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Interpreting pachyderm single carcass sites in the African Lower and Early Middle
Pleistocene record:
a multidisciplinary approach on the site of Nadung'a 4 (Kenya)

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Abstract

Nadung'a 4 lists among the pachyderm single carcass sites recorded in East Africa during the Lower and early Middle Pleistocene. The site has yielded an abundant lithic assemblage in close association with the partial carcass of an elephant. Conjoined pedological, geoarcheological, spatial, technological and taphonomical analyses have been carried out to address the relationship between hominids and elephant. The resulting data are consistent with a non fortuitous association between both categories of remains. The lithic artefacts do not match up with a classical Acheulean tool-kit as it would be expected for the related time period, and the functional patterns inferred from the analysis make this site radically different from the other purported butchery sites. The implications of these original features are discussed.

Keywords

East Africa, West Turkana, Lower Pleistocene, early Middle Pleistocene, butchery site, pachyderms, geoarcheology, spatial analysis, lithic technology, site function.

Hominid processing of pachyderm carcasses is illustrated by a set of sites in the African archaeological record. They range from the beginning of the Lower to the Middle Pleistocene. The sites most specifically interpreted as *butchery sites* or *type B sites* according to Isaac's model (Isaac and Crader 1981) usually yield a single, large mammal skeleton and a small number of associated stone tools. This functional interpretation relies upon the spatial vicinity of both categories of remains and is rarely documented by direct evidence of hominid intervention on the carcasses, such as cutmarks, intentional breakage of the bones or transport of some body parts from the sites. The site of FLKN-6 at Olduvai is one of the rare occurrences where cutmarks have been observed on elephants bones (Bunn 1981; Potts and Shipman 1981). And when such observations are possible, the traces are always very few and too tenuous to suggest even a rough idea of the butchery operations carried out. The mode of procurement of these very large carcasses, either by scavenging or by hunting, is also almost impossible to infer from the archaeozoological data, a situation that is equally true for European sites (Villa 1990; Villa et al. 2004).

The main interest of such occurrences is the monospecific aspect (*i.e.* butchery) of hominid activities and related stone tools, as assumed from the faunal assemblage. Although criticized as an "oversimplified rendering" (Potts 1988, p.150), the *type B sites* model is still commonly used by prehistorians when referring to this type of site. Is the single task interpretation confirmed when questioning the whole set of data provided by the archaeological context ? This issue has been addressed with the recently excavated site of Nadung'a 4 (West Turkana, Kenya) where an abundant lithic assemblage has been recovered in close association with the partial carcass of an elephant. The unusual quantity of artefacts recovered from this site, outnumbering any other assemblage known in similar contexts, gives additional interest to

such an issue. To compensate the lack of direct evidence of hominid intervention on the elephant carcass, conjoined pedological, geoarcheological, spatial, technological and taphonomical analyses have been carried out.

Archaeological context.

The site of Nadung'a 4 is located on the west bank of lake Turkana, in the Nachukui formation. This geological formation includes a succession of hominid occupations dated between 2.4 my and 700,000 years (Roche et al. 2003; Roche and Kibunjia 1994, 1996; Roche et al. 1992; Prat et al. 2003). At the beginning of this time interval, south of the formation, the Lokalalei sites list among the very few African Pliocene sites (Kibunjia et al. 1992; Kibunjia 1994; Roche et al. 1999; Delagnes and Roche in press; Roche et al. 1999). At the top of the sequence and north of the formation, the Nadung'a sites are part of the well documented set of East African sites related to the end of the Late Pleistocene or to the very beginning of the Middle Pleistocene generally characterized by Acheulean industries. Between those two time periods some 20 Oldowan and Acheulean sites are recorded in the same formation, showing various levels of technological achievement (Roche et al. 2003).

The site has been excavated during three field seasons, in 2002, 2003 and 2004, as part of the West Turkana Archaeological Project co-directed by H el ene Roche and Mzalendo Kibunjia (National Museums of Kenya). The excavation covers an area of 53 m² (Fig. 2), the whole site in its actual limits. Although both eastern and western edges of the deposit have been truncated by erosion, we deduce from the configuration of the archaeological layer that its initial extension was not much greater. The total thickness of the deposit, ranging between 0.30 and 1.50 m, has been excavated. The *in situ* recovered assemblage comprises 6797 lithic artefacts made from lavas (rhyolite, phonolite, trachyte and basalt) and 142 faunal remains

mostly attributed to Proboscidean. The density of remains is high, contained in one unique sedimentological horizon, and spatially confined within a small area. The corresponding horizons in the surroundings of the site were completely sterile, and the surface material scattered on the erosional slopes west and east of the site originated from the same confined area.

The Nadung'a sites complex spans a series of small hills cut by gullies. According to Harris' mapping (Harris et al. 1988), the outcrop deposits are correlated to the Nariokotome member, which ranges from 1.33 my to ~700,000 years. The seven sites recorded in the Nadung'a complex are all located in the middle part of the Nariokotome member, 17 to 20 m above the top of the Lower Nariokotome Tuff (Fig. 1). This marker horizon outcrops at a distance of one hundred meters north-west of Nadung'a 4. The stratigraphic position of the site has been established through successive surveys along Nadung'a ephemeral stream and through a bed to bed correlation. Nadung'a 4 is the most recent site of the complex and of the Nachukui formation, and is situated some 150 m north of Nadung'a 1 and a few meters above this site where pumices have been recorded, the composition of which is similar to pumices from the Silbo dated to 740,000 years (Kibunjia et al. 1992). Nadung'a 4 is slightly younger and can be correlated to the beginning of the Middle Pleistocene, *i.e. circa* 700,000 years.

This time period is crucial for understanding the place of *Homo erectus* in human evolution and the place and mode of origin of *Homo sapiens*. Despite abundant lithic and faunal evidence for this time period in Africa, the hominid fossils are rare. They are represented by partial crania from Buia, Eritrea (UA 31, ~1 my, (Abbate et al. 1998), Daka calvaria, Ethiopia (BOU-VP-2/66, ~ 1 my, (Asfaw et al. 2002), Melka Kunture, Ethiopia (Gombore II, ~ 0.8 Myr, (Chavaillon and Piperno 2004), Olororgesailie, Kenya (KNM-OL 45500, 0.97-0.9 my,

(Potts et al. 2004) and Olduvai, Tanzania (OH 12, OH 22, OH 23, OH 51). Unfortunately, no hominid specimens have been discovered in the Nachukui Formation for this time period.

Site formation processes.

The archaeological deposit lies in the lower part of a stratigraphic unit made of brown clays including lenses (about one meter thick) of ill-sorted sands and gravels. The sand and gravel lenses result from the filling of small sinuous channels, as attested by the high-angle planar cross-bedding of the infilling (Reineck and Singh 1980). This feature, associated with high textural contrasts, indicates a seasonal stream regime or at least an intermittent one (Reading 1996). All these characteristics point to a sedimentary environment of mud flats crosscut by small streams and regularly swamped during the seasonal floods of the lake or tributaries. The sedimentological sequence of the site is homogeneous, with only slight differences in the first 30 cm due to the smaller size of the carbonated concretions and to the presence of desiccation cracks. The sediment is a massive sandy silty clay with a prismatic structure. A noteworthy feature is the slickensides (glossy and striated surfaces), which cross the deposit without any preferential orientation. Secondary characteristics are hydromorphic features, *i.e.* green punctuations on the slickensides and dark punctuations inside the deposits. Whitish nodules of carbonates, the dimensions of which increase with depth, are also visible. Two other characteristics related to wet/dry cycles can be observed in thin sections: cracks infillings and cross-striated b-fabric (Blockuis et al. 1990).

Such features are indicative of a pedogenesis of vertisol type (Soil Survey Staff 1999). This diagnosis is based on the conjunction of three criteria that are used to define a vertisol (Eswaran et al. 1999):

- the presence of cracks developed during dry periods;

- a proportion of clay greater than 30%;
- the development of slickensides with long axes tilted 10 to 60 degrees from the horizontal in the deep horizon of the soil.

This type of pedogenesis is typical of wet/dry tropical climates with soil swelling upon wetting and shrinking when dried. A carbonated horizon is found when vertisols have been formed under semi-arid to arid climates (Eswaran et al. 1999). The Nadung'a 4 vertisol shares similar morphological, structural and textural features with the cumulative pedotype *Aberegaiya* identified in Northern Kenya (Wynn 2001). Wynn's paleoenvironmental interpretation of this type of paleosol can be applied to Nadung'a 4: low topographical positions such as floodplains, in semi-arid regions with an alternation of long dry seasons and short pluvial events. Such soils usually support a woody savannah vegetation. These contexts are equally characterized by frequent seasonal floods and subsequent sedimentation episodes, as suggested by the sedimentary features.

In such cases of vertisols on mud flats, two main processes are likely to have distorted the archaeological layer: water transport and argilliturbation. Estimating the impact of such processes is crucial for assessing whether bone and lithic remains were primarily associated or rather fortuitously brought together within the same unit. This issue is particularly relevant with regard to the dispersal of the remains within a thick archaeological layer.

The hypothesis of water transport has been tested through a series of criteria initially used by Schick and by Petraglia and Potts (Petraglia and Potts 1994; Schick 1986): artefacts size distribution, physical alterations and horizontal distribution of lithic remains. Neither the fabric (orientation and dip) nor the small-scale spatial features such as *shadow effects* (Schick

1986) are considered here for estimating the impact of water transport. We assume that such features would not have been preserved owing to the argiliturbation inferred from the sedimentary context.

- Artefacts size distribution

The sediments of two test squares have been water-screened and all the artefacts thus collected have been measured, together with the plotted material. The data recovered have been used for comparison with an experimental assemblage produced with respect to the technical principles identified in the assemblage. It has consisted in the knapping of one block of rhyolite according to a discoidal method. The proportions of small lithic artefacts (ranging between 2 and 10 mm screen mesh) are very similar between the two test squares (89,9% in B20 and 86,3% in J20) and consistent with the experimental set (88,9%). The strong similarity in size distribution between the experimental and archaeological sets (Fig. 2) makes it compatible with a knapping spot assemblage.

The size distribution of the products resulting from this experimental set is consistent with the data recorded for experimental assemblages (Fig. 2) produced by other means and on different rocks (Schick, 1986; Lenoble 2005). Such observation has made possible a comparison in terms of size distribution between the archaeological assemblage and several other experimental assemblages either sorted by various types of water flow or non-sorted (Lenoble 2005). The lithic sample corresponds to a non-sorted assemblage.

- Physical alterations

All the artefacts have been macroscopically examined. Neither abrasion nor any other edge damage due to a mechanical alteration have been observed. As a whole the lithic assemblage is extremely fresh. This is especially true for the rhyolite artefacts, while the

other volcanic rocks sometimes show an in-depth alteration, which could be the result of a geochemical alteration in relation with their porosity. The elephant bones are also badly preserved: desquamated bone surfaces and an in-depth alteration of a large part of the bones resulting in a white and chalky structure are the most common observable features. A post-burial alteration deduced from the sedimentary context and due to repeated episodes of desiccation/dampening within the deposit is enough to account for the bones alteration, even if a previous weathering, no longer distinguishable, may be assumed.

- Horizontal distribution

A rough examination of the horizontal scatterplot shows a non-homogeneous distribution (Fig. 3): highly concentrated areas (less than 1 m in diameter) adjoin low-density areas. The concentrations have a circular shape and are clearly distinct from the linear concentrations documented by Schick for deposits reworked by fluvial flows (Schick 1986).

All the criteria tested for evaluating the impact of water transport are consistent with the absence of any modification by flows related to the system of flood plain.

The effects of argiliturbation have been sought through the vertical distribution of the remains and their fabric.

- Vertical distribution

The archaeological layer is very dilated with a total thickness ranging over 1.5 m in the southern part of the site (Fig. 3). In detail the distribution of the artefacts appears more complex. The slickensides, formed during massive localized slips within the deep horizons of the vertisol, have distorted the overall distribution of the pieces (plotted pieces

> 2 cm), which is characterized by sharp lower outlines, following oblique plans ranging between 15° and 35°. The slickensides are also responsible for the splitting into two secondary concentrations of the dense area visible in the northern part of the site, as it has been observed when excavating. Their organization results typically in a bowl structure. Such bowl structures characterize the in-depth geometry of vertisols associated with a gilgai topography: involutions of deep buried horizons related to slipping along slickensides are regularly arranged in the polygonal network of desiccation cracks (Eswaran and Cook 1988). These structures explain the wavy limits of the archaeological layer.

Regarding the whole assemblage (all pieces > 2 mm) in the two test-squares, the vertical spreading of the material, according to the successive levellings realized when excavating, follows a normal distribution (Fig. 4). There is a progressive decrease in the number of recorded artefacts towards the top and towards the bottom of the deposit. Such characteristics are consistent with a dispersal from only one archaeological layer. The vertical dispersal is more important towards the bottom of the deposit. Such a feature is indicative of argiliturbation when artefacts dropped into the cracks, as mentioned by Duffield (1970) and Wood and Johnson (1978).

- Fabric

Considering the fabric, the vector magnitude L (Curry 1956) has a low value: 4,6%, which means that the remains do not follow any preferential orientation (Lenoble and Bertran 2004). As shown by figure 5, their inclinations are also extremely heterogeneous, indicating an isotropic fabric. The position of Nadung's 4 lithic assemblage on Benn's diagram (Benn 1994) is consistent with a deformation due to argiliturbation.

Argilliturbation appears to be the main diagenetic process involved in the formation of the site. The swell/shrink process is responsible for the presence of cracks and for the bowl structure of the deposit. Both phenomena have produced up and down vertical displacements within the sediment, together with a limited vertical size-sorting of the material. Lateral displacements, *i.e.* one meter or so, may have also occurred as a result of the formation of bowl structures and the localized massive slips of sediments. Spatial plotting per categories of remains brings additional information to estimate the extent of deformations and the homogeneity of the assemblage.

For such purpose a number of artefacts from the same original block of raw material have been regrouped. Particularly relevant are six groups corresponding to blocks of rhyolite showing very distinctive physical features (in terms of colour and veining). Inside these groups, some products have even been refitted. Their vertical dispersal corresponds to the overall dispersal of the material inside the archaeological layer (Fig. 6: 1). Such distribution is consistent with an homogeneous assemblage deposited during a single event or at least a single period of human presence. For each block, most of the corresponding products are grouped within one of the concentrations, and only a few pieces are dispersed some meters away from it. This configuration confirms that these concentrations are anthropic features, and most likely knapping areas subsequently dilated.

When comparing the vertical dispersal of the elephant remains with the dispersal of the stone tools, it appears also clearly that both categories of remains are closely associated (Fig. 6: 2): the elephant bones are found from the bottom to the top of the archaeological layer. Owing to their large dimensions they cannot correspond to intrusive elements, and they clearly form

part of this *in situ* layer. Most elephant elements were recovered in the concentrations with artefacts scattered all around (Fig. 7), which suggests that hominids knapped directly around the elephant bones.

Geoarchaeological and spatial data recovered at Nadung'a 4 demonstrate that:

- Lithic and elephant remains are primarily associated in the archaeological layer, insofar as: 1. no water flow has affected the lithic remains, and neither the sedimentary context nor the spatial configuration of the scattered bones suggest that the elephant remains could have been washed in, 2. the vertical dispersion of the remains has developed from a single original layer as a result of argiliturbation;
- A short period of open-air exposure and a rapid burying of the remains, as suggested by the sedimentary context, substantiates the hypothesis of a single event or at least of a single period of occupation.

Assuming that the human occupation is contemporaneous with the elephant bones deposit, the uncommon association between an abundant lithic assemblage and these elephant remains as well as its functional significance still have to be discussed. Lithic technology can provide the key to such questions, by exploring the functional potential of the stone tools.

Knapping activities : technological and functional issues

Raw material procurement consisted in the transport of volcanic rocks available in the close vicinity of the site. A raw material sampling was carried out in a debris-flow outcrop, situated stratigraphically a few meters above the archaeological level. This deposit corresponds to the development of an alluvial fan. It is included in the same regressive sequence as the unit of brown clays containing the archaeological level. We deduce from this position that such a fan

existed when the site was formed, but was situated a few hundred meters away towards the ranges that lie on the western border of the formation. It is therefore assumed that this horizon is representative of the raw material sources that could have been exploited by the Nadung'a 4 knappers. That makes relevant a comparison between the different kinds of rocks collected in the archaeological assemblage and in the debris-flow outcrop. This comparison indicates a clear preference for rhyolite (fig. 8). Poorly represented at the raw material source (5%), it is the predominant raw material in the archaeological assemblage (64%), thus pointing to highly selective raw material procurement. Rhyolite, mostly red, sometimes green or more rarely grey, brown or yellow, is a particularly fine-grained raw material, very suitable for obtaining sharp cutting edges, but less compact and homogeneous, owing to frequent internal fissures, than the other available rocks. These are phonolite, basalt and trachyte, ranging mostly from medium to coarse-grained qualities. Unlike rhyolite, which comes as diclastic angular blocks, phonolite, basalt and trachyte correspond to rounded compact pebbles.

The artefacts fit in two main categories: light-duty tools and heavy-duty tools. Light-duty tools, by far the most abundant, result from a debitage reduction sequence. They correspond to flakes and debris smaller than 2 cm, flakes greater than 2 cm, some of which were secondarily transformed into formal tools, and the related cores. All these products are mainly made from rhyolite and to a lesser extent from medium-grained phonolite. Heavy-duty tools correspond to worked pebbles, which are exclusively shaped from phonolite, basalt and trachyte. A few hammerstones in quartz, basalt and phonolite are also present in the assemblage. The high proportion of small elements (< 2 cm), the significant quantity of cores as well as the presence of hammerstones (Fig. 9), are consistent with knapping activities carried out on the spot.

The cores are made from blocks or pebbles, but also frequently from large flakes. Four distinct types of cores have been identified (Fig. 10). The corresponding flakes are inferred from a small number of refittings as well as from the morpho-technical analysis of the flakes compared with the cores:

- discoidal cores (Fig. 10: 1-2), with one preferential flaked surface and centripetal removals extending all around the cores. Platforms are prepared with large deep removals on the other face, and natural surfaces are often directly used as striking platforms. The resulting flakes (Fig.10: 6-11) are mostly short and wide with multidirectional removal negatives on their dorsal face, wide and thick plain or dihedral butts, at least one long sharp cutting edge and frequently a pointed disto-lateral end. Pseudo-Levallois points are also part of the products obtained from these cores;
- cores with one preferential flaked surface and unidirectional removals (Fig. 10: 3-4). They are produced from a single platform prepared with one large removal or consisting of a fracture plane. They usually have a prismatic cross-section. The corresponding flakes (Fig. 10: 12-14) are somewhat elongated, with negatives of unidirectional removals on their dorsal face as well as regular and continuous sharp cutting edges, on at least one of their lateral edges. The opposite edge can be backed, resulting from the removal of the core's edge (corresponding to an *éclat débordant* : Beyries and Boëda 1983). Their butts are mostly wide and plain;
- cores with several alternatively flaked surfaces and multidirectional removals (Fig. 10: 5). No specific platform preparation has been conducted insofar as each negative serves as a striking platform for the following removal, on a secant face. The flakes produced that way have various shapes, and are frequently short with thick and asymmetrical cross-sections;

- cores on flakes or large multiple notches ? This ambiguous category is characterized by at least one large and deep removal creating a notch, or several non contiguous notches on the blanks' edges. It is impossible to estimate whether they correspond to cores or to tools (or both ?) on flakes. The resulting products are small and wide, with a large plain butt and an acute dorsal face/butt angle. Some, detached from the ventral face of the blank, are Kombewa flakes.

These types of cores are found for the rhyolite and to a lesser extent for the phonolite. The debitage reduction sequence is clearly carried out preferentially on the fine-grained rocks. The other rocks, corresponding mostly to medium and coarse-grained qualities, are exploited according to the same principles but with less normalization. On the whole, the flakes detached from these different types of cores are quite diverse in terms of size, morphology and elongation. Nonetheless they share common morpho-functional features, which are: long, continuous and sharp cutting edges, either in lateral or distal positions, opposed to a thick and steep edge formed by a lateral back or by the butt of the flake, equally suitable for prehension. The sharp cutting edges may have been used as such, without any modification. This is suggested by the high ratio of unmodified flakes (> 2 cm) per core (17 per 1), which shows that most of these flakes have been abandoned on the spot, after being produced and probably partly used there.

A significant portion of the flakes and a few cores have been transformed by retouches (410 pieces, *i.e.* 11% of the potential blanks, which are flakes > 2cm and cores). Most of them are in rhyolite (77%). They correspond for a large majority (98%) to notches and denticulates (Fig. 11: 1-9). The notches are either single or multiple. Their retouches are similar to those of the denticulates : clactonian, deep and often invasive. They are mostly located on the initial

sharp cutting edge of the blank, either lateral or distal, and this had the effect of radically transforming its functional properties. Denticulates can be single or more seldom double, with two convergent edges creating a roughly pointed extremity. Notches as well as denticulates are often situated close to an unmodified narrow or pointed end, resulting in a kind of *bec* (Fig. 11: 5-9). The repeated location of the retouches on the same portion of the blanks, their depth as well as the freshness of the adjacent edges strongly suggest that we are dealing with an intentional set of notched tools and not with “tools” accidentally created by mechanical alterations, as documented in other contexts (Vallin et al. 2001). With regard to the transformations generated by retouches and the morpho-technical features thus produced, we assume that such tools fulfil functional needs distinct from the unmodified flakes component.

Besides some whole pebbles (N = 37) in phonolite and basalt, the worked pebbles comprise only few pieces (N = 10, Fig. 11: 10-11) made from the same rocks. They proceed from a very simple shaping reduction sequence, consisting in the removal of a limited number of large alternate flakes on one or several adjacent portions of the pebbles, creating sinuous and bulky edges. Such edges are clearly not suitable as cutting edges. The large dimensions of these tools (maximum length: 10 to 24 cm, maximum width : 6 to 12 cm), their compactness and the sturdiness of the edges indicate that they rather correspond to blunt implements, in keeping with heavy-duty activities such as breaking or crushing hard materials.

The Nadung'a 4 assemblage shows a clear complementarity between:

- the fine-grained raw materials (rhyolite and to a lesser extent phonolite) exploited for producing flakes and notched tools, as a result of a debitage reduction sequence,
- and the coarser raw materials (phonolite, basalt) dedicated to the making of heavy-duty tools (worked pebbles) by means of a simple shaping sequence.

Direct functional inferences are of course impossible to propose without micro-wear data (tests are in progress by J.P. Caspar). Nevertheless such a technological complementarity as well as the functional potential of each group of artefacts makes this assemblage fully suitable for processing an elephant carcass: light duty tools, in this case unmodified flakes, could have been used for cutting meat, while heavy-duty tools could have served for breaking bones.

The production system is quite elaborated with regard to the selective procurement and exploitation of raw materials according to their properties and in relation with functional needs. The debitage process itself is not very elaborated; it looks simple but at the same time it is fully efficient for the inferred purpose (*i.e.* the obtaining of cutting edges). Discoidal debitage is the predominant method: such a method, which is found in many different chronological and cultural contexts (Peresani 2003), appears in East Africa as early as 1.5 my in the Ugandan site of Nyabusosi (Texier 1995). Little attention has been paid to the flakes and more generally to the light duty tools present in the contemporaneous Acheulean assemblages. Direct comparisons are therefore difficult to carry out. But it is at least possible to point out that in many Acheulean assemblages the technical complexity lies with the shaping process for producing large cutting tools (handaxes and cleavers), rather than with the debitage component (Texier and Roche 1995, Roche and Texier 1996). Flakes and tools on flakes proceeding from a debitage reduction sequence are usually presented as expedient in the Acheulean record; such is not the case at Nadung'a 4. Moreover, the large cutting tools, *i.e.* handaxes and cleavers, which form the diagnostic features of the Acheulean and which are present in other sites of this complex, are totally absent there.

Assemblages without large cutting tools have already been mentioned and described in East Africa during the Lower and Middle Pleistocene. Such industries are usually likened to the Mode 1 (Clark 1961) or Oldowan techno-complex. They are documented for instance in the Middle Awash Formation in Ethiopia (de Heinzelin et al. 2000; Schick and Clark 2003), where they are interpreted as a variant, without handaxes and cleavers, of the local Acheulean. They would be connected there with an expedient production, fulfilling immediate needs by means of local raw materials during short periods of occupation of the sites by small groups of hominids. This interpretative model does not apply to Nadung'a 4 assemblage: lithic production cannot be considered there as expedient, and is a structured activity requiring planning and anticipation. Nadung'a 4 assemblage is therefore not consistent with a Mode 1 or Oldowan techno-complex. Neither can it be grouped with the Middle Stone Age, the earliest occurrences of which are much more recent and significantly different technologically (McBrearty and Brooks 2000). Should we consider such an assemblage as an atypical form of Acheulean, related to the Acheulean assemblages very poor in large cutting tools, or should we assign it to another techno-complex partly contemporaneous of the Acheulean ? This is still an open issue.

This assemblage supports the assumption already stated (Clark and Haynes 1970) that handaxes are not systematically associated with the butchering of large animals. A similar archaeological occurrence is found at the Middle Pleistocene site of Mwanganda's Village in Malawi (Clark and Haynes 1970), interpreted as a butchery site. It has yielded an elephant carcass associated with a lithic assemblage composed predominantly of light cutting tools, with a significant proportion of notched pieces, and few heavy-duty tools. On the other hand, large cutting tools are present at Olduvai WK Hippo Cliff (Leakey and Roe 1994), Gombore II-2 (Chavaillon and Berthelet 2004) and Olorgesailie Hippo Banda Site (Isaac 1977). These

sites, sub-contemporaneous of Nadung'a 4, are interpreted as pachyderm butchery sites. It seems therefore that the view considering the lack of the classical Acheulean tool-kit in some assemblages as an activity variant is not tenable, at least for this time period. Nadung'a 4, just like Mwanganda's Village assemblage, raises the question of technological diversity at the end of the Lower Pleistocene and beginning of the Middle Pleistocene, irrespective of the function of the sites.

Elephant carcass processing.

The elephant bones were found together with a few other faunal remains, corresponding to rare isolated fragments attributed to bovids and fishes (Tab. 1). Owing to their scarcity and their relation with different paleoenvironmental contexts (savannah *versus* aquatic environment), such remains must very likely be interpreted as a background fauna, accumulated before or after the occupation. If those remains are subtracted from the site's record, the faunal assemblage consists exclusively of elephant remains, with a significant portion of undetermined fragments (due to their alteration) belonging also mostly to an elephant carcass. Only a minority of bones (19/49), for the recognizable elephant remains, have been determined anatomically. The body parts distribution (Fig. 12) suggests that they came from a single individual, represented by the skull, a scapula and few long bones. From their size and lamellae structure (Fig. 13), they can be attributed to a young adult *Elephas recki*. Its incomplete state, worsened by the high ratio of undetermined fragments, is probably due to combined taphonomical processes, such as the compaction/alteration caused by repeated dry/wet episodes (see above) and recent erosive phases. It can also be envisaged that a previous scattering with a first weathering step has weakened the material before its burial into the vertisol. The lack of small parts, *eg.* basipodials or metapodials, as well as most of the axial elements (vertebrae, ribs) is a striking feature, which could very likely be related to the

same processes. In any case, an intentional transport by hominids would be impossible to sustain. Some long bones (*eg.* tibia and ulna) were broken, but their state of preservation does not allow to determine whether such fragmentation is anthropic or natural, as a result of pressures within the sediment in relation with the shrink/swell alternations. In the same way, no cutmarks or blowmarks are observable on the bones surfaces.

The high degree of alteration of the bones makes it difficult to assess whether the elephant died on the spot, or in the immediate vicinity and was subsequently transported by hominids. The co-occurrence of lithic and elephant remains in an environment sterile of any other bone remains but nevertheless conducive to fossil preservation, argues for the hypothesis that the site corresponds to the place where the animal died. When referring to actualistic data (Crader 1983; Haynes 1991), the body parts representation, the age of the elephant, as well as the paleoclimatic context (seasonal contrasts with alternations of dry/wet episodes) make very plausible the assumption of a natural death, even if there is no way to prove it directly. On the other hand, the geoarcheological, spatial and technological data demonstrate that the hominid occupation is at least partly linked to the presence of this elephant. Processing its carcass was very likely the primary reason for hominids to settle on the spot, carrying the adequate raw materials from a short distance in order to make the necessary tools. The practice of knapping on the spot is quite common for this type of site: it is documented in particular at Barogali (Chavaillon et al. 1987; Berthelet 2001) and Mwanganda's Village (Clark and Haynes 1970). At Nadung'a 4 such a practice is linked to a selective raw material sampling, which is in keeping with a non-random food procurement strategy.

Discussion

What is unusual at Nadung'a 4 is the high quantity of artefacts produced in comparison with the small amounts recorded in the other pachyderm single carcass sites (Tab. 2). In those sites the lithic component has very likely been almost entirely used for butchering activities. Nadung'a 4 lithic assemblage cannot be the result of a single activity, dedicated exclusively to butchery, owing to the quantity of unmodified flakes and to the presence of notches and denticulates, whose function is difficult to link directly to meat processing. Considering the unmodified flakes component, it is clear that several thousands of flakes were not necessary to process a single elephant carcass: a few hundred are more than enough. Notches and denticulates could have been multipurpose tools, but functional data are very poor for this category of tools. It is not even clear whether the working edge is the notched one, which in any case is not suitable for cutting soft materials. However, such tools are quite frequent in the pachyderm butchery sites; their proportions are significant at Mwanganda's Village (Clark and Haynes 1970) and they are also documented in the European record, *e.g.* at Torralba in Spain (Freeman 1978). But they are also found in many other contexts and are not specifically associated with one type of site.

What can be inferred from the whole data set recovered from Nadung'a 4 is that:

- important knapping activities were carried out on the spot, directly around an elephant carcass;
- the artefacts produced were in all likelihood partly dedicated to butchery and carcass processing: such is probably the case for the heavy-duty tools and some unmodified flakes;
- a significant portion of the assemblage (notched tools and a large proportion of unmodified flakes) was probably devoted to other tasks, *e.g.* transformation of non perennial materials such as wood or plants in relation or not with meat processing and

consumption. It is also possible that the meat was transported to another place (home base ?), an activity that would have required the manufacture of implements for food transport.

These features do not match up with the current model of a single carcass butchery site or *type B* site (Isaac and Crader 1981). When looking closely at the archaeological record, few sites show the expected patterns for such a type of site, either because of the diversity and quantity of other faunal taxa present, *e.g.* Olduvai FLKN-6, (Potts 1988) and Koobi Fora FxJj3 (Bunn 1997), or because of the absence of associated artefacts when cutmarks are observable, *e.g.* Koobi Fora (Bunn 1994) and Buia, (Fiore et al. 2004), or finally because of the important knapping component abandoned on the spot, *e.g.* Nadung'a 4. The sites that would more likely fit the definition of butchery sites, and are interpreted as such, never provide direct evidence of human intervention on bones, *e.g.* Barogali, (Chavaillon et al. 1987), Gombore II-2 (Chavaillon and Berthelet 2004), Olduvai WK Hippo Cliff (Leakey and Roe 1994), Olorgesailie Hippo Banda site (Isaac 1977) and Mwanganda's Village (Clark and Haynes 1970). It could be the result of bone alteration (*eg.* Nadung'a 4) or weathering, but it could also be related to the inherent scarcity of cutmarks on pachyderm processed carcasses, as previously pointed out by Crader (1983). What is not debatable is the fact that Lower and Early Middle Pleistocene hominids, in Africa as well as in Near East and Europe, have exploited pachyderms. How is that part of their food procurement activities economically structured? It is still an open issue. No doubt that the situation is indeed more diversified and complex than what the *type B* site model implies. And owing to the specific features (*eg.* scarcity of cutmarks) and constraints related to the exploitation of pachyderm carcasses, multidisciplinary analysis appears as the most promising approach.

To conclude, Nadung'a 4 forms an original occurrence, which can be considered as a new type of site among the pachyderm single carcass sites. It also opens interesting perspectives for discussing the presence of different techno-complexes in East Africa at the end of the Lower and very beginning of the Middle Pleistocene.

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Figures captions

Fig. 1 : Schematic lithostratigraphic log

Fig. 2 : Class-size frequencies of the lithic remains in two test-squares compared with an experimental flaking set made on rhyolite (left). The experimental set has been carried out following the same principles of debitage than in the archaeological assemblage. The interpretation field of the experimental set (dashed) has been drawn after Schick (1986) and Lenoble (2003) experiments. Fields indicating the water-flow modifications on size distribution (right) are based on the experiments carried out by Lenoble (2003). As seen on this graph, the hypothesis of fluvial modification can be refused

Fig. 3 : Distribution of all the remains in the archaeological layer, A: horizontal distribution, B: density areas, C: vertical projection according to the Y axis, D: partial vertical projections (bands 1 and 2 mapped in A)

Fig. 4 : Lithic artefacts frequency per levelling

Fig. 5: Fabric of the assemblage plotted on the triangular Benn's diagram (1994) with interpretation fields from Lenoble and Bertran (2004)

Fig. 6 : Vertical projections according to the Y axis, 1: artefacts attributed to the same initial block of rhyolite (one symbol per block), 2: faunal remains (the large triangles correspond to the remains identified as elephant while the small black triangles are the undetermined fragments which are probably mostly altered elephant remains)

Fig. 7 : elephant scapula surrounded by artefacts

Fig. 8 : Raw materials frequencies at Nadung'a 4 in comparison with the potential source

Fig. 9 : Lithic assemblage composition, 1 : whole pebbles, 2 : worked pebbles, 3 : hammerstones, 4 : flakes and fragments < 2 cm, 5 : flakes and fragments > 2cm, 6 : cores

Fig. 10 : Cores and flakes, 1, 2: discoidal cores, 3, 4: cores with one preferential flaked surface and unidirectional removals, 5: cores with several alternatively flaked surfaces and multidirectional removals, 6-11: flakes issuing from discoidal cores, 12-14: flakes issuing from cores with one preferential flaked surface and unidirectional removals

Fig. 11 : Formal tools, 1-5, 9: denticulates, 6-8: notches, 10, 11: worked pebbles

Fig. 12 : anatomical distribution of the determinable elephant remains (grey coloured)

Fig. 13 : Elephant tooth lamellae (M/1 ?) from Nadung'a 4

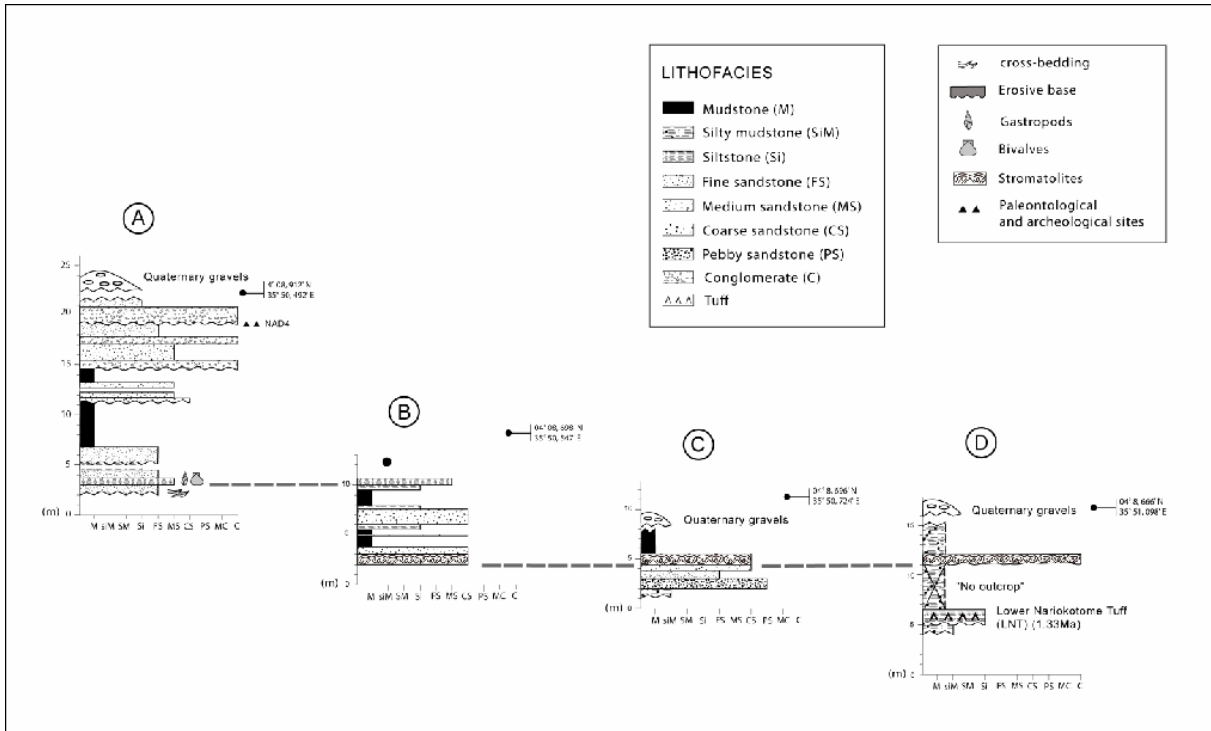


Figure 1

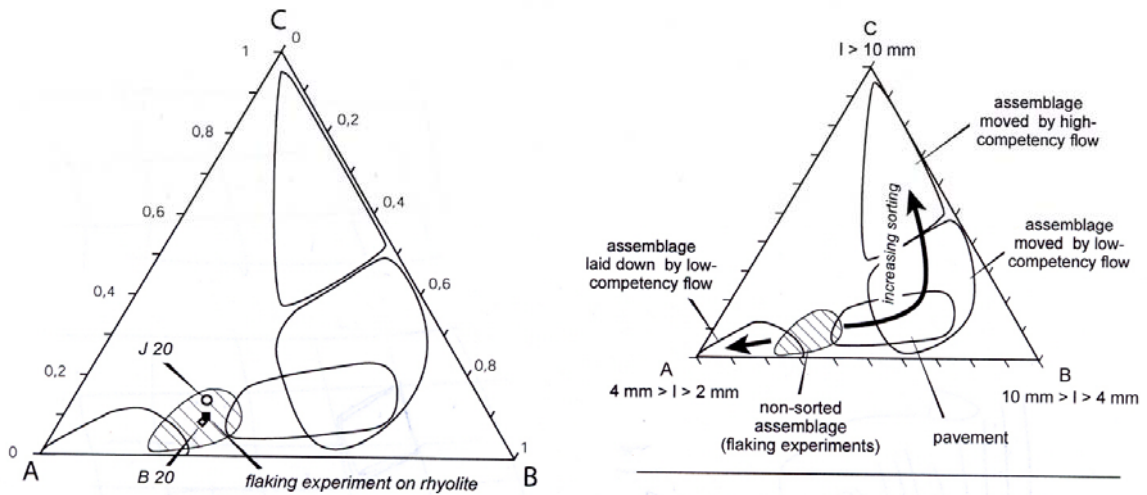


Figure 2

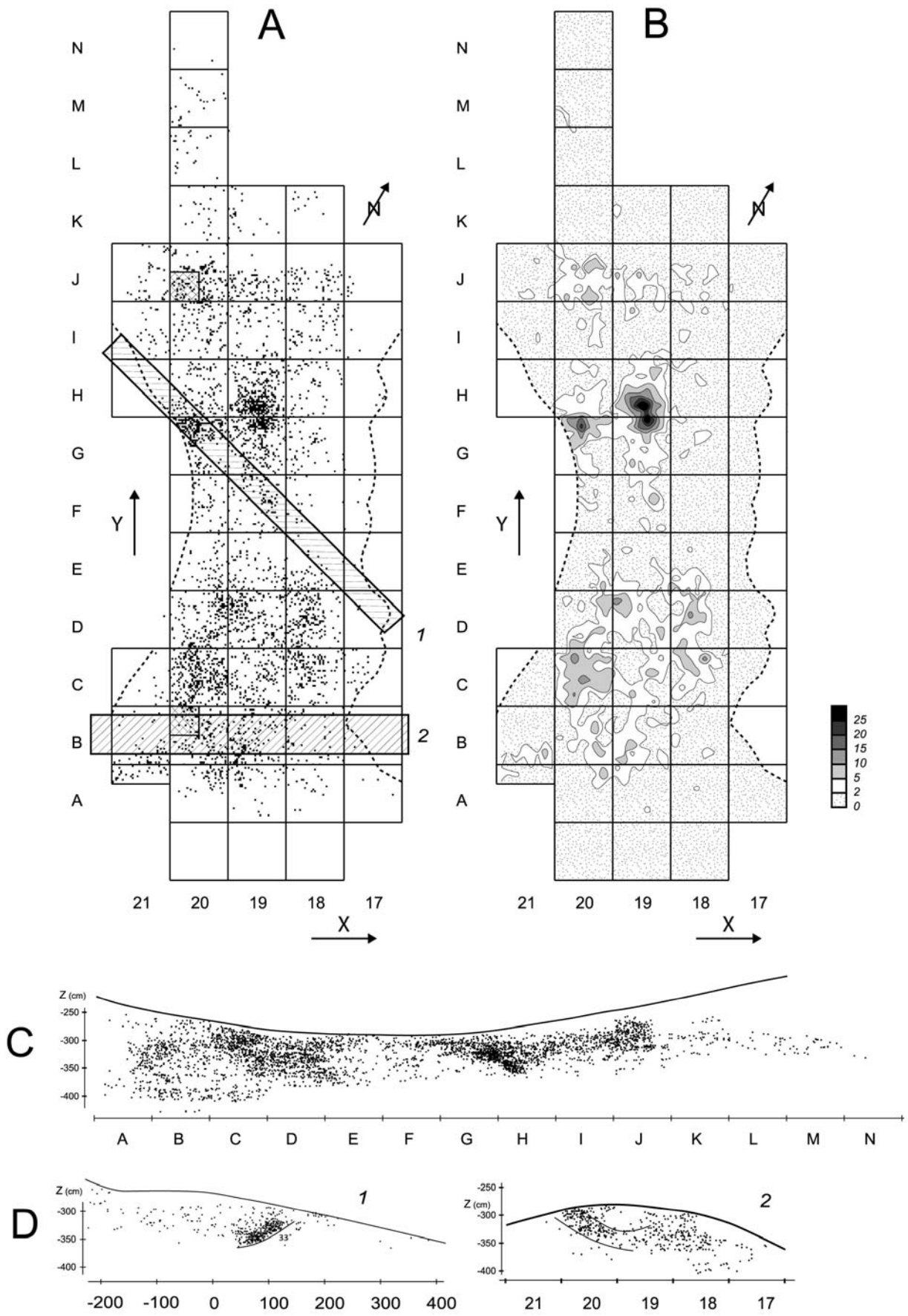


Figure 3

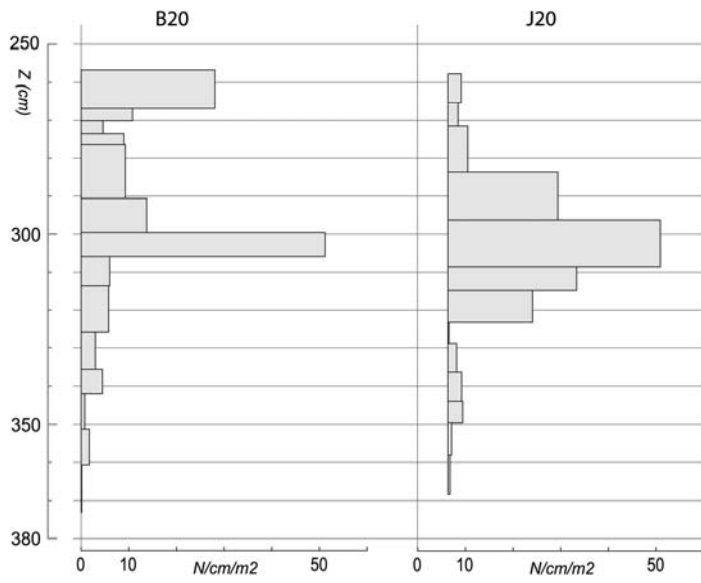


Figure 4

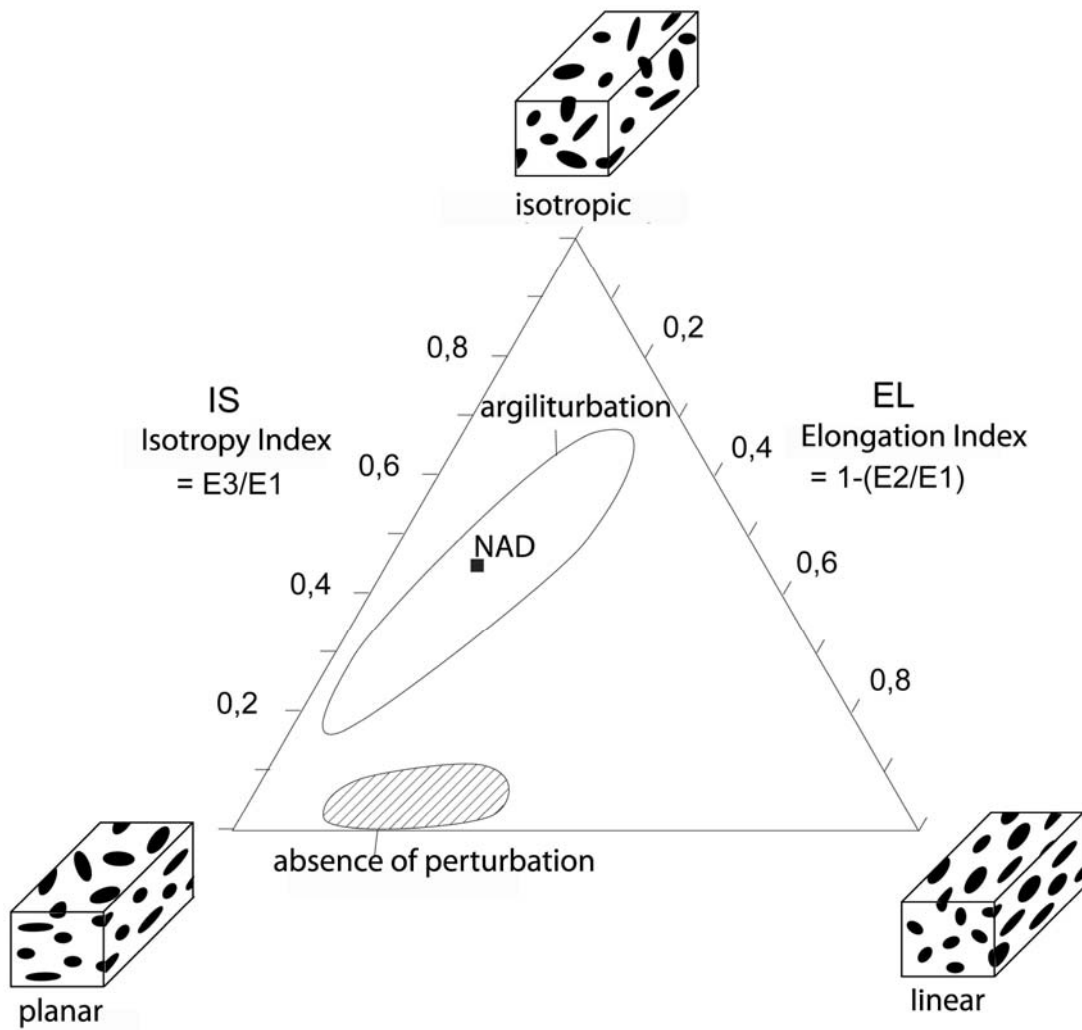


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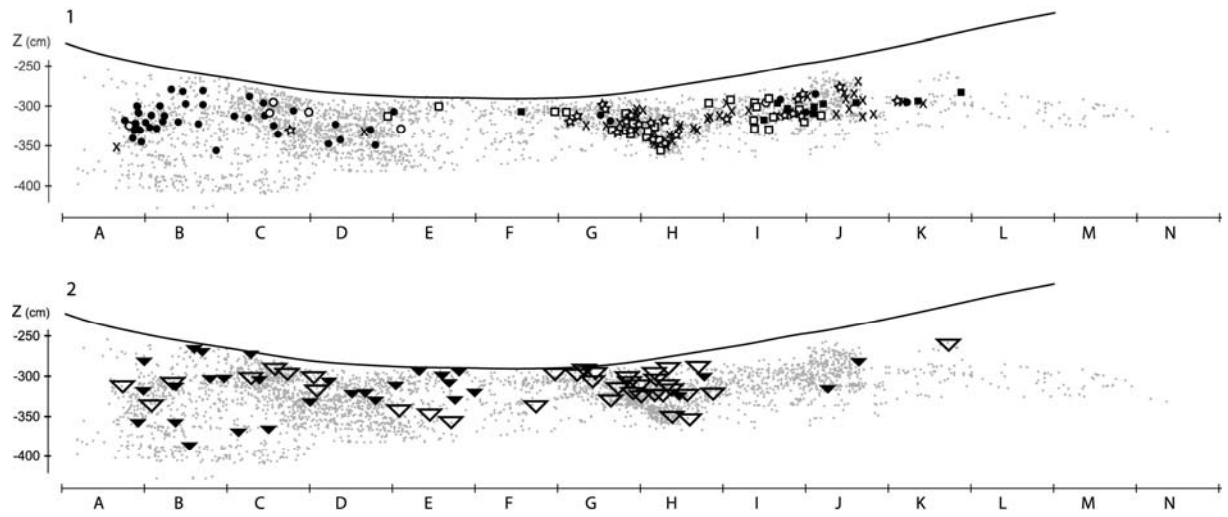


Figure 6

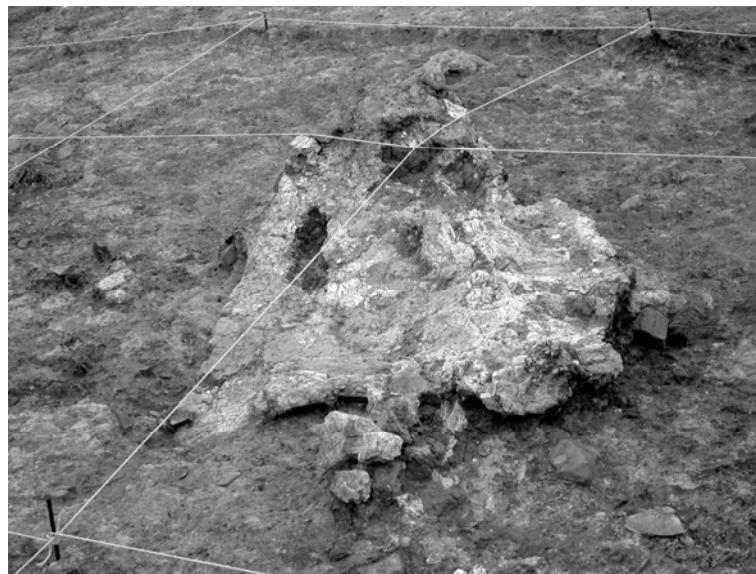


Figure 7

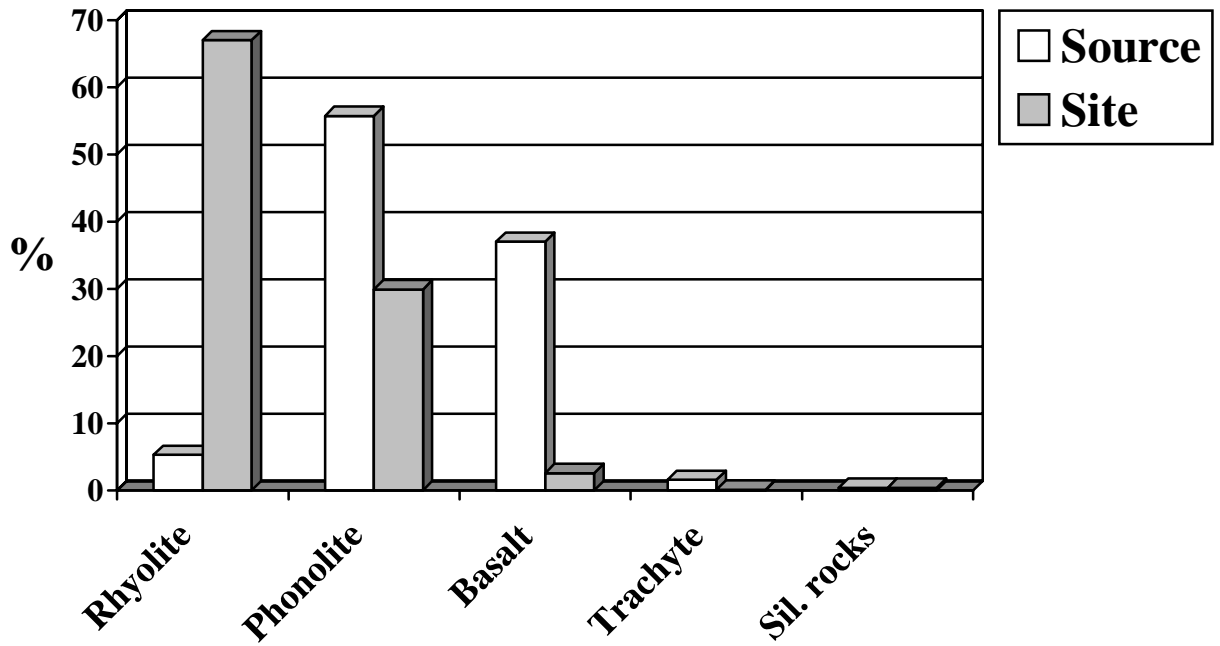


Figure 8

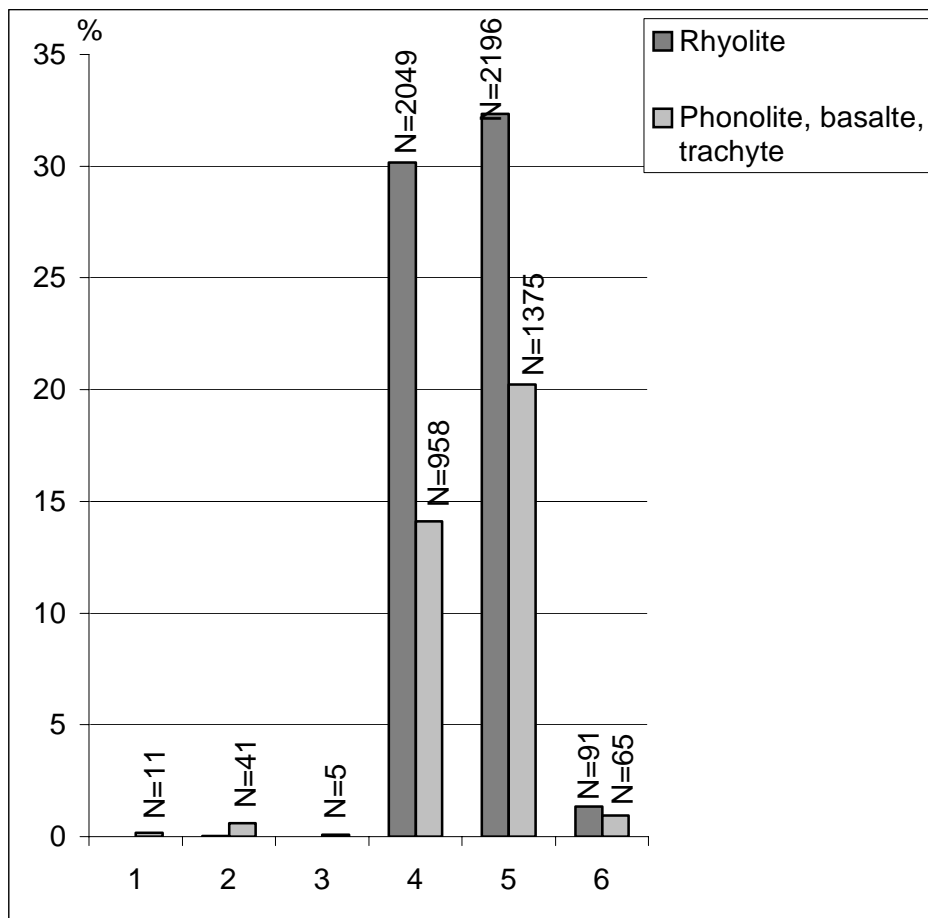


Figure 9

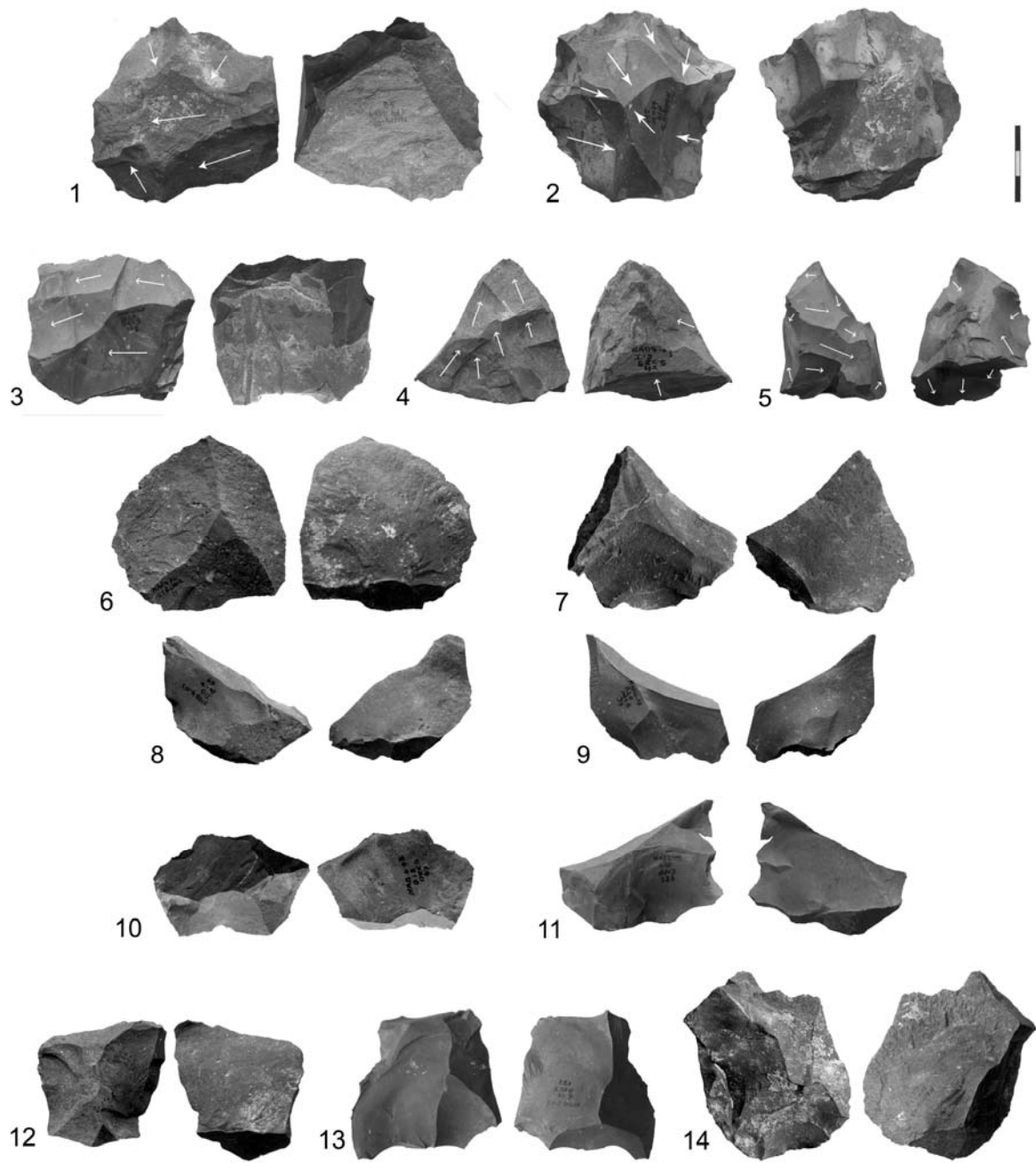


Figure 10

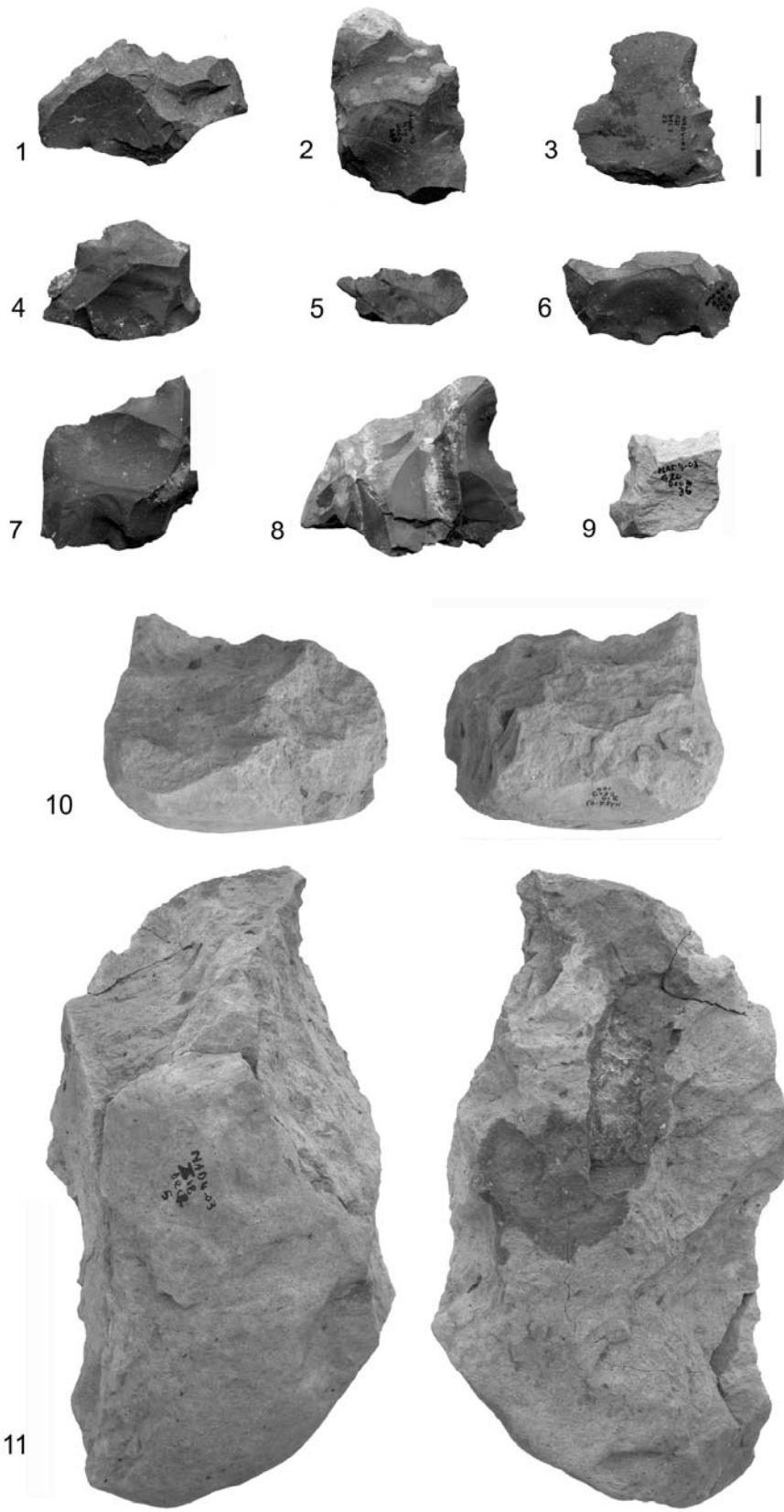


Figure 11

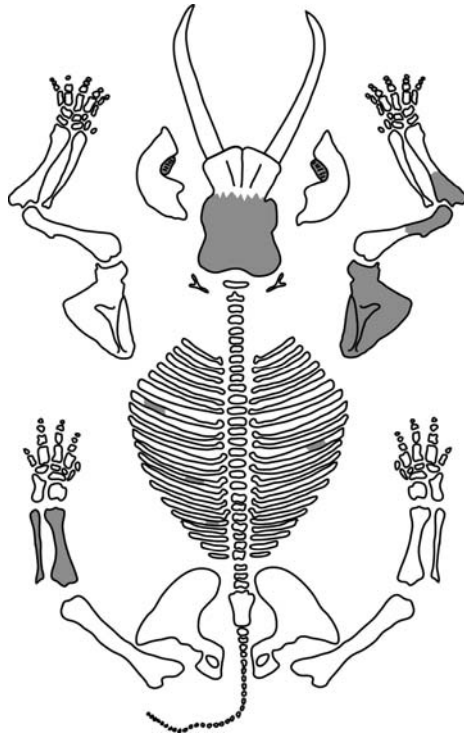


Figure 12



Figure 13

Tables

Tab. 1

Nadung'a 4 fauna composition

Taxa	Age	Biotope	Surface (Nb)	Excavation (Nb)	Total (Nb)
<i>Elephas recki</i>	Young adult	Woody savanna	16 ¹	49	65
<i>Potamochoerus porcus</i> (M3/)	Young adult	Shrubs	1	-	1
Medium size Bovid	-	Savanna	4	3	7
<i>Aves</i> (marabou size)	adult	-	-	1	1
Crocodile	-	Aquatic	1	-	1
<i>Silur</i> (catfish)	-	Aquatic	-	2	2
Indet.	-	-	66 ²	90	156
TOTAL	-	-	88	145	233

¹ small pieces of elephant enamel

² small splinters

Tab. 2

Main pachyderms single carcass sites from the Lower and Middle Pleistocene of East-Africa:
related archaeological data

Sites	Chronological estimation	Excavated areas (m ²)	Nb of associated artefacts	Pachyderm taxa	MNI (aga)	Butchery marks	References
Koobi Fora	~1.9 my	34,5	122	<i>Hexaprotodon</i>	1	absent	Bunn, 1997
FxJj3 (Kenya)				<i>karumensis</i>			
Olduvai FLKN-6 (Tanzania)	1.9-1.7 my	32	130	<i>Elephas recki</i>	1 (juvenile)	present	Bunn, 1981; Potts, 1981
Barogali (Djibouti)	1.6-1.3 my	35	569	<i>Elephas recki</i> <i>ileretensis</i>	1 (adult)	absent	Chavaillon et al., 1987
Nadung'a 4 (Kenya)	1.0-0.7 my	53	6797	<i>Elephas recki</i>	1 (young adult)	absent	-
Olduvai WK Hippo Cliff	~ 0.7 my	16	51	<i>Hippopotamus</i> <i>gorgops</i>	2 (1 ad., 1 juv.)	absent	Leakey and Roe, 1994
Gombore II-2 (Ethiopia)	~ 0.7 my	26	51	<i>Hippopotamus</i>	2	absent	Chavaillon and Berthelet, 2004
Olorgesailie - Hippo Banda Site (Kenya)	< 0.7 my	?	565	<i>Hippopotamus</i> <i>gorgops</i>	1	absent	Isacc, 1977
Mwanganda's Village (Malawi)	Middle Pleist.	~ 44	314	<i>Elephas</i>	1	absent	Clark and Haynes, 1970