels (Méndez-Quintas *et al.* 2019).

4. Material and methods

4.1. Recent fieldworks and sampling

In 2015 and 2017 fieldwork was conducted to assemble updated information on the stratigraphy, the chronology and the taphonomic processes leading to the formation of Garba IB. The original excavation was relocated, test-pits were opened and level B was reached and cleared. The test-pits made use of the extant standing walls where the stratigraphic section was still visible. Test-pit 1 (**Fig. 5**) was excavated over 2 x 1.3 m extending to the north the limits of the original grid. This allowed to recover controlled data on the position and density of the remains in the archaeological level. Furthermore, 27 stratigraphic sections were cleared and recorded at regular intervals on both scarps along the gully (**Fig. 5**). Geologic samples were taken for radiometric dating.

4.2. Stratigraphy

The stratigraphic study, carried out in 2016, is based on the fieldwork analysis of the sections exposed along the Garba gully (**Fig. 5**). Detailed logs were produced, notably for logs 13 and 2, respectively along the gully scarp and the standing walls of the excavated Garba I site). Sedimentary features at macro-meso scale (structure, texture, unconformities) and facies were studied for the reconstruction of the depositional processes, environments and for log correlation. The archaeological layers were incorporated into the stratigraphic sections.

4.3. ESR dating of quartz grains: analytical protocols

The quartz grains extraction and preparation protocol of quartz for ESR dating has been described in Voinchet *et al.* (2004). The recovered quartz grains were then dated using the Multiple Aliquots Additive (MAA) method. The pure quartz sample was split in eleven aliquots. One of them was conserved as natural reference while nine aliquotes were irradiated to increasing doses ranging from 264 to 12500 Gy with a gamma source (^{60}Co - CEA Saclay, France) emitting 1.25 MeV radiation with a dose rate of around 200 Gy/h. Lastly, the last aliquot was exposed in a Dr Honhle SOL2 solar simulator during 1600h to light (light intensity around 3.3 10^5 Lux, in order to determine the unbleachable part of the ESR-Al signal (Toyoda *et al.*, 2000).

The set of eleven aliquots was then measured by ESR spectrometry at the MNHN dating laboratory (Paris, France). The measurements were performed at least three times on three different days at 107K temperature with an EMX Bruker X-band spectrometer in a high sensitivity spherical cavity cooled by liquid nitrogen Brcker device. In order to consider angular dependence of the signal due to sample heterogeneity each aliquot was measured daily also three times after an approximatively 120° rotation of the tube in the ESR cavity (leading to a set of 9 ESR intensities for each used signal).

In this work, both ESR signals associated with Aluminum (Al) and Titanium (Ti-Li and Ti-H) paramagnetic centers of quartz have been studied in order to apply the multi-centre method as defined by Toyoda *et al.*, (2000) (Tissoux *et al.*, 2007). This approach if founded on the difference of sensibility of these two kinds of paramagnetic centers to light. While Ti centres are totally zeroed by sunlight exposure in few days, Al-center cannot be reset even after several months' long exposure, due to the presence of Al-centers that cannot be bleached by light (DAT, Tissoux *et al.* 2012). In these conditions, the results obtained from both signals permit to discuss of the quality of the initial bleaching of the samples before its deposition on the site. Unfortunately, for the Garba 1.15 sample, Ti-H signal was not exploitable.

The ESR signal intensities of the Al and Ti-Li centres were measured from the obtained spectra following the recommendations of Voinchet *et al.* (2020). These ESR spectra were acquired using the following parameters: for titanium center, 10 mW microwave power, 1024 points resolution, 20 mT sweep width, 100 kHz modulation frequency, 0.1 mT modulation amplitude, 40 ms conversion time, 20 ms time constant and 2 scans; for aluminum center, 5 mW microwave power, 1024 points resolution, 20 mT sweep width, 100 kHz modulation frequency, 0.1 mT modulation amplitude, 40 ms conversion time, 20 ms time constant and 1 scan. The signal intensities of Ti-Li and Al centers was measured following recommendations of Duval and Guillarte (2015) (option D) and Toyoda and Falguères (2003) respectively.

For these two different paramagnetic centers, equivalent doses (D_e) were then determined from the obtained ESR intensities vs doses growth curve with an exponential+linear function (Duval *et al.* 2009; Voinchet *et al.* 2013) using Microcal OriginPro 8 software with $1/I^2$ weighting. For Al-center, ESR intensity of the bleached aliquot was systematically subtracted from the ESR intensities of the other aliquots before the D_e determination to account the DAT proportion in the sample.

The dose rate d_a was obtained from the sum of the α, β, γ and cosmic-ray contributions, determined from the sediment radioelement contents (U, Th and K) determined in laboratory by high resolution and low background gamma-spectrometry (Yokoyama and Nguyen 1980) and using the Prescott and Hutton's (1994) equations.

4.4. Digitizing unpublished maps

In order to study the taphonomic and distribution patterns of the archaeological records, Chavaillon´s original excavation maps, kept in the archives of the Mission, were fully digitalised. The maps had been accurately drawn on graphic paper using a plumbline and a 1 x 1 m-grid subdivided into 100 10 x 10 cm squares. The following procedure had been established by Chavaillon all over MK: once an archaeological surface was cleared, a map was drawn. Then the material free from the sediment was removed, cleaned and each item was marked with a number. The excavation continued until a new group of items from the same level was in full view, allowing the procedure to be repeated. We scanned, resized and georeferenced the maps of the different phases of excavation using ArcGis Pro 2.7 software. With georeferenced maps we digitized all items (artefacts, faunal remains and natural clasts), eventually producing polygon maps with a great accuracy. Item data were saved in shape files (.shp) which were later combined with the data derived from the directly analysed artefact assemblage, creating a complete geo-database.

The excavated surface was of 243 m^2, with archaeological remains preserved over 224.3 m^2. 17506 polygons were drawn using the digitalised maps (faunal remains = 1746; lithic industry = 7008; unmodified pebbles = 8752) (**Fig. 6a**). After combining them with the analysed artifacts we retained 15925 polygons: faunal remains = 1746; lithic industry = 4435; unmodified pebbles = 9744 (**Fig. 6b-c; Fig. 7**). On this data a specific software GIS process (minimum bounding rectangle) calculates the main geo-archaeological information provided by each item (length, width, and axial direction). This data acquisition method has already been successfully used elsewhere at MK (Méndez-Quintas *et al.* 2019).

4.5. Lithic taphonomy

A detailed taphonomic analysis of the archaeological material was conducted to evaluate the degree of integrity on the assemblage. The evaluation of post-depositional processes started with the observation of all macroscopic alterations. The sample used on this analysis counts 1678 lithic elements and includes LCTs, cores and retouched pieces. In this approach, we have evaluated the macroscopic alterations linked to two different post-depositional processes: mechanical alteration and patina or chemical alteration. The degree of intensity was evaluated in a scale from 0 to 3 (low to high degree). Each raw material was evaluated independently as different rocks react differently to the same post-depositional process.

- **Mechanical alteration**: corresponding to the loss of material produced by processes other than chemical alteration. Two distinct mechanical alterations were identified, associated to two different taphonomic processes.
    - Abrasion or blunting; it is the smoothing of the angular surfaces as defined by Inizan *et al.* (1999): “blunting is the outcome of any action that has altered a cutting edge by making it less sharp”. It is possibly the outcome of water transport which, repeatedly making the pieces to impact or rub against each other, causes the rounding of the edges. Four degrees of abrasion have been identified: 0 (pristine), 1 (slightly abraded, the limits of the removals are visible and the edges still present), 2 (highly abraded, the removals are visible, but it is not possible to distinguish their limits), and 3 (highly abraded and rolled).
    - Edge-damage or pseudo-retouch; notches are observed along the edges of the tools. This alteration has been associated to sediment pressure and trampling by biological agents (McBrearty *et al.* 1998). It is important to identify it in order to discriminate anthropic and natural retouch. The criteria used here to recognise natural alteration are a combination of those

proposed by Tringham (1974), Pryor (1988) and C. Thiébaut (2007), who identify two main morphologies of pseudo-retouch: short, abrupt and irregular retouch on thick edges; and notches and denticulation created by a single removal with a fracture angle of 90º on slim pieces, usually on the edges or on a distal part of shaping flakes.

- **Patina or chemical weathering:** commonly refers to a film, rind, encrustation, or layer produced on the surface of flint due to chemical weathering (Glauberman and Thorson, 2012). In the case of obsidian, patination is mainly related to de-hydration (Hurst and Kelly 1961). Here we include more broadly any visible alteration of the chemical composition of the rock. Four degrees of alteration have been identified: 0 (pristine), 1 (light patina, the original colour is still visible), 2 (thick patina all over the surface), and 3 (deep chemical alteration leading to the disintegration of the material and blunting of the edges) (**Fig. 8**).

Additionally, we have analysed size ranges as another method of assessing the degree of disturbance of an archaeological assemblage (Schick, 1986; Petraglia and Potts 1994; Bertran *et al.* 2006; Bertran *et al.* 2012; Byers *et al.* 2015). This method must be used cautiously when dealing with assemblages excavated by other researchers, although in the case of Chavaillon we know for sure that the largest part of the items was always carefully mapped and kept. With these methodological constraints in mind, we have compared the size and size-range of the lithic industry and bones with those of the unmodified pebbles. We applied statistical tests to quantify any difference among the variables: F test (*F*), Mann-Whitney (*U*) tests, Kolmogorov-Smirnov test (*D*) or Chi square test (X^2).

4.6. Orientation pattern

Orientation analysis is suitable to assess the sedimentary post-depositional disturbance of archaeological assemblages (Schick 1986; Domínguez-Rodrigo *et al.* 2012; Cobo-Sánchez *et al.* 2014; Domínguez-Rodrigo *et al.* 2014; Méndez-Quintas *et al.* 2019; Panera *et al.* 2019; Méndez-Quintas *et al.* 2021). The items considered for this part of the study were those measuring >50 mm with an elongation index (i.e. = length/width) >1.6, following the methodological standards defined by Drake (1974). The retained pieces are 2520: natural clasts = 1442, artefacts = 925 and faunal remains = 153. We used the Rayleigh and Kuiper tests to differentiate uniform (isotropic) from non-uniform (anisotropic) distributions (Fisher 1993).

4.7. Spatial analysis

The excavations conducted in 2015 confirm the dispersion of the archaeological material in a single 20 cm-thick layer. Most elements lie horizontally on the surface and the gap among pieces rarely exceeds 3 cm. Patches of material are also common with some showing a higher density of pieces that happen to be partially or totally on top of each other. In such cases considerable edge damage is due to overlapping.

A first approach to the distribution patterns of the material is presented here and will be further developed in other publications. Density patterns were calculated using the geostatistical tools of ArcGis Pro 2.7 software. We calculated the assemblage density through kernel density methods (Baxter *et al.* 1997) and the degree of clustering through Nearest Neighbor (Ripley 2005; Conolly and Lake 2006).

5. Results

5.1. Stratigraphy

A fluvial-volcano sedimentary sequence about 3 m-thick is exposed in the middle part of the Garba gully (**Fig. 9**), where the Garba I site is located. It consists of silty to coarse sandy beds and lag deposits alternating with primary and reworked ash fallout deposits. Taieb (1974) and Chavaillon (1968) referred this sequence to the Middle Pleistocene.

The stratigraphic analysis was carried out from exposed sections along the gully scarp and in the archaeological area of Chavaillon´s excavation. A composite stratigraphic log (**Fig. 10**) was constructed from the section logs that includes the depositional units. The units show sharp to gradational contacts within a short vertical succession and are laterally discontinuous. From bottom to top, five major stratigraphic units were identified.

Unit 1, ~1.5 m-thick, was recorded in sections 6, 5, 3, 7, and 27 in the gully sector close to the archaeological area (**Fig. 5 and 9**). The well-sorted medium-coarse sand, low-cross to plane parallel stratification and ripple cross-lamination, all suggest low-energy sedimentation in a shallow fluvial channel.

A distinct erosive surface separates the channel fill unit 1 from overlying **unit 2** (~ 1 m-thick) which is horizontally-bedded and crops out discontinuously along the gully. This unit, consisting of layers of reworked pumice clasts, may be interpreted as crevasse splay deposits. The thin slickensides between the two layers suggest a short subaerial exposure. In the sector of the gully close to the archaeological area (sections 3-6), unit 2 is affected by a crevasse channel filled by a conglomerate with reworked pumice clasts, sporadic artifacts and bones. The erosional and depositional processes probably are the outcome of volcanic inputs overloading the channel.

Unit 3 (50-100 cm-thick), overlying unit 2, is a poorly stratified floodplain deposit containing sand lens, *lapilli*, and distal ash fallouts in shallow water. Coarse layers intercalated within unit 3 are interpreted as crevasse splay deposits (sections 5-9-11) Artifacts and bones were discovered at the bottom of the unit. Unit 3 is capped, after an erosional unconformity, by **unit 4** which is up to 30-50 cm-thick. It consists of red coarse fluvial channel deposits with cross-bedding stratification and of a lag channel deposit rich in pebbles and cobbles, indicating higher energy of the channel flow and the migration of the paleo-Awash in the floodplain. Along the gully the red alluvial deposits are laterally discontinuous, while the lag deposit crops out in the area of Chavaillon’s excavation where the archaeological layer Garba IB (Chavaillon 1970; Chavaillon and Berthelet 2004) was unearthed. This layer with Acheulean lithic industry is capped by **unit 5** (~1.5 m thick) consisting in a silty clay overbank deposit with ash fallout, pedologically altered at the top. A massive white ash deposit with diatoms, 1 m-thick, caps the Acheulean artefacts lying above the red alluvial deposits of unit 4, as evidenced by stratigraphic correlations. This tuff deposit exposed upstream (section 22) is dated as described below. It suggests ash fallout in a backswamp or oxbow lake environment under stable water conditions.

The sedimentary sequence suggests that the human presence at Garba I happened in a dynamic fluvial context. All deposits show a floodplain environment. The sedimentation was strictly related to the migrating paleo-Awash channel and to flood events influenced by climate and volcanic inputs. The human activities occurred mainly on the lag deposits exposed after flooding.

5.2. Chronological framework

The results of the measurements of the activities of the different radioelements contained in the sediments extracted from sample Garba 1.15 are presented in **Table 2**. The α, β, γ and cosmic contributions, as well as the resulting annual dose, the equivalent doses determined for the Al and Ti-Li centres and the ages calculated for these two centres are presented in **Table 3**. Age calculations were performed using the dose-rate conversions factors from by Guerin *et al.* (2011) and a k-value (α efficiency) of 0.15 ± 0.1 (Yokoyama *et al.*, 1985). Alpha and beta attenuations estimated for the selected grain sizes from the tables of Brennan *et al.* (1991) and Brennan (2003) respectively. A water content (W%) of 5±5% was used and water attenuation was then determined using formulae from Grün (1994). The internal dose rate was considered as negligible because of the low contents of radionuclides usually found in quartz grains (Murray and Roberts 1997; Vandenberghe *et al.* 2008). ESR age estimates are given with one sigma error range.

The D_e values displayed in **Table 3** correspond to the weighted average of the D_e values obtained on each daily measurement. The dispersion between these daily results is less than 5%. The ages obtained for the two centres (543 ± 67 ka for Al and 533 ± 68 ka for Ti-Li) are in agreement and therefore indicate good conditions for bleaching the quartz grains during transport. The results are equivalent given their associated uncertainties and a weighted quadratic mean age can be calculated using IsoPlot 3.0 (Ludwig 2003) and given at 95% of confidence. An age of 538 ± 48 ka can thus be given for the Garba 1.15 dated sedimentary level. The sample was extracted from section 22 (fig. 5) and stratigraphically overlies Garba IB, the archaeological level discussed here (fig. 9 and 10).

5.3. Taphonomical processes

5.3.1. Degree of conservation of artefact surfaces

Our analysis points to a moderate and homogeneous degree of alteration of the lithic tools (**Fig. 11a**). Patination is pronounced on fine grained basalts and obsidian, while it is almost absent on other rocks. It is the outcome of the disintegration of the rock surface, starting with increased porosity (especially so in the case of obsidian) along with a change of colour. Chemical alteration affects 93% of the assemblage, altering the original colour, although there can be a different degree of change from one face to the next. Sometimes an item is only partially affected (**Fig. 11**). In some instances, a vermicular patina *sensu* Glauberman and Thorson (2012) was also observed.

Pseudo-retouches are widespread without differences among raw materials (**Fig. 12**). The detailed analysis of the main archaeological layer excavated in Pit 1 allows to explain it as resulting from the high density of artefacts. The artefacts are packed together and overlapping, which produces extensive notching of the edges (**Fig. 12-13a-b**). All the same, the edges of a large percentage of the obsidian artefacts are extremely well preserved. (**Fig. 13c**). Finally, most pieces display a degree of edge roundness. However, the intensity of the abrasion is often difficult to evaluate because of the chemical alteration, which disintegrates the surface and smooths the edges. At Garba I the raw materials affected by edge roundness are those also affected by chemical weathering. Only 20% of the pieces showing no or very little chemical alteration (index 0-1) also present highly abraded edges (index 2), corresponding to 0.9% (n=71) of the assemblage analysed here (n=7227). Additionally, we have identified a low percentage (n = 488; 6.8%) of LIV artefacts. In the case of Garba I all these pieces correspond to elements affected by marked post-depositional processes. **Fig. 11d** show highly fragmented, abraded and chemically altered pieces.

5.3.2. Size and size range distribution of artefacts and natural clasts

As explained above, the assemblage retained here includes mostly natural clasts (n = 9744) and artefacts (n = 4435), and a lower number of faunal remains (n = 1746). To get a complete record, the 29835 items < 20 mm from the sieve have to be added. Those are mainly small flakes, flake fragments and knapping waste.

A first analysis on the mean lengths of natural clasts and artefacts returns values close to each other (65.2 and 63.6 mm, respectively), while faunal remains produce a lower value (34.9 mm) (**Table 4**). Note the existence of some large cobbles (at least seven specimens) between 300 and 500 mm in maximum length, whose presence on the site does not have any straightforward geological explanation. The huge difference between the number of natural clasts and artefacts, requires adjusting the analysed samples (**Fig. 14**). Following this criterion, the average length of the random sample of natural clasts (n = 4435) displays a slightly larger value (68.3 mm) (**Table 4**). Also, this value is somewhat different from those measured at nearby archaeological sites (e.g., Gombore II: 58.0 mm) or in similar modern sedimentary environments (Kella Bed: 28.2 mm) (Méndez-Quintas *et al.*, 2019). More accurate tests are needed to fully assess the differences between whole samples. In this case both samples show a non-normal distribution (Shapiro-Wilk test W = <0.05). Accordingly we will use only non-parametric tests. The test of equal variance (F; p = <0.05), medians (K; p = <0.05) and distribution (D; p = <0.05) produces results that statistically exclude that the two samples are from the same population, i.e., the artefact assemblage and the natural clasts are not the outcome of the same sorting pattern.

The size range analyses also produce statistical differences (**Table 5; Fig. 14**). The faunal remains are concentrated in the <60 mm range (94.4%), while only half of both natural clast and artefact samples are comprised in this group (52.1% and 64.1%, respectively). For ranges >60 mm the distribution of elements is different in natural clasts and in artefacts, with larger percentages of the former ones (**Table 5; Fig. 14**). In addition, the statistical analysis of the distribution by size ranges of natural clasts and artefacts (X^2 = 28.2 p = <0.05), as well as of faunal remains (X^2 = 771.5 p = <0.05 and X^2 = 75.6 p = <0.05), shows again marked statistical differences. Focusing on the former two, the sample distribution is different, suggesting that the two assemblages were deposited by distinct sedimentary processes.

These data and the large number of micro-artefacts, i.e. those <20 mm, suggest a pattern of scarce sorting, and a low degree of sedimentary disturbance of the archaeological assemblage.

5.3.3. Orientation patterns

M. Taieb (1974) was the first to analyse the orientation pattern of the natural clasts (**Fig. 15a**). The results suggested a clearly bi-modal preferential orientation (Taieb 1974). Our re-analysis confirms this: both the natural clast and the artefact assemblages definitely display an anisotropic -i.e., preferential- orientation pattern (**Table 6; Fig. 15b**). We have recently observed on modern and Pleistocene sedimentary environments such as Garba I (Méndez-Quintas *et al.* 2019), that natural clasts display a clear preferential orientation pattern and that this is a common trend of sedimentary dynamics at MK. In contrast, the faunal remains do have an isotropic feature which might suggest a different depositional history (**Table 6; Fig. 15b**).

The technological study of the tool assemblage allows a detailed analysis of the orientation patterns, mainly comparing the main LCTs types (handaxes and cleavers) with the other technological categories. This topic is important at a site like Garba I, featured by extensive accumulations of LCTs. The results of the tests are significant and once again we observe a clear anisotropic distribution pattern for the extensive flake assemblage (**Table 6; Fig. 15c**). While the sample of other technological groups is not representative enough (<50 cases) to allow any statistical analysis (**Table 6; Fig. 15c**), the statistical data of the LCTs assemblage are conclusive ($Z = 2.011$, $p = 0.134$ and $V = 1.549$, $p = >0.10$). The LCTs display an isotropic distribution pattern, without prevailing orientation trends (**Table 6; Fig. 15c**).

5.3.4. Spatial analysis

The density of natural clasts is higher than that of artefacts, with 43.4 items/m^2 compared to 19.8 items/m^2, while faunal remains are even less, i.e. 7.8 items/m^2 (**Table 7; Fig. 16**). Comparing the values observed at Garba I with those of other close archaeological sites (e. g. Gombore II OAM) and in modern environment at the mouth of the nearby Kella gully, it is quite clear that the natural clasts occur at significantly lower densities (Kella bed = 495.95 items/m^2; Gombore II OAM = 142.55 items/m^2) (Méndez-Quintas *et al.*, 2019). This suggests different sedimentary dynamics, especially between the archaeological environments (Gombore II OAM and Garba I) and the ephemeral Kella tributary. The artifact density values (19.8 pieces/m^2) are rather similar to those observed elsewhere at MK as at Gombore IB (18.4 pieces/m^2), Gombore Iγ (19.7 pieces/m^2) and Gombore II OAM (25.5 pieces/m^2) (Méndez-Quintas *et al.* 2019; Mussi *et al.* 2021). The density values of the main technological categories show high numbers of flakes and LCTs, (11.4 and 3.8 pieces/m^2, respectively), with localised extreme values of up to 16.2 LCTs/m^2 (**Table 7; Fig. 16**). Comparatively, the density value of the faunal remains (7.8 pieces/m^2) is very low, suggesting that the processing of animal biomass was not the main activity at Garba I. The nearest neighbour index for unmodified clasts, faunal remains and whole lithic industry displays a larger cluster value, which does not disappear splitting the analysis by main technological categories (**Table 7**).

The kernel maps by natural clasts show a high-density pattern, but a non-homogeneous distribution over the surveyed surface (**Fig. 16**). A similar trend is also displayed by the artefacts, although in this case the highest values do not exactly match those of the natural clasts. In contrast, the dispersal pattern of faunal remains is different, with a large and localised concentration coinciding with one of the largest accumulations of natural clasts and artefacts (**Fig. 16**). More detailed spatial analyses is requested to properly understand the distribution patterns, which will be addressed elsewhere. As in the case of density, the high clustering values and kernel density maps further substantiate the hypothesis that the distribution pattern of the archaeological assemblage, and mostly so of the LCTs, is not the outcome of natural sedimentation.

5.4. Paleobotanical data

Paleobotanical samples were collected directly from the archaeological level B during the original excavations, carefully avoiding any modern aerial contamination.

The extraction of fossil pollen followed classical chemical procedures on a relevant amount of sediment (Bonnefille 1969). The detailed composition of the obtained pollen assemblage is illustrated in **Table 8**. Grass pollen grains are the main component of the herbaceous flora and constitute 78% of the total pollen count versus 63% at the time of the Gombore IB Lower Pleistocene Archaeological occupation. Although variable grass proportions were reported throughout the 0.9 to 0.6 Ma time-period at Melka Kunture (Fig 5.11 in Bonnefille *et al* 2018), the value obtained at Garba I remains among the greatest grass percentages ever registered. High grass proportions indicate openness of vegetation considered as mountain grassland with other herbs such as Asteraceae and *Plantago*. There are no dry savanna herbaceous components. Among the trees, the amount of *Acacia* pollen is remarkable and indicates a noticeable proportion of such tree cover since *Acacia* is known to disperse very few pollen in modern vegetation. Together with the occurrence of *Combretum* and *Brucea*, they automatique indicate a vegetation zone corresponding to the lower horizon of the mountain forest also attested by the occurrence of *Podocarpus* trees, abundant fire resistant *Dodonaea* shrubs frequent on basaltic soils, and the tall erect herb *Rumex*. The occurrence of 5 pollen grains of *Celtis*, a tree frequently encountered along riverine wooded vegetation, such as nearby in the Awash gorges, fits with the fluvial deposition of the sediment.

In conclusion, the fossil pollen composition attests of a sub-montane wooded grassland similar in composition to the subforest zone now occurring at about 1600-1800 m elevation on the Northern Ethiopian plateau (Bonnefille 1971; Friis *et al*. 2010). Comparison with pollen results from older archaeological deposits at Melka Kunture attests of much warmer conditions than earlier during the Lower Pleistocene. Indeed, the abundance of the Coniferous juniper pollen reported in the archaeological layer Gombore IB (Bonnefille *et al.* 2018) and other forest trees found at Gombore II (Mussi *et al*. 2016) associated with afroalpine herbs are not present in the Garba I pollen flora. Therefore more favourable climatic conditions, warmer, but still humid, prevailed during the Acheulean occupation of Garba I. Big trees such as Podocarpus provided shading, *Acacia* produced edible pods, and Celtis edible fruits for the users of the beautiful and great handaxes and cleavers ~0.6 Ma ago.

5.5. Vertebrate Palaeontology

We have examined about 100 faunal remains from Garba I. Of these, 55 could be identified to family level, which is a satisfactory proportion, given the high fragmentation of bones and teeth at MK. Bovids and hippos are each represented by 23 specimens, and such equal abundances are also usual in the other localities. Of the 17 bovid specimens that could be identified to tribe, 12 belong to *Alcelaphini*, antelopes of open landscapes that are always dominant at MK. Based on the few horn-core remains, we identify *Damaliscus* cf. *lunatus*, the tsessebe, and a large *Connochaetes*, probably *C. taurinus*, the common blue wildebeest.

Possible differences with earlier sites are the presence of a lower third molar of a small Reduncini (cf. *Kobus kob*), a tribe with is quite rare elsewhere, and of two teeth of *Aepyceros*, the impala, which is almost unknown at the other localities. There is also a bovin tooth (probably a buffalo, *Syncerus* sp.), a tooth fragment of an elephant (a group that is quite rare at MK), a few *Equus* elements not identifiable to species, and two suid remains, including a canine, probably of *Phacochoerus*.

Paleoecological interpretations must remain extremely tentative, given the low number of specimens. The abundance of alcelaphins demonstrates that wood cover was low, but the relative diversity of the faunal assemblage (given the low number of identifiable specimens), together with the presence of the impala, that favours today the savanna-forest ecotone, is more indicative of open woodland than of the open landscape that the faunas of earlier sites suggest. Thus, although the evidence remains scanty, the fauna confirms the environmental change suggested by the pollen data.

6. Discussion

6.1. Site formation process

Throughout the paper we present mostly unpublished information on Garba I, a site characterized by an extensive accumulation of LCTs. One of the main questions about these sites is to understand if they are the result of hominin behaviour or if they are instead extensively disturbed and made by repeated accumulation events (Schick 1992; Shipton 2011; Walter and Trauth 2013). The detailed taphonomic analysis performed here on both artefacts and natural assemblages (natural clasts and faunal remains) allows to better understand site formation processes and points the integrity of the archaeological record.

The sedimentary features of the main layer (unit 4) that contains the archaeological assemblage correspond to a lag on the margins of a plain fluvial channel. This points to a higher energy sedimentary environment, linked to the migration of the paleo-Awash on the floodplain. Chavaillon's data and our own observations during the excavation of the test pits show that the artefacts and faunal remains are placed on the lag and immediately capped by a loam layer (unit 5; silty clay overbank layer with ash fallout). This stratigraphic position suggests that the hominins carried on their activity on the fluvial channel while the features of the overlying archaeological remains do not indicate high sedimentary energy.

The artefacts display much edge-damage (linked to extensive mechanical alteration by trampling) and chemical alteration (with changing rock colour and/or texture), but the percentage of highly weathered or abraded artefacts is very low (6.8%). We also recognized a large percentage of pristine elements, mainly obsidian ones. This, and the large percentage of small artefacts <20 mm is further evidence of low sedimentary disturbance and scarce sorting of the archaeological assemblage. Some large cobbles and boulders (>400 mm) do not fit well with this sedimentary environment, and could possibly be linked to the hominin behaviour.

The faunal assemblage displays much fragmentation and weathering. The overabundance of bones resistant to water transport (e.g., teeth or horn) points to some fluvial disturbance (Behrensmeyer 1982, 1988; Domínguez-Rodrigo *et al.* 2018). The hard and dense bones might have experienced some limited displacement from the channel sides, but this was neither heavy disturbance nor relevant horizontal movement (Behrensmeyer 1982, 1988; Domínguez-Rodrigo *et al.* 2018). In addition, the chemical weathering or alteration observed on the faunal material is quite similar to that observed at other MK sites (Geraads *et al.* 2004). In this sense, the lesser abundance of bone at Garba I is possibly not linked to poorer preservation or sampling bias. The scarcity of faunal remains seems related to site function rather than to taphonomy. Furthermore, the distribution patterns and densities of artefacts and even faunal remains contrast with those of natural clasts. Some spatially well-defined accumulations of artefacts or bones will require further analysis to understand if they are linked to specific activity areas.

While the observed percentages of abraded artefacts and the fragmentation and weathering of faunal remains points to some sedimentary disturbance, the statistical analysis of the size of artefacts and natural clasts excludes any substantial sorting. However, the orientation patterns of natural clasts show a marked preferential orientation, while faunal remains and LCTs clearly display an isotropic pattern. The trends of the LCTs are important as these artefacts, under strong fluvial conditions, usually align their major axis (longitudinally or transversally) following the flow direction (Schick 1992; Walter and Trauth, 2013). Differences in the orientation trends among the elements of the archaeological record could suggest multiple phases of activity and/or sedimentation. These features have also been identified elsewhere at MK (e.g., Gombore II OAM) and interpreted in the same way (Méndez-Quintas *et al.* 2019). Some recent literature discusses representativeness as evidence of disturbance of anisotropy patterns (Domínguez-Rodrigo *et al.* 2012; Cobo-Sánchez *et al.* 2014; Domínguez-Rodrigo *et al.* 2014).

In summary, the results of the taphonomic analysis, coupled with the sedimentary features point to minor disturbance and/or to distinct deposition phases for the archaeological remains. The natural clasts and the highly altered and weathered elements of the archaeological assemblage (LIV) seem to have been deposited/disturbed during the same event(s), just as most of the faunal remains (very fragmented, weathered and with a large percentage of the bones most resistant to transport). However, the large amount of artefacts <20 mm, the patterned spatial distribution, the low percentage of highly abraded artefacts, and the isotropy of the main lithic remains (LCTs) contrasting with the natural clasts, all point to a low degree of disturbance which only seems to have slightly re-oriented the remains. We conclude that Garba I shows a reasonable degree of taphonomic integrity and that this site, characterised by extensive accumulations of LCTs, is not the result of long and extensive sedimentary processes.

6.2. Site function

At Garba I the spatial organisation is preserved well enough and therefore reflects to some extent hominin activities and behaviour, allowing a first approach to the site function. Acheulean sites with extensive accumulations of LCTs are relatively common in Africa, the Middle East and to a lesser proportion in Europe (an updated summary of these sites can be found in the SI section “Overview of extra-European sites with large LCT accumulations” of Méndez-Quintas *et al.* 2018). As noted above, these sites are usually explained as the result of marked sedimentary selection and accumulation processes, without considering hominins as a main factor (Schick 1992; Petraglia and Potts, 1994; Shea, 1999; Walter and Trauth, 2013). Alternative explanations focus on the hominin behaviour and signature at these sites. They interpret them as consumption sites of small-medium mammals (Shipman *et al.* 1981), intermediate “storage” sites in the context of an arranged paleo-landscape (Potts *et al.* 1999), or areas of activity unrelated to animal biomass consumption (Santonja *et al.*, 2014; Santonja *et al.* 2018).

Our analysis of Garba I suggests a site formed by repeated and frequent short visits of hominins groups, resulting in the superimposition of multiple small “living-floors”. The extensive patination of the lithic artefacts, together with edge alteration (trampling), and the presence of more pristine elements (mainly in the obsidian assemblage) possibly exemplify the “slow-accumulation palimpsests’ model of Malinsky-Buller *et al.* (2011). Concerning the activities, the lithic assemblage suggests distinct behaviours. The analysis of the LCTs assemblage demonstrates that basalt cleavers and handaxes were produced elsewhere and introduced on site as finished product (Sánchez-Dehesa Galán 2020). On the opposite, the obsidian assemblage rather points to the introduction of partially shaped blanks, eventually finished on site (Sánchez-Dehesa Galán 2020). Small-medium basalt *debitage* is documented by several cores, while basalt flakes and retouched tools are scarce. On the opposite, obsidian scrapers and borers on small-medium flakes are relatively abundant and show different stages of resharpening, while the cores are totally missing (Sánchez-Dehesa Galán 2020).

Recent research has underlined the importance of small tools in butchery activities (Venditti *et al.*, 2019a; Venditti *et al.* 2019b), but the scarce faunal remains of Garba I contrast with any hypothesis of extensive carcass processing at Garba I as in other similar African Acheulean sites (Yravedra *et al.* 2016). This suggests a different type of butchery, perhaps linked to the transformation of now disappeared organic elements, as also in the case of pounding tools. Hammerstones, together with polyhedral and spheroidal tools show percussion marks different to those produced by knapping activities. However, the dearth of faunal remains unambiguously points to percussion not linked to knapping and possibly not associated with bone-breakage. On the opposite, the identification, in the pollen spectrum, of species producing edible pods and fruits, allows to hypothesise plant use and processing, as suggested at other Early Stone Age sites, where pounding tools occur (see Lemorini *et al*. 2014). Overall, the artefacts themselves as well as the dearth or even lack of faunal remains all suggest diversified activities, probably related to the discontinuous occupation of the site. However, while the small flake and pounding tools point to *in situ* activities, the reasons for LCTs transport and deliberate accumulation still need to be clarified.

6.3. Garba I in the context of the chronostratigraphical and archaeological sequence of MK

At MK the Pleistocene landscape was characterised by the meandering paleo-Awash and by environmental and geological changes that impacted on hominin behaviour and activities (Bonnefille *et al.*, 2018; Gallotti and Mussi, 2018a; Mussi *et al.*, 2021). Most layers with archaeological remains were deposited in a fluvial-lacustrine environment, while volcanic activity was frequent. Hominins settled on stable geodynamic surfaces, such as channel beds with pebbles and/or sand, which were the focus of archaeological research. This happened as Garba I, but also at Garba IVD and Gombore IB (~1.6 Ma) (D´Andrea *et al.* 2002; Mussi *et al.* 2021); at Gombore Iγ (1.4 Ma) and Gombore Iδ (1.3 Ma) (Mussi *et al.* 2021); at Simbiro IIIB and Garba XIIJ (~1.2-1.1 Ma) (Chavaillon and Berthelet 2004); at Garba XIIIB (~1 Ma) (Gallotti *et al.* 2014) and Gombore II-1 (Gallotti *et al.* 2010; Méndez-Quintas *et al.* 2019). As discussed here, in the case of Garba I, and at Gombore II OAM as well (Méndez-Quintas *et al.* 2019), the degree of taphonomic integrity is variable. However, overall those are not extensively disturbed sites.

Sites in low-energy environments have been much less frequently investigated, but allow a new insight, as at Gombore II-2 (0.7 Ma) (Altamura *et al.* 2017; Altamura *et al.* 2018; Altamura *et al.* 2020b). This site, earlier but close in age to Garba I, provided a complex scenario of human and animal activity close to a small water body. Traditionally interpreted as a single-carcass site (Chavaillon 1978), new fieldwork revealed instead a living floor where butchering episodes were performed, possibly transporting to the site portions of one or more hippopotamus carcasses scavenged at short distance (Altamura *et al.* 2020b). The excavations over more than 60 m^2 produced mostly flakes and debris and just two handaxes, associated with hominin and animal tracks (Altamura *et al.* 2018). The excellent preservation of the quickly erased tracks suggests that the site was short-lived and disappeared when volcanic ash blanketed the area. The evidence of butchering activities with very few LCTs at Gombore II-2, compared with the high density of LCTs and scarce faunal remains at Garba I, point to the fragmentation of the archaeological landscape of MK during the early Middle Pleistocene.

6.4. The African Acheulean during the early Middle Pleistocene

The age of the main level at Garba I, ~0.6 Ma, places this site in the early Middle Pleistocene. In East Africa there are Acheulean sites of similar age, but only a small percentage has been thoroughly researched. Accordingly, the information provided by Garba I significantly adds to our knowledge of this "grey" archaeological stage. This is also when *Homo erectus/ergaster* disappears in Africa while new hominin forms develop, which will eventually lead to *Homo sapiens* (McBrearty and Brooks 2000; Gilbert and Asfaw 2008; Klein 2009; Rightmire 2009; Stringer 2016; Grün *et al.* 2020; Bergström *et al.* 2021).

Major sequences of the early Middle Pleistocene are known elsewhere in Ethiopia, notably in the Middle Awash in the Dawaitoli Formation and the Herto-Bouri Member, where sites as HAR-A4 are located (de Heinzelin *et al.* 2000; Schick and Toth 2017). The Hugub Bed in the Kesem-Kebena-Dulecha area, dated to 500-600 ka (Gilbert *et al.* 2016), is one of the few African sites of this chronology fully excavated and well preserved. Both Melka Wakena (MW1-L1) and Gadeb (Gadeb 8F) are located on the Ethiopian highlands, i.e. in a geographical and paleo-landscape environment comparable to Garba I (Clark 1987; de la Torre 2011; Hovers *et al.* 2021). They are also dated to the beginning of the Middle Pleistocene while the sequences of Konso-Gardula have a few sites in this age range (KGA18 and 20) but are possibly earlier than Garba I (Beyene *et al.* 2013). To the South, outside Ethiopia, Kilombe (Kenya) (Gowlett *et al.* 2015; Hoare *et al.* 2021) and Isimila (Tanzania) (Cole and Kleindienst 1974) stand out, although the published data are not much detailed.

All these sites are characterised by extensive artefact assemblages (flakes, cores etc.) and large percentages of handaxes and cleavers. At this stage, the main innovations of the more advanced Acheulean technocomplex are present and well developed, as the consistent large flakes and the Kombewa flaking. In addition, the LCTs display a large degree of shaping and morphological standardisation, as at Garba I (Sánchez-Dehesa Galán 2020).

7. Conclusions

Garba I is one of the most extensively explored sites at MK, but the published data were so far scarce and fragmentary. In this paper we present in detail the sedimentary, chronological and paleoenvironmental features, also exploring the degree of integrity and the processes of accumulation of the archaeological record.

We conclude that the high-density of artefacts, mainly LCTs, results from recurrent short occupations on a large channel around 0.6 Ma. The hominins settled in a fluvial environment, shaped by the migrations of the paleo-Awash river, on a lag layer exposed after flood events. While limited, faunal and palaeobotanical data suggest an open environment, mountain grassland with a noticeable proportion of Acacia trees and a wetter and more arborescent vegetation installed on the banks of the river. These plants produced shadow and edibles pods and fruits that, together with nearby running water, made of Garba I a perfect spot for human occupation.

The taphonomic approach reveals how complex the site formation was, supporting a low degree of sedimentary disturbance, which did not equally affect all the archaeological record. The large assemblage of artefacts contrasts with the scarcity of faunal remains, not justified by conservation bias. Possibly, it is rather linked to hominin activities, which were not directed at processing of animal carcasses. At MK, high-density sites such as Garba I with scarce faunal remains, penecontemporaneous to lower-density sites, as Gombore II-2, with multiple butchering episodes (Altamura *et al.* 2020b), suggest spatial organisation of activities in early Middle Pleistocene times.

Garba I yielded a lithic assemblage focused on LCTs. Handaxes and cleavers, occurring in the hundreds, are the outcome of a standardised bifacial production. Moreover, a specific technical procedure, the tranchet blow technique, was identified both in the small retouched tools and in the LCTs assemblage. This procedure requires very accurate knapping gestures and elaborate skills, mastered only after a long learning process. It points to the emergence of regional cultural markers, a process so far associated with the Middle Stone Age.

Researchers interested in the emergence of our species have focused on the study of the Early Middle Stone Age. This is the result of the scarcity of well preserved and dated middle and late Acheulean sites. Today new fieldwork and accurate methods of analysis allow to precise the late Acheulean chronology and to enrich our understanding of this stage, which leads the way to the Early Middle Stone Age.

Garba I provides important information on the technical behaviour and spatial organisation of human groups during early Middle Pleistocene, and on the cognitive capacities of Middle Pleistocene hominins. This works opens the path for future investigation on the Acheulean/Middle Stone Age transition at MK and overall in the East African context.

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