



Anne Delagnes ^{a,*}, Arnaud Lenoble ^a, Sonia Harmand ^b, Jean-Philip Brugal ^c,
Sandrine Prat ^d, Jean-Jacques Tiercelin ^e, H  l  ne Roche ^b

^e CNRS/UBO, UMR 6538, Institut Universitaire Européen de la Mer, Place Copernic, 29280 Plouzané, France

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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 supported 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 elephant bones

E-mail address: a.delagnes@ipgq.u-bordeaux1.fr (A. Delagnes).

The main interest of such occurrences is the monospecific aspect (i.e., butchery) of hominid activities, as implied by the faunal assemblage and related stone tools. Although criticized as an “oversimplified rendering” (Potts, 1988, p. 150), the *type B site* model is still commonly used by prehistorians when referring to this type of site. Is the single-task interpretation confirmed when questioning the whole data set provided by the archaeological context? Conjoined pedological, geoarchaeological, spatial, technological, and taphonomic analyses have been carried out to deal with this question on the recently excavated site of Nadung’a 4 (West Turkana). An abundant lithic assemblage has been recovered from this site in close association with the partial carcass of an elephant. The unusual quantity of artefacts, outnumbering any other assemblage known from similar contexts, provides additional interest to this research.

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 million years (My) and 700,000 years BP (Prat et al., 2003; Roche and Kibunjia, 1994, 1996; Roche et al., 1992, 2003). At the beginning of this time interval, south of the formation, the Lokalalei sites are among the very few known African Pliocene sites (Delagnes and Roche, 2005; Kibunjia, 1994; Kibunjia et al., 1992; Roche et al., 1999). At the top of the sequence and north of the formation, the Nadung'a sites are part of a well-documented series 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. Some 20 Oldowan and Acheulean sites are recorded in the same formation between these two time periods, showing various levels of technological development (Roche et al., 2003).

of the West Turkana Archaeological Project co-directed by H  l  ne Roche and Mzalendo Kibunjia (National Museums of Kenya). The excavation covers an area of 53 m² (Fig. 2), including the entire site as it actually exists. 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 spatial 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 Proboscideans. The density of the remains is high, contained in a single sedimentological horizon, spatially confined within a small area. The corresponding horizons surrounding the site are 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 in age from 1.33 My to about 700,000 years BP. The seven sites recorded in the Nadung'a complex are all located in the middle part of the Nariokotome member, 17–20 m above the top of the Lower Nariokotome Tuff (Fig. 1). This marker horizon outcrops at a distance of 100 m north-west of Nadung'a 4. The stratigraphic position of the site has been established through successive surveys along an ephemeral stream (Nadung'a) and through a bed to bed correlation. Nadung'a 4 is the most recent site of the complex 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 BP (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 BP.

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, hominid fossils are rare. They are represented by partial crania from Buia, Eritrea [UA 31, dated about 1 My (Abbate et al., 1998)], the Daka calvaria, Ethiopia [BOU-VP-2/66, about 1 My (Asfaw et al., 2002)], Melka Kunture, Ethiopia [Gombore II,

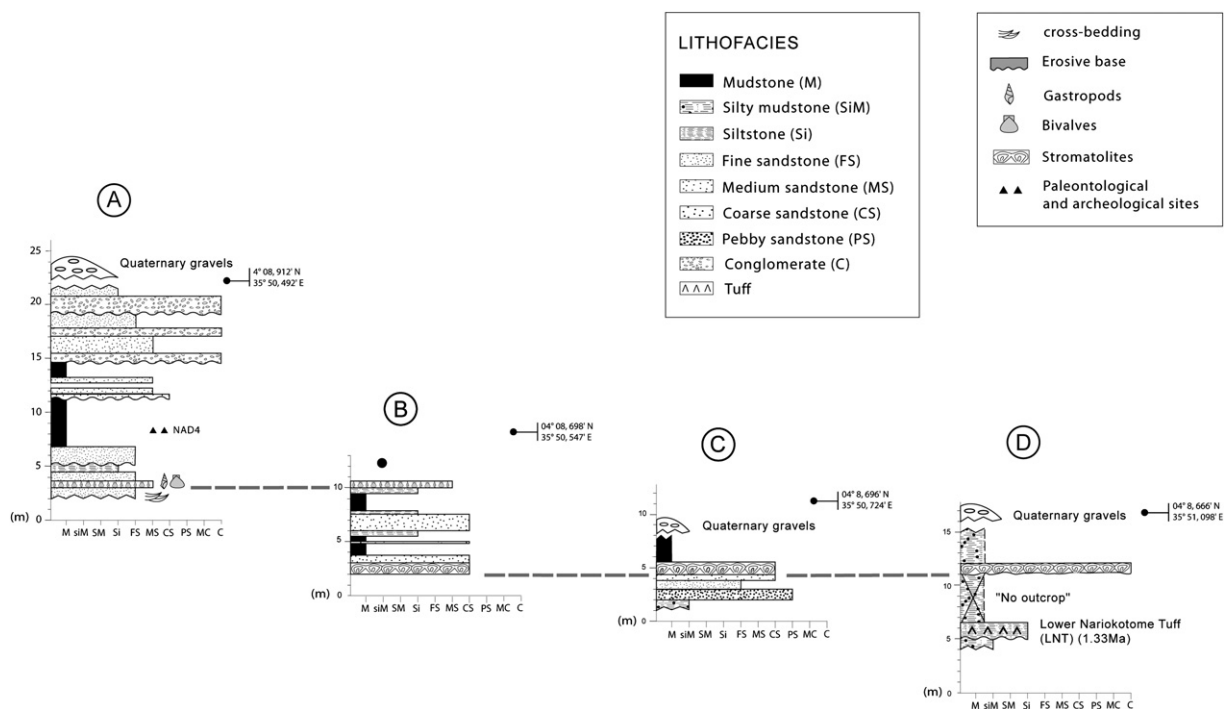


Fig. 1. Lithostratigraphic log established through four sections (A, B, C, D) spaced out along the Nadung'a stream. Nadung'a 4 stratigraphic position is inferred from a bed to bed correlation between the archaeological deposit (A) and the Lower Nariokotome Tuff (D).

about 0.8 My (Chavaillon and Piperno, 2004), Olorogailie, Kenya [KNM-OL 45500, between about 0.97 and 0.9 My (Potts et al., 2004)], and Olduvai, Tanzania [OH 12, OH 22, OH 23, and OH 51]. Unfortunately, no hominid specimens have been discovered in the Nachukui Formation for this time period.

Site formation processes

The archaeological deposit at Nadung'a 4 lies in the lower part of a stratigraphic unit made of brown clays including lenses (about 1 m 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 of deposits 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: crack 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°–60° from the horizontal in the deep horizon of the soil.

This type of pedogenesis is typical of wet/dry tropical climates, where soils exhibit swelling upon

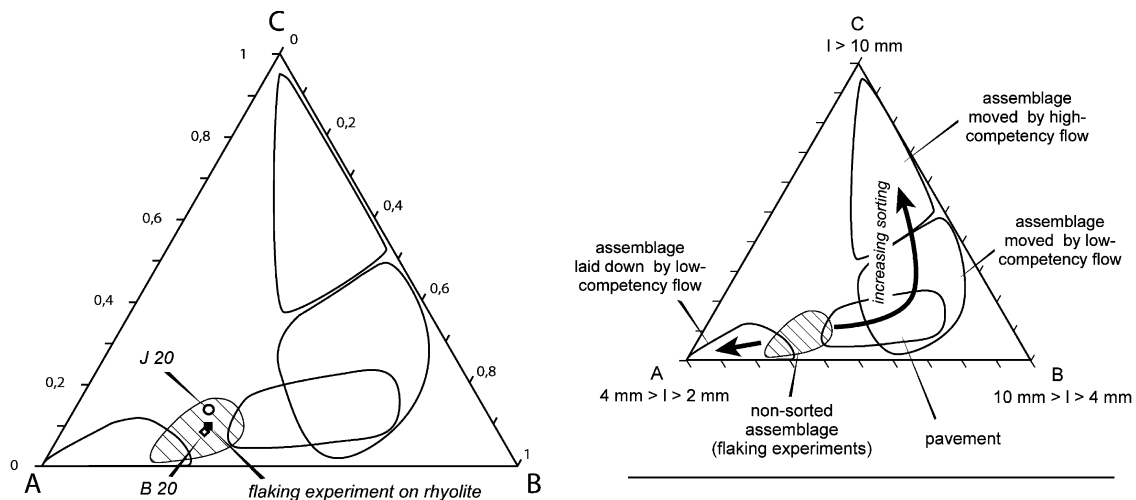


Fig. 2. Class-size frequencies of the lithic remains in two test-squares compared with an experimental flaking set made on rhyolite (left). The experimental set has been carried out following the same principles of debitage than in the archaeological assemblage. The interpretation field of the experimental set (dashed) has been drawn after Schick (1986) and Lenoble (2005) experiments. Fields indicating the water-flow modifications on size distribution (right) are based on the experiments carried out by Lenoble (2005). As seen on this graph, the hypothesis of fluvial modification can be refused.

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 savanna vegetation. These contexts are equally characterized by frequent seasonal floods and subsequent sedimentation episodes, as suggested by the sedimentary features.

In the case 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 secondarily 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 (1986) and by Petraglia and Potts (1994): artefact size distribution, physical alteration, and the horizontal distribution of lithic remains. Neither the fabric (ori-

entation and dip) nor the small-scale spatial features such as *shadow effects* (Schick, 1986) are considered here for the purpose of estimating the impact of water transport. We assume that such features would not have been preserved owing to the argilliturbation inferred from the sedimentary context.

Artefact size distribution

Sediments from 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 compared with an experimental assemblage produced using the same technical principles identified in the archaeological assemblage and consisting in the knapping of one block of rhyolite according to a discoidal method. The relative proportions of small lithic artefacts recovered from the two test squares during screening (between 2 and 10 mm screen mesh) are very similar (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 the latter compatible with a knapping locality. The size distribution of the products resulting from the experimental set is also consistent with the data recorded for experimental assemblages (Fig. 2) produced by other means and on different rocks (Lenoble, 2005; Schick, 1986). Such observations

have made possible a comparison in terms of size distribution between the archaeological assemblage and several other experimental assemblages sorted by various types of water flow, or non-sorted (Lenoble, 2005). The lithic sample from Nadung'a 4 corresponds to a non-sorted assemblage.

Physical alterations

All of the artefacts were macroscopically examined. No abrasion or any other edge damage related to 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 related to their porosity. The elephant bones are also badly preserved: desquamated bone surfaces and in-depth bone alterations, resulting in a white and chalky structure, are the most common observable features. Post-burial alteration is deduced from the sedimentary context; repeated episodes of desiccation and then dampening within the deposits are sufficient to account for the alteration of the bones, even if previous weathering, no longer distinguishable, may also be assumed.

Horizontal distribution

A rough examination of the horizontal spatial distribution of archaeological material (Fig. 3) shows a non-homogeneous spatial distribution: 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 water flows related to the flood plain system. The effects of argilliturbation are investigated through the vertical distribution of the remains and their fabric (below).

Vertical distribution

The archaeological layer is very diluted, 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 (>2 cm) which is characterized by sharp lower outlines, following oblique plans ranging between 15° and 35°. The slickensides are also responsible for splitting the dense area visible in the northern part of the site into two secondary concentrations, as was observed during excavation. 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 deeply 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 (i.e., all pieces >2 mm) from the two test-squares, the vertical distribution of the material, according to the successive levels established during excavations, 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 artefact dispersal from a single archaeological layer. The vertical dispersal is more important towards the bottom of the deposit, which is indicative of argilliturbation—when artefacts dropped into the cracks—as mentioned by Duffield (1970) and Wood and Johnson (1978).

Fabric

Considering the fabric, the vector magnitude L (Curray, 1956) has a low value: 4.6%, which means that the remains do not follow any preferential orientation (Lenoble and Bertran, 2004). As shown in Fig. 5, their inclinations are also extremely heterogeneous, indicating an isotropic fabric. The position of Nadung'a 4 lithic assemblage on Benn's diagram (Benn, 1994) is consistent with deformation due to argilliturbation.

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 limited vertical size-sorting of the material. Lateral displacements, on the order of 1 m or so, may have also occurred as a result of the formation of bowl structures and localized massive slips of sediments.

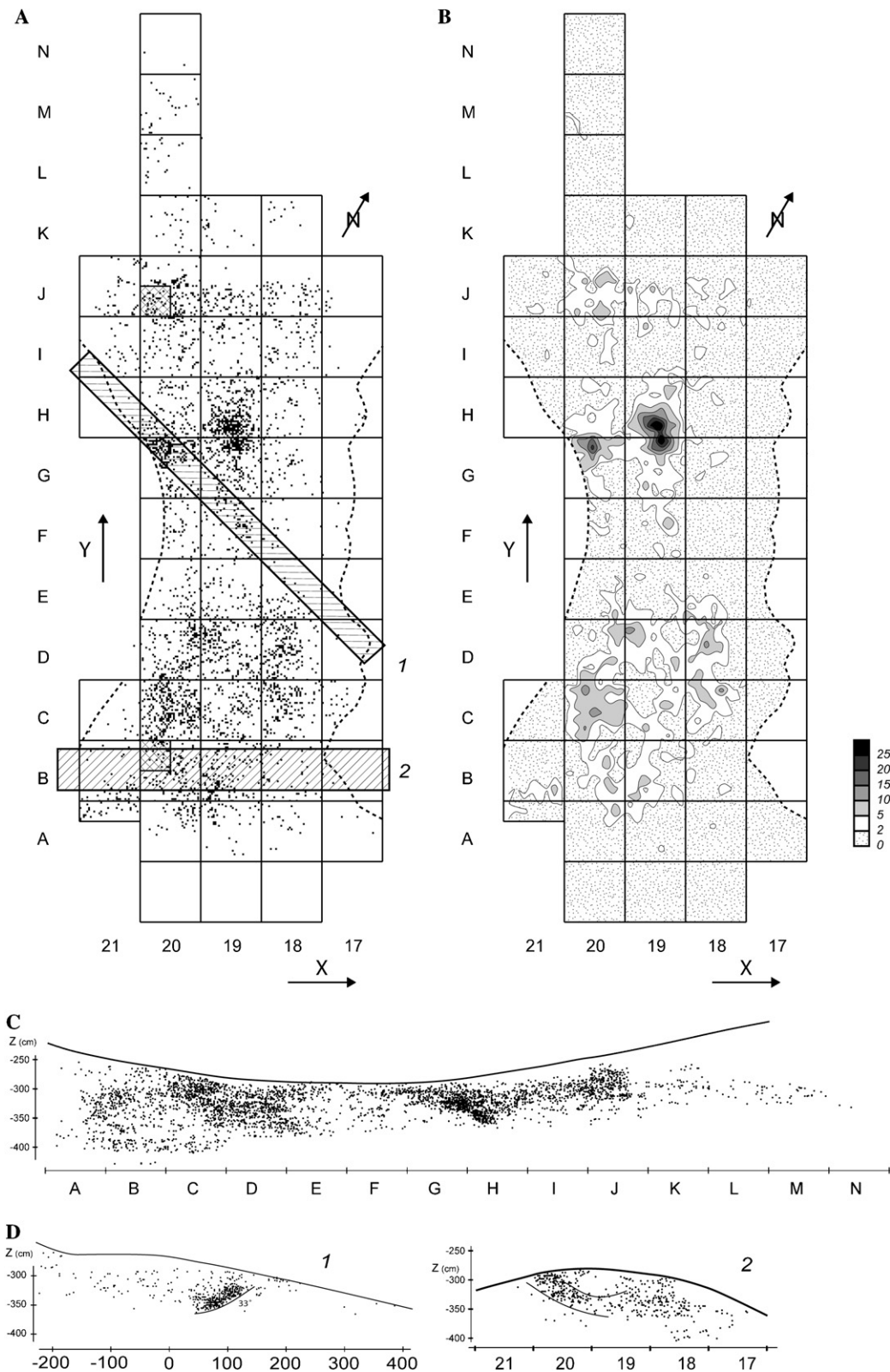


Fig. 3. Distribution of all the remains in the archaeological layer, (A) horizontal distribution, (B) density areas, (C) vertical projection according to the Y-axis, and (D) partial vertical projections [bands 1 and 2 mapped in (A)].

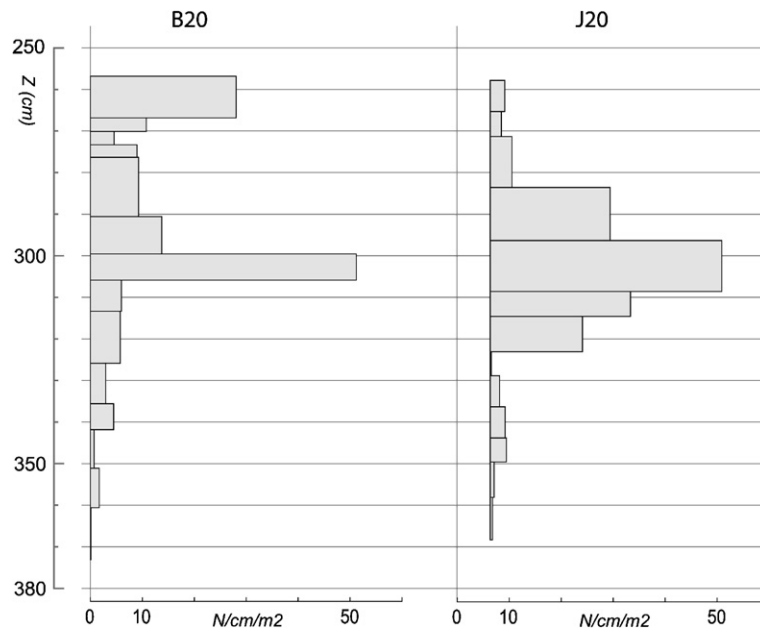


Fig. 4. Lithic artefacts frequency per levelling.

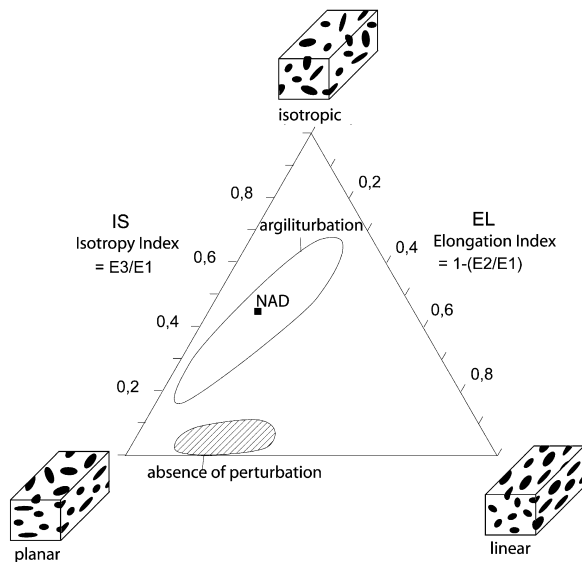


Fig. 5. Fabric of the assemblage plotted on the triangular Benn's diagram (1994) with interpretation fields from Lenoble and Bertran (2004).

Spatial plotting per category of remain brings additional information to estimate the extent of deformations and the homogeneity of the assemblage. For this purpose, artefacts derived from the same original block of raw material have been grouped together. Particularly relevant are six groups corresponding to blocks of rhyolite showing

very distinctive physical features (in terms of their color 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, panel 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 reflect knapping areas whose spatial distribution was subsequently diluted.

When comparing the vertical dispersal of the elephant remains with the dispersal of the stone tools, it appears that both categories of remains are closely associated (Fig. 6, panel 2). The elephant bones are distributed throughout the archaeological layer. Owing to their large dimensions, they cannot be intrusive elements and they clearly form part of this in situ layer. Most elephant elements were recovered within the artefact concentrations described above, 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:

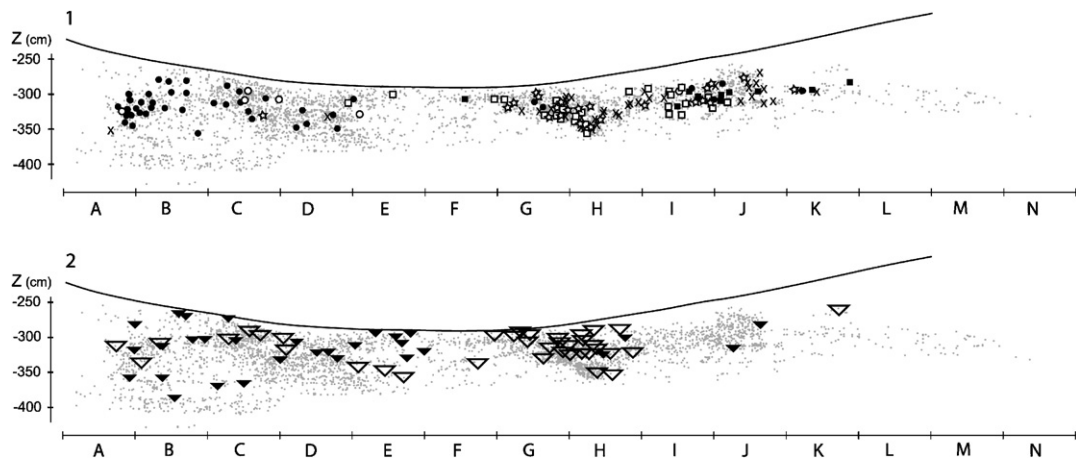


Fig. 6. Vertical projections according to the Y-axis; panel 1, artefacts attributed to the same initial block of rhyolite (one symbol per block); panel 2, faunal remains (the large triangles correspond to the remains identified as elephant while the small black triangles are the undetermined fragments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

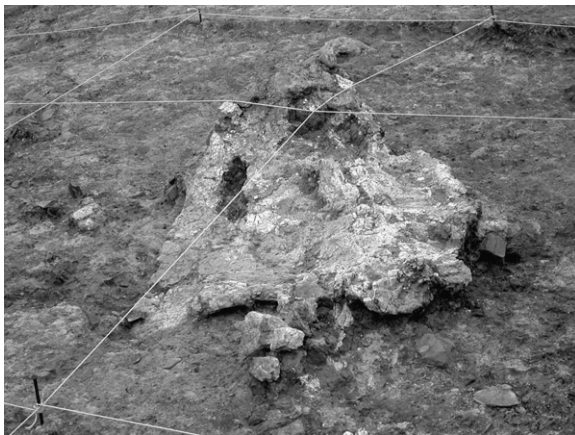


Fig. 7. Elephant scapula surrounded by artefacts.

- Lithic and elephant remains are primarily associated in the archaeological layer, insofar as:
 - water flow has not 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, and
 - the vertical dispersion of the remains derives from a single original layer subsequently affected by argilliturbation;
- A short period of open-air exposure was followed by the rapid burying of the remains, as suggested by the sedimentary context, which 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 deposition of the elephant bones, the functional significance of this uncommon association between an abundant lithic assemblage and the elephant remains still has 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. Raw material sampling was carried out in a debris-flow outcrop, stratigraphically situated a few meters above the archaeological layer. This deposit corresponds to the development of an alluvial fan and 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 a comparison between the different kinds of rocks collected in the archaeological assemblage and in the debris-flow outcrop relevant. This comparison indicates a clear preference for rhyolite (Fig. 8). Poorly represented at the raw material source (5%), it is

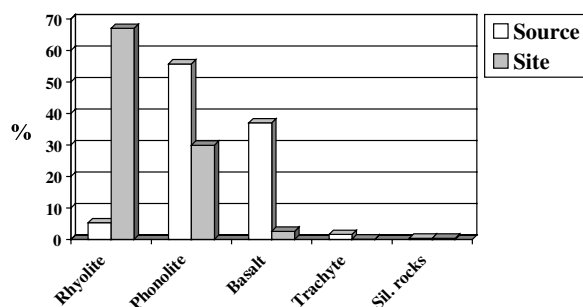


Fig. 8. Raw materials frequencies at Nadung'a 4 in comparison with the potential source.

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 which include phonolite, basalt and trachyte, ranging mostly from medium to coarse-grained qualities. Unlike rhyolite, which comes as diaclastic angular blocks, phonolite, basalt and trachyte correspond to rounded compact pebbles.

The artefacts can be segregated into 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 related cores. 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 and 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 refits as well as from the morpho-technical analysis of the flakes compared with the cores. The core types include:

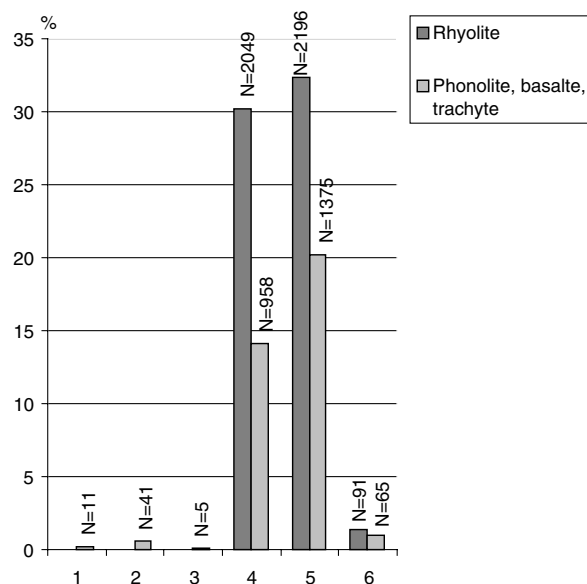


Fig. 9. Lithic assemblage composition; 1, whole pebbles; 2, worked pebbles; 3, hammerstones; 4, flakes and fragments <2 cm; 5, flakes and fragments >2 cm; 6, cores.

- discoidal cores (Fig. 10: 1 and 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 and 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;

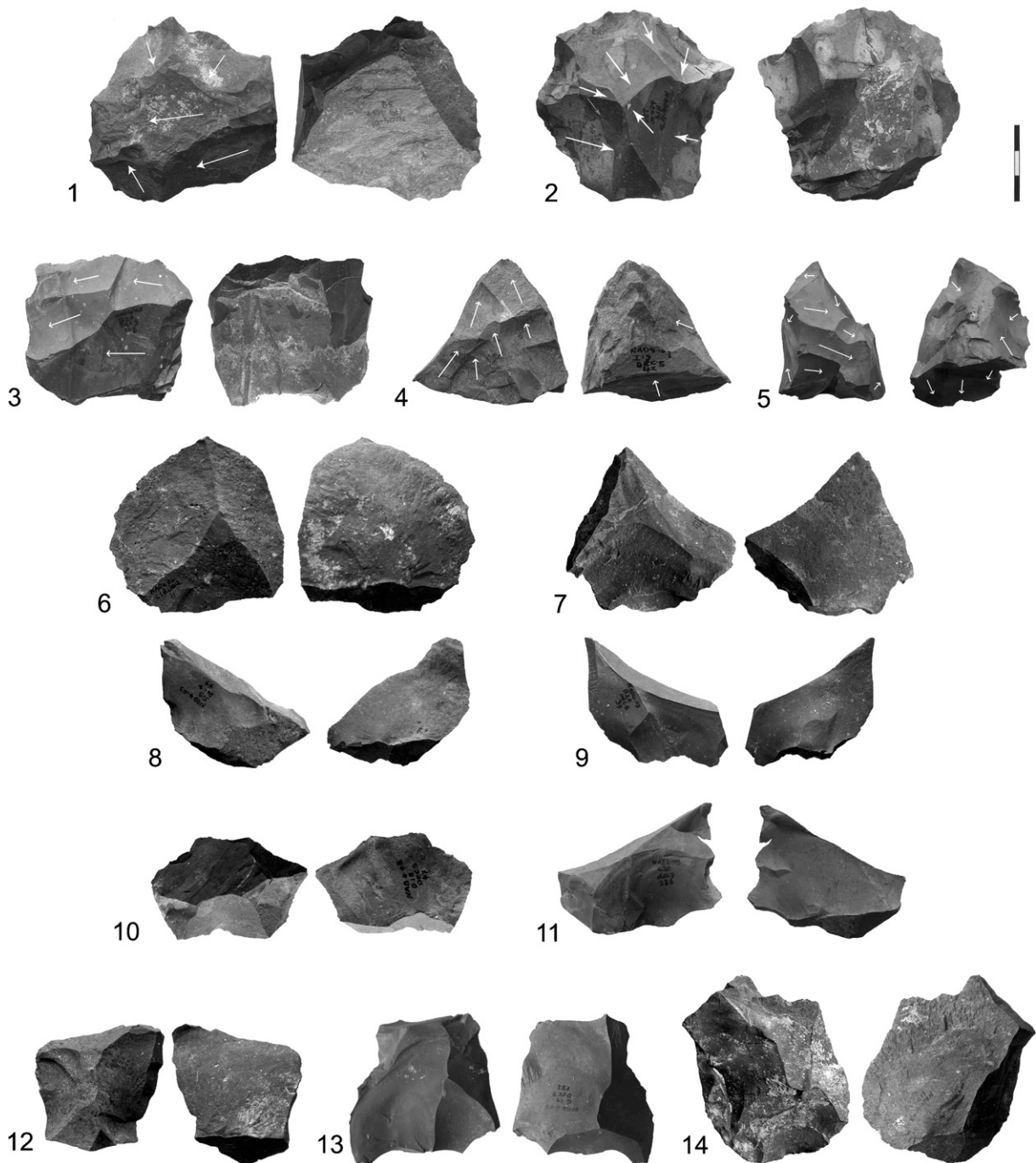


Fig. 10. Cores and flakes; 1 and 2, discoidal cores; 3 and 4, cores with one preferential flaked surface and unidirectional removals; 5, cores with several alternatively flaked surfaces and multidirectional removals; 6–11, flakes issuing from discoidal cores; 12–14, flakes issuing from cores with one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

- 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 plat-

form 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 edge of the blank. It is impossible to establish 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 flakes, detached from the ventral face of the blank, are Kombewa flakes.

The cores are made using the rhyolite and, to a lesser extent, the phonolite. The reduction sequence is clearly carried out preferentially on the fine-grained rocks. The other rocks, mostly of medium and coarse-grained quality, 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 (17 to 1) of unmodified flakes (>2 cm) per core, 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 retouching (410 pieces, i.e., 11% of the potential blanks, including flakes >2 cm 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 and the retouch is similar to that 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, which has 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 retouch 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” acci-

dentally 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 flake component.

Besides whole pebbles ($N = 37$) in phonolite and basalt, worked pebbles comprise only a few pieces ($N = 10$, Fig. 11: 10 and 11) made from the same raw material. 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: 10–24 cm; maximum width: 6–12 cm), their compactness and the sturdiness of the edges indicate that they 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, the technological composition of this assemblage and its functional potential make it 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 elaborate with regards to the selective procurement and exploitation of raw materials according to their properties and in relation to functional needs. The debitage process itself is not very elaborate; 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),

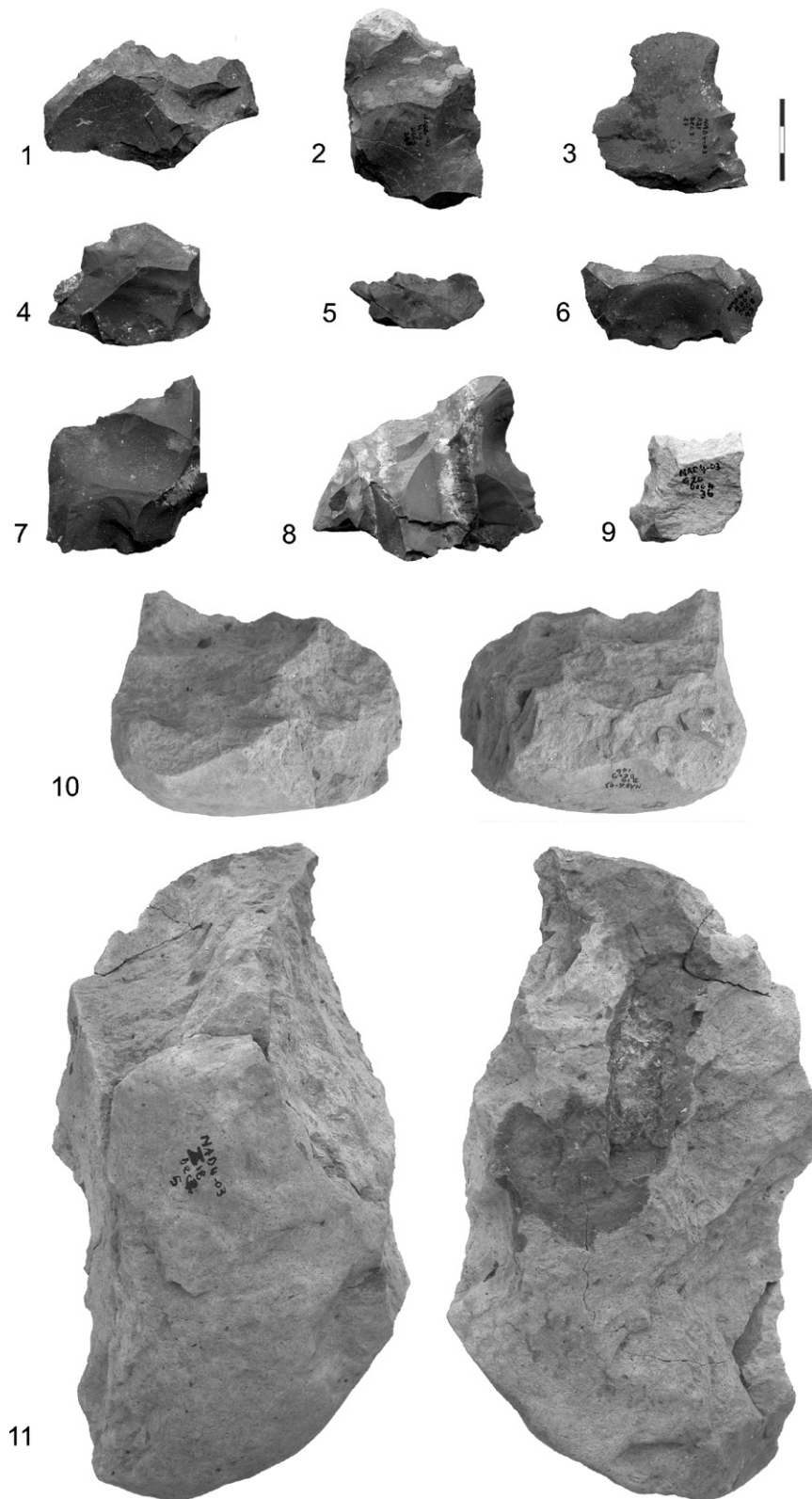


Fig. 11. 1–5, Formal tools; 9, denticulates; 6–8, notches, 10 and 11, worked pebbles.

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 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 (Roche and Texier, 1996; Texier and Roche, 1995). 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 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 are correlated in this context with expedient tool 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 the Nadung'a 4 assemblage: lithic production cannot be considered expedient here—rather, it is a structured activity requiring planning and anticipation. The 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 other Acheulean assemblages 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.

The Nadung'a 4 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 with Nadung'a 4, are interpreted as pachyderm butchery sites. It seems, therefore, that the position connecting the lack of the classical Acheulean tool-kit in some assemblages with 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 fish (Table 1). Owing to their scarcity and their relation to different paleoenvironmental contexts (savanna *versus* aquatic environment), such remains must very likely be interpreted as background fauna, accumulated before or after the occupation of the site. If these remains are subtracted from the site's record, the faunal assemblage consists exclusively of elephant remains, with a significant portion of undetermined fragments (owing to their alteration) mostly belonging to an elephant carcass. Only a minority of recognizably elephant bones ($N = 19$ out of 49) have been determined anatomically. The body part 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 and 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 the bones were initially scattered and weathered which weakened the bone before to burial in the vertisol, making it more liable to post-depositional alterations. The lack of small parts, e.g., basipodials or metapodials, as well as

Table 1
Nadung'a 4 fauna composition

Taxa	Age	Biotope	Surface (Nb)	Excavation (Nb)	Total (Nb)
<i>Elephas recki</i>	Young adult	Woody savanna	16 ^a	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 ^b	90	156
TOTAL	—	—	88	145	233

^a Small pieces of elephant enamel.

^b Small splinters.

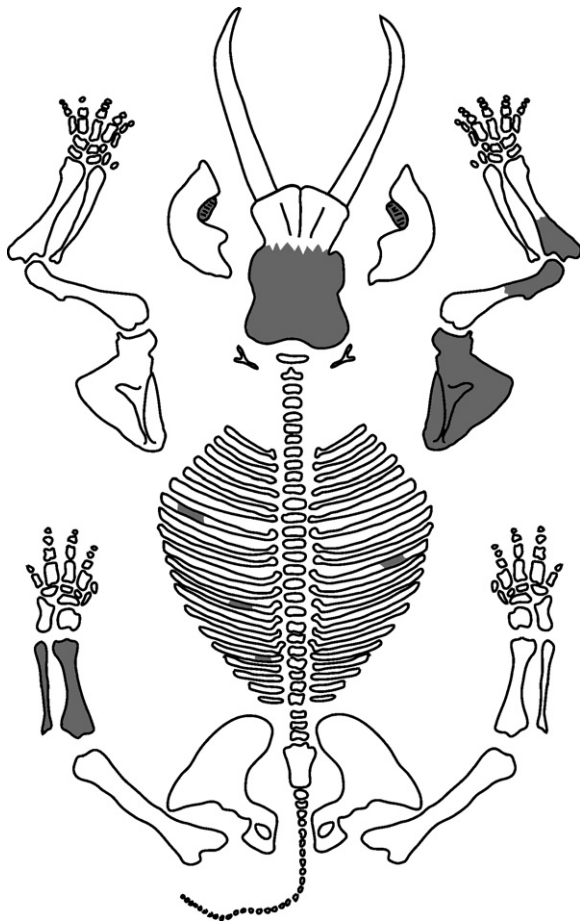


Fig. 12. Anatomical distribution of the determinable elephant remains (grey colored).

most of the axial elements (vertebrae, ribs) is a striking feature of this assemblage which is likely to be related to the same taphonomic processes. In any case, an argument for the intentional transport by hominids would be impossible to sustain. Some long bones (e.g., tibia and ulna) were broken, but their



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

state of preservation does not allow us to determine whether the fragmentation is anthropic or natural, i.e., a result of pressures generated within the sediments in relation to their cyclical shrinking and swelling. Similarly, no cutmarks or blows are observable on the bone 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 of the site and whether it was subsequently transported by hominids. The co-occurrence of lithic and elephant remains in an environment devoid of any other bone remains, but nevertheless conducive to fossil preservation, argues in favor of the hypothesis that the site

corresponds to the place where the animal died. When referring to actualistic data (Crader, 1983; Haynes, 1991), the body part representation, the age of the elephant, and the paleoclimatic context (seasonal contrasts with cyclical dry/wet episodes) makes an assumption of a natural death very plausible, even if there is no way to prove it directly. On the other hand, geoarchaeological, spatial, and technological data all demonstrate that the hominid occupation is at least partly linked to the presence of the elephant carcass. Processing the carcass was very likely the primary reason for hominids to settle on the site, importing adequate raw materials from a short distance away in order to make the necessary tools. The practice of knapping on the spot is quite common for this type of site and is documented at Barogali (Berthelet, 2001; Chavaillon et al., 1987) and Mwanganda's Village (Clark and Haynes, 1970). At Nadung'a 4, such a practice is linked to 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 large quantity of artefacts produced when compared with the small quantities recorded in other pachyderm single carcass sites (Table 2). In those sites, the lithic component was likely almost entirely used for butchering activities. The 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 flake component, it is clear that several thousand 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 of these tools is the notched one, which is not suitable for cutting soft materials in any case. 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). They are also found in many other contexts, however, and are not specifically associated with one type of site.

What we can infer from the 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., the transformation of non-perennial materials

Table 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 FxJj3 (Kenya)	~1.9 my	34,5	122	<i>Hexaprotodon karumensis</i>	1	absent	Bunn, 1997
Olduvai FLKN-6 (Tanzania)	1.9–1.7 my	32	130	<i>Elephas recki</i>	1 (juvenile)	present	Bunn, 1981; Potts and Shipman, 1981
Barogali (Djibouti)	1.6–1.3 my	35	569	<i>Elephas recki 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	~0.7 my	16	51	<i>Hippopotamus gorgops</i>	2 (1 ad., 1 juv.)	absent	Leakey and Roe, 1994
Hippo Cliff	~0.7 my	26	51	<i>Hippopotamus</i>	2	absent	Chavaillon and Berthelet, 2004
Gombore II-2 (Ethiopia)	~0.7 my	?	565	<i>Hippopotamus gorgops</i>	1	absent	Isaac, 1977
Olorgesailie - Hippo Banda Site (Kenya)	< 0.7 my	?	565	<i>Hippopotamus gorgops</i>	1	absent	Isaac, 1977
Mwanganda's Village (Malawi)	Middle Pleist.	~44	314	<i>Elephas</i>	1	absent	Clark and Haynes, 1970

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 (such as a home base), an activity that would have required the manufacture of implements for food transport.

These features do not match the current model of a single carcass butchery site or *type B* site (Isaac and Crader, 1981). Looking closely at the archaeological record, however, few sites show the expected patterns for this site type, 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, as at 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 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). This lack of butchering evidence could be the result of bone alteration (e.g., Nadung'a 4) or weathering, but it could also be related to the inherent scarcity of cutmarks on processed pachyderm 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, exploited pachyderms. How is this part of their food procurement activities economically structured? This is still an open issue. No doubt, the situation is more diversified and complex than what the *type B* site model implies. Owing to the specific features (e.g., scarcity of cutmarks) and constraints related to the exploitation of pachyderm carcasses, multidisciplinary analysis appears as the most promising approach to deal with this question.

To conclude, Nadung'a 4 is a unique occurrence which can be considered a new type of site among pachyderm single carcass sites. It also opens interesting new 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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