The Oldowan industry of Peninj and its bearing on the reconstruction of the technological skills of Lower Pleistocene hominids

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Abstract

The Oldowan technology has traditionally been assumed to reflect technical simplicity and limited planning by Plio-Pleistocene hominids. The analysis of the Oldowan technology from a set of 1.6–1.4 Ma sites (ST Site Complex) in Peninj adds new information regarding the curated behavior of early hominids. The present work introduces new data to the few published monographic works on East African Oldowan technology. Its relevance lies in its conclusions, since the Peninj Oldowan assemblages show complex technological skills for Lower Pleistocene hominids, which are more complex than has been previously inferred for the Oldowan stone tool industry. Reduced variability of tool types and complex use of cores for flaking are some of the most remarkable features that identify the Oldowan assemblages from Peninj. Hominids during this period seem to have already been experimenting with pre-determination of the flaked products from cores, a feature presently assumed to appear later in time. Planning and template structuring of flaked products are integral parts of the Oldowan at Peninj.

Keywords: Peninj; Oldowan; East Africa; Plio-pleistocene; Lithic technology

Introduction

The traditional Darwinian paradigm that shapes a wide range of evolutionary interpretations is responsible for the current views on the behavioural and technological meaning of the earliest stone tools. The Oldowan, as these early
industries have been defined, was initially conceived of as the earliest, and therefore, the simplest attempts of hominids to elaborate stone tools in the dawn of technology (Leakey, 1971; Wynn, 1981). These tools consisted, basically, of simple core-artefacts (shaped in different forms: choppers, polyhedrons, discoids...) and flakes (unretouched, retouched and fragments). Initially, hominids were thought to have knapped simple forms on cores, and flakes were mostly the debris detached from them (Leakey, 1971). The simplicity of concepts of these early tools did not require skills more developed than those observed in apes (Wynn, 1981; see Schick et al, 1993 for an opposite view).

The Oldowan was seen as an expedient tool kit. Hominids flaked artefacts when they needed them and discarded them after use. Toth's (1982, 1985) pioneering re-analysis and re-interpretation of the Oldowan led to a somewhat different picture: hominids were aiming at flakes rather than at cores. Cores seemed to have been the by-product of flake extraction. Besides, differential transport, selection and flaking of raw material types implied complexity and planning, since artefacts were documented to have been carried from site to site. Hominids were, thus, anticipating their use in other places. The Oldowan was re-assessed as the result of a more complicated technological behaviour than documented among non-human primates. However, even if more complex, this technology was conceived of as much more simple and more expedient than later industries.

The discovery of 2.5 Ma sites at Gona (Ethiopia) and sites older than 2 Ma in other East African localities such as Omo and West Turkana promoted the idea of the existence of more simple and less developed technology that was designated as “pre-Oldowan” (Roche, 1989; Kibunjia, 1994). This step was conceptually necessary to account for the complexity documented by Toth in Oldowan assemblages younger than 2 Ma. Evolution operates from simple to complex. The traditional Oldowan technology had to be derived from a previous simple technology. Thus, assemblages showing a “Shungura facies” or defined as “Nachukui industry” were part of a larger concept of pre-Oldowan technology (Chavaillon, 1976; Kibunjia, 1994). The recent re-dating of the Gona deposits and the analysis of the technological skills of the 2.5 Ma stone knapping hominids, showed that at the very beginning of tool manufacture, “the Oldowan artefacts showed a surprisingly sophisticated control of stone fracture mechanics equivalent to much younger Oldowan assemblages of Early Pleistocene age” (Semaw et al., 1997: 333).

The evidence of a one-million-year stasis of the Oldowan technology made the “pre-Oldowan” concept obsolete; in some cases, even from the beginning of the discussion (see Harris, 1983).

However, the emergence of complexity at the beginning of tool manufacture is still incompatible with traditional Darwinian ideas. Semaw et al. (1997), despite acknowledging this elaborate technology at 2.5 Ma, claim that the Oldowan is conceptually more simple compared to the Acheulian, which show elements of more specific and pre-conceived design. They also predict that older artefacts will be found, more simple in concept and design than the 2.5 Oldowan tools. This will make the complexity documented at 2.5 Ma more understandable from an “evolutionary” point of view.

In the present work, we introduce new elements for this debate. The 1.6–1.4 Ma Oldowan industry of Peninj is presented showing elements of much more complexity than reported so far. This calls for a revision of the Oldowan. Either the Oldowan is conceived of as complex as some later industries both in concept and in elaboration or the younger Oldowan (circa 1.5 Ma) is clearly different from the traditional older Oldowan (2.5–1.7 Ma), questioning the one-million-year old stasis defended by some researchers (Semaw et al., 1997).

Location, analysis of the sample and results

Presently, research at Peninj (West of Lake Natron, Tanzania) is being carried out in three geographical areas: North Escarpment (NE), South Escarpment (SE) and Type Section (Fig. 1). The first two areas are more distant to the former paleo-lake than the latter. In those two areas, sites devoid of fauna and containing Acheulian stone tools have been discovered. Type Section is, conversely, situated in a deltaic paleoenvironment.
close to the former lake shoreline. Sites in Type Section preserve dense concentrations of bones and lithic tools ascribed to the Oldowan industry. Previous publications (Isaac, 1965, 1967; Domínguez-Rodrigo et al., 2001a) have paid special attention to the Acheulian sites discovered in the region. The present work is the first contribution to the systematic study of the Oldowan technology of Peninj, thus far unpublished.

In this work, the Oldowan assemblages analyzed come from a determined area in Type Section: The ST Site Complex. This site complex is composed of a pene-contemporary cluster of 11 archaeological sites, which share the following properties: similar stratigraphic position on the same paleosol, similar taphonomic conditions and topographic proximity, since all these sites appear in a reduced area (Fig. 2). The ST Site Complex is situated in the Upper Sands with Clays of the Humbu Formation, on a sandy context overlying Tuff 1 (T1). T1 is widely exposed in most of the outcrops, over an area comprising almost 75% of Type Section. The archaeological materials appear on a paleosol right on the surface of the tuff in most of the area, except when the tuff is eroded or cut through by river channels. In this case, artifacts and fauna appear in sandy clays and sands. A channel, which originated in the northwest,
across ST4 and by ST3, two of the main sites. Other smaller streams joined this main channel. The direction of relief is north-south. Another feature that makes the ST site complex remarkable is not only its peculiar spatial distribution, but its occurrence right on the surface of a tuff. The redundant stratigraphic situation of all the archaeological sites of the ST complex on the surface of T1, suggests that all the sites were deposited on the same paleosol. This could make it a complex of sites spanning circa 3.500 m² of outcrops exposed. For more specific information regarding the sedimentary, stratigraphic, taphonomic and zooarchaeological characteristics of the ST Site Complex see Domínguez-Rodrigo et al. (2002). Radiometric dating (Manega, 1993; Isaac and Curtis, 1974), paleomagnetic dating (Thouveny and Taïeb, 1986, 1987), and biostratigraphic correlations (Geraads, 1987; Denys, 1987; Domínguez-Rodrigo, 1996) place these archaeological sites in the 1.6–1.4 Ma interval (Domínguez-Rodrigo et al., 2001a, 2001b, 2002).

**Raw materials**

The difraction X-ray analyses and the mineralogical analyses have resulted in the identification of several types of basalt (basanites, aphyric basalts, hawaiian basalts and aphytic basaltic tuffs), as well as piroxenic nephelinites and quartz, in the ST Site Complex. However, the internal variability of the rocks cannot be macroscopically distinguished. Due to this reason, only three types of raw materials are clearly differentiated de viso: basalt, quartz and nephelinite. Quartz is the most difficult raw material, of those represented, to be transformed through an organized knapping process. A large variability in the properties of the basalts that hominids used in Type Section has
Some artefacts were elaborated from very fine-grained basalts, which are very apt for flaking. Other basalts are very porous, thick-grained and with internal irregularities. Conchoidal fractures would have been very hard to obtain from this type of basalts. Nephelinite must have been highly appreciated by hominids, since it is fine-grained and produces very sharp-edged tools without internal vesicular irregularities. Thus, nephelinites and some basalts were the most adequate raw materials for tool elaboration.

Raw material sources have not yet been precisely identified. As pointed out previously (Domínguez-Rodrigo et al., 2002), Type Section is composed of deltaic sediments. Depositional energy is, thus, very low and the sedimentary matrix is fairly fine-grained, missing conglomerate deposits. So far, no gravel or conglomerate level exposed during the formation of the Humbu Formation has been discovered. Raw material sources are so far unknown, but they must have been transported into the area from outside the two-mile radius occupied by Type Section. Nephelinite might be an exception. Raw material sources have been identified in the mid-course of the Peninj river and in the Shirere Hills, both 12 km. away from Type Section.

The information available can be used to support the hypothesis of a differential use of raw materials by hominids. Basalt is the predominant raw material type in the ST Site Complex, comprising 74.3% of the total number of stone artefacts. Nephelinite is represented by 16.9% of all the lithic tools. The presence of quartz is smaller (8.6%), although in some sites, such as ST2E or ST3, it is more abundant than nephelinite (Table 1).

With respect to the representation of raw materials according to artefact type (Fig. 3), quartz seems to have been used mostly for hammerstones. This fact is not unique of the ST Site Complex. It has also been documented for other Plio-Pleistocene sites. It has been suggested (Schick and Toth, 1994; Ludwig and Harris, 1998) that during the Oldowan, there exists a clear preference for quartz hammerstones by hominids, because of its plasticity with which this raw material absorbs impacts. The remaining tool types are evenly made in basalt and nephelinite. Detached pieces (flakes, debris and flake fragments) are mostly made of basalt (75.4%), nephelinite (18.4%) and quartz (5.3%). Light-duty tools are also distributed, according to raw material type, in similar percentages: basalt (77.8%), nephelinite (18.5%) and quartz (3.7%). Cores are made in basalt (72.4%), nephelinite (24.1%) and quartz (3.4%). Therefore, raw material use in the ST Site Complex is similar to its distribution in the landscape. Basalt is the most abundant rock type. Nephelinite and quartz are more geographically located and limited in distribution. Their exploitation by hominids, thus, was more ocassional.

### Tool types

Detached pieces are the most abundant tool type (Fig. 4 and Table 2) in all the lithic assemblages from the ST Site Complex. They make up 66.4% of the total number of artefacts. Flake fragments are predominant (30.5%), followed by complete flakes (21.5%). Debris (6.5%) is scarcer, being represented by a smaller amount than expected from experimental replication (Schick, 1984). This may support a slight taphonomic bias in the preservation of lithic components of the assemblages in the ST Site Complex.

Cores are represented by 8.2% of all the artefacts retrieved. This representation is indicative of
in situ knapping at sites. There is a core:flake index of 7.3 flakes per core. This is in accordance with the mean number of negative scars that can be observed on cores. However, most cores have been highly reduced, which suggests that negative scar count does not realistically reflect the number of flakes that were originally obtained from them.

Retouched flakes constitute 7.9% of the ST Site Complex lithic assemblage. Approximately 22% of these retouched pieces were made from complete flakes. The remaining retouched artefacts were made on flake fragments. The size of these retouched tools is similar to the average size of regular flakes (Table 3). Light-duty side scrapers (*sensu* Leakey, 1971) are the most abundant retouched elements (71.4%), followed by notches (17.8%) and endscrapers (7.1%) (Fig. 5).

Despite its scarce representation (7.1%), it is important to stress the presence of burins, rarely mentioned in Oldowan assemblages and never numerous in those sites in which they are supposedly documented, such as at Olduvai (Leakey, 1971; see Potts 1991 for a different view). Several retouched pieces are also composite tools. The associate forms that appear on the same tool are: sidescrapers and notches, sidescrapers and endscrapers and sidescrapers and burins.

Flakes are 4 cm long on average (Table 3). Their quadrangular shape is even in all the assemblages from the ST Site Complex. This is indicative of both similar flaking processes and homogeneous core volumes in all these sites. Pieces showing cortical surfaces are rare. Only 20.6% of flakes and flake fragments show some cortical areas and none of them belong to the initial flaking stage. The application of Toth’s (1982) flake types shows a predominance of regular non-cortical flakes (Type VI) and the absence of flakes with dorsal
surfaces covered by cortex (Types I and IV) (Fig. 6). Flake type distribution is also similar in all the ST sites (Table 4).

In summary, the low percentages of elements with some cortex is indicative of the lack of representation of the initial flaking stages of cores at sites. Knapping and tool making is supported by the presence of cores, hammerstones and rejuvenation flakes. However, the lack of Toth’s (1982) types I and IV suggests that the initial flaking of cores took place somewhere else outside the ST Site Complex. The technological attributes of flakes also supports this. Approximately, 90.9% of the striking platform of flakes show no cortex at all. This indicates that either the striking platform was prepared before flaking or that previous flakes had been obtained in the same direction. Striking platforms are mostly uni-facial (79%), although bifacial (8.4%) and multi-facial (3.5%) striking platforms are also documented, suggesting that there was a redundant care in the extraction of flakes with determined characteristics (Fig. 7). The analysis of the dorsal surfaces of flakes is also relevant to reconstruct the technological strategies used by hominids. More than 70% of the flakes analysed show 3 or more negative scars from previous flaking (see Fig. 8). The presence of these previous flaking does not show per se the complexity of the knapping process. However, the high percentage of flakes this type indicates that hominids were repeatedly exploiting the same flaking surfaces. This undoubtedly is uncommon.
in a non-systematic tool production such as has been proposed for the Oldowan tradition (i.e., Wynn, 1981, 1993).

The striking platform of a core can be defined as the surface used to strike flakes off it. The flaking surface is the one receiving the percussion and resulting in the flake detachment. The directionality of previous flaking on the dorsal surfaces of flakes can also be used to reconstruct the knapping process used by hominids. As can be seen in Fig. 9, most dorsal sides show unidirectional exploitation schemes (unipolar and bipolar) (70.3%). Thus, a substantial amount of these flakes show a longitudinal flaking direction with respect to the striking platform. The flaking surface exploited was systematically reduced from the same direction (unipolar). In this exploitation category, flakes showing a bipolar strategy are also widely documented. In this case, two opposite striking platforms were used to extract, in a parallel way, flakes from the same flaking surface.

However, a large number of flakes (29.7%) suggest a more complex strategy. As can be observed in Fig. 9, the presence of previous flaking that was carried out in a perpendicular way documents a redundant rotation of the flaking surface. This rotation is evident in the last examples of Fig. 9, where a completely centripetal exploitation strategy is clearly observed. In this case, flakes have been extracted from the periphery of the core. Some of these flakes even show dorsal scars indicating previous radial flaking, which are similar in concept to more recent exploitation strategies documented in the late Middle Pleistocene and early Upper Pleistocene.

The exploitation strategies in the ST Site Complex lithic assemblage

The study of the cores from the ST Site Complex can also yield important information regarding the exploitation of lithic resources by hominids. There have been few attempts to classify Oldowan cores. The traditional perspective (i.e., Leakey, 1971) does not pay special attention to cores, since it includes choppers, polyhedrons, discoids and heavy-duty scrapers in the tool type category. More recent works (Toth, 1982, 1985;
Isaac et al., 1997; Ludwig, 1999) analyze cores according to relevant attributes, such as the unifacial or bifacial character of the pieces or the directionality of flaking. Despite this important innovation, a systematic classification of the core flaking strategies during the Oldowan has not been carried out. We have incorporated a core classification based on the consideration of cores as geometric volumes in which, at least, six schematic surfaces have been differentiated. Flaking on these surfaces and the resulting interaction among them result in unifacial, bifacial, trifacial and multifacial systems. The directionality of flaking allows the distinction of unipolar, bipolar and centripetal strategies. The angle formed by the intersection of the different exploited surfaces can be described as simple or as abrupt. Considering all these attributes together, the exploitation strategies followed by hominids and documented in the ST site lithic assemblage are (Fig. 10):
Type 1. Unifacial simple partial exploitation. It is represented by choppers. Flaking takes place on a surface generated by the natural or cortical plane. The striking platform and the flaking surface adopt an acute angle; that is, the edge appears only on part of the perimeter of the core.

Type 2. Unifacial centripetal exploitation. It consists of the exploitation of the horizontal plane from both the sagittal and transversal planes. Flaking is carried out from unprepared striking surfaces. It is differentiated from Type 1 in the development of the edge, which now occupies all the perimeter of the core. In addition, the only exploitation (flaking) surface is generated through radial flaking.

![Figure 6. Representation of the different types of flakes in the ST site complex, according to Toth's (1982) classification.](image)

![Table 4. Distribution of the different types of flakes, according to Toth's (1982) classification method.](table)

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Type 3. Unifacial abrupt exploitation. It can also be defined as the exploitation of the transversal and/or sagittal plane from one or two of the horizontal planes. Thus, from natural or prepared striking platforms, parallel and longitudinal flakes are obtained. The flaking surface forms a straight percussion angle with respect to the striking platform.

Type 4. Bifacial partial exploitation. It is the strategy documented for chopping tools or bifacial choppers (Leakey, 1971). The negative scars of flaking on one plane are used as the striking surface to flake the adjacent plane. A configuration edge is obtained this way with a simple angle. The edge occupies only a determined area of the piece and not all its perimeter.

Type 5. Bifacial hierarchical centripetal exploitation. The geometric volume of these cores is divided into two asymmetrical convex surfaces which share an intersection plane. The surfaces are hierarchical; the subordinate surface acts as a preparation plane to obtain the radial flakes that characterize the main surface. Besides, the striking surface is oriented with respect to the flaking surface in a way in which the edge created by the intersection of both surfaces is perpendicular to the knapping axis of the centripetal flaking.

Type 6. Multi-facial irregular exploitation. This group is constituted by the cores that present several exploitation surfaces without a clear organization in the reduction process. In the ST Site Complex, cores of this category are always small-sized and with hardly any cortex. This suggests that they may be overexploited cores which could have been more systematically flaked in a previous stage of the reduction sequence.

Type 7. Polyhedral exploitation. It is similar to type 6. It consists of cores exploited from
several planes or striking surfaces. However, in this case, it is supposed that the striking surfaces are intentionally chosen to shape the artefact. The tendency is for cores to become spherical (Willoughby, 1987). Some researchers think that these polyhedrons are just unintentionally elaborated and result from a regular reduction sequence (Potts, 1991; Schick and Toth, 1994; Sahnouni et al., 1997). Others, like Isaac (1986) stress the complexity in the elaboration of these polyhedral forms. Texier and Roche (1995) think that they are the result of a complex planned sequence and not just the anecdotal result of the flaking process.

None of these types of exploitation are predominant in the ST Site Complex lithic assemblage. Therefore, even if the hierarchical centripetal exploitation is the most common strategy used by the Peninj hominids (30%), type 3 (unifacial abrupt) is also frequently represented (20%), as well as type 6 (multi-facial irregular) (20%) and type 2 (unifacial centripetal) (16.7%). Unifacial choppers (type 1), bifacial choppers (type 4) and polyhedrons (type 7) are poorly represented (3.3%, 6.7%, and 3.3%, respectively). This makes Peninj very different from the tool type distribution observed at Olduvai (Leakey, 1971), where choppers and polyhedrons are always a relevant proportion of the Oldowan assemblages, and from Koobi Fora (Isaac et al., 1997).

Basalt has been more extensively used in all the exploitation strategies. The only exception in which nephelinite becomes more abundant than basalt is in the representation of the multi-facial irregular cores, with 50% and 33.3% respectively of the cores of this category. Its interpretation is

Fig. 8. Percentages of the amount of negative scars on the dorsal sides of the flakes from the ST site complex.
simple. It was mentioned above that nephelinite was appreciated by hominids both because of its scarcity and flaking properties. It was also suggested that the most exploited cores at the ST Site Complex systematically correspond to those made in nephelinite. This is also supported by their dimensions; nephelinite cores are much smaller than the basalt ones, as would correspond to an intensive use of alloctonous raw material.

The technology of the ST Site Complex

The bifacial hierarchical centripetal strategy of core exploitation (type 5, our classification) is quite unexpected for the Oldowan technology. This flaking technology is fairly complex, since a bifacial flaking process is obtained through the creation of an artificial edge of configuration, keeping this structure throughout all the flaking process. This bifacial structure is not maintained by simply alternating the impacts on both sides (discoid method), but through the configuration of one of the surfaces as a subordinate plane used to exploit the principal surface. The maintenance of the adequate convexities of such a surface is a key part of the process. This explains the redundancy in creating rejuvenation flakes used to recreate the necessary angles and to continue reducing the core until its exploitation is not feasible anymore (Fig. 11). This process is documented by several examples from the ST Site Complex. This is an extremely important (and unexpected) fact, because it reveals that hominids had the capabilities to undertake complex reduction processes from a bifacial edge and to keep them through the whole flaking sequence. The technical and conceptual skills implicit are evident.

The definition in the previous section of the present work of this bifacial method as hierarchical centripetal was based on several criteria first outlined by Boëda (1988, 1993, 1994, 1995) for the identification of the Levallois method (for a summary of Boëda’s ideas see Chazan, 1997 and also, Schlanger, 1996). According to the volumetric conception of the Levallois method, “the core is divided into two different adjacent surfaces with opposing convexities and whose intersection indicates the plane from which pre-determined flaking will take place. One of the surfaces (Levallois preparation surface) shows distal and lateral
convexities capable of guiding the extraction of a pre-determined flake. The other surface (preparation plane of the striking platform) acts as a striking surface for the flaking of the pre-determinant and pre-determined detached pieces. The discontinuity between the Levallois
surface and the striking surface results in none of the surfaces being able to be enlarged since both depend on each other. Thus, the capability of producing pre-determined flakes from a Levallois core is reduced to the volume of the core comprised between the Levallois preparation surface and the plane in which both surfaces are intersected” (Boëda, 1988: 42; 1994:13).
This definition is accompanied by 6 criteria which Boëda considers essential to the concept of Levallois. When applying these criteria (see Boëda 1993:393–394; 1994:255; 1995:46–48; Chazan, 1997:724) to the ST Site Complex lithic assemblage, the Oldowan collection from Peninj shows most of them. As can be seen in the Fig. 12, the artefacts from Peninj have two different surfaces with an intersection plane that divides them. The surfaces are hierarchical; one is the principal exploitation surface (flaking surface) and the other becomes the preparation surface (striking platform). This structure is preserved throughout all the reduction sequence. The hierarchical centripetal cores from Peninj show a subordinate surface with secant flakes with respect to the edge created by both surfaces. The aim of this process is the preparation of flake extraction on the main flaking surface. Besides, the extraction planes of the centripetal flaking process are parallel or sub-parallel to the plane created by the intersection of both surfaces. Both of them are obtained through direct percussion with hard hammer.

This process seems to be aimed at obtaining pre-determined flakes (Fig. 13). By pre-determination, it is understood the application of some specific technical criteria which condition the way that a flake is detached from the core. For this purpose, the flaking surface must adopt a lateral and distal convex shape which will guide the fracture waves. This conception does not involve...
the attainment of symmetrical morphologies. For the Peninj Oldowan industries, the idea of the Levallois core obtained by multiple flaking, or Levallois core of recurrent centripetal flaking (Boëda, 1993, 1994) is applicable. These “Levallois” cores are conceived of as a volume presenting negatives of previous successive flaking on all their flaking surface. In this method, the flaking surface of each of the detached pieces is parallel to the plane of intersection of both surfaces. This is different from the previous flaking on the striking platform which shows secant planes or planes of intersection between both surfaces. From this perspective, and after having exposed some of the characteristics of some of the cores from the ST Site Complex, we think that the use of the definition “hierarchical centripetal exploitation strategy” is merely an euphemism for what is more commonly understood as the Levallois recurrent centripetal method.

Fig. 13. Some examples of pre-determined flakes in the ST site complex. These are understood as those flaking products with a longitudinal symmetry bearing a cutting edge around all the perimeter but the striking platform. The negative scars on the dorsal sides show the structure of the debitage surface (Boëda, 1994: 6).
If Boëda’s definition is applied, the technology of the Peninj assemblage would be similar to the Levallois technology; a strategy seemingly typical of later periods. This similarity is observed not only when applying Boëda’s criteria, but also when applying the Levallois phases as defined by Van Peer (1992). According to him, in the Levallois cores, the original volume is conceived as an asymmetrical opposition between two surfaces. Thus, the volume of the striking platform is larger than that used for the flaking surface. Therefore, through the whole reduction sequence, the core assumes an asymmetrical profile. From the beginning of flaking, each surface adopts a specific role (striking-flaking) not being exchangeable during the core reduction process. This can be observed in Fig. 11, where some Peninj cores belonging to different phases of the reduction sequence can be observed to show the same exploitation system with the same flaking surfaces. As pointed out by Van Peer (1992), this implies that the volume available for flaking is restricted during all the flaking process, being limited to the plane that divides both surfaces of the core. From these initial conditions, the core reduction method can be that of preferential flake, recurrent centripetal, etc... Once more, the concepts proposed to define Levallois coincide with the features represented in the Peninj Oldowan. The flaking process at Peninj shows continuous stabilization of the hierarchy of both surfaces. This indicates planning in the core flaking sequence.

To sum up, the originality of the Levallois concept resides in the volumetric conception of the core to which the technical criteria of premeditation are added (Boëda, 1994; Schlanger, 1996). Predetermination is defined here as a set of technical criteria applied to a core to control the flaking process by guiding the fracture wave through the surface to obtain a predetermined detached piece. This predetermination is not specific of the Levallois method, as pointed out by Boëda (1994), Slimak (1998–1999), and Tuffreau (1995) among others. For this reason, the name applied to the technique documented at Peninj is irrelevant. Slimak (1998–1999), for instance, argues that it is absurd to multiply the definitions. For Slimak, the technological similarity between the discoid and the Levallois recurrent centripetal method allows one to identify both methods in a concept similar to what could be termed recurrent centripetal method (see a contrary view in Boëda, 1993, 1994).

It might not be very useful to discuss what can be truly considered Levallois. It is an old debate still unresolved (see Dibble and Bar-Yosef, 1995; Perpère, 1986; Chazan, 1997; Van Peer, 1992 for a summary of the different trends). The technology displayed by the Peninj hominids is fairly complex. Whether this clearly structured and planned set of strategies can be defined as Levallois or not is not relevant, as long as the complexity of the processes implied is assumed. This clashes against the traditional view of the Oldowan as a simple expedient lithic industry (i.e., Wynn, 1981, 1993; Wynn and McGrew, 1989).

Discussion

The co-occurrence of Oldowan and Acheulian sites in East Africa between 1.6 Ma and 1.4 Ma is documented in areas like Chesowanja (Gowlett et al., 1981), Konso Gardula (Asfaw et al., 1992), East Turkana (Isaac et al., 1997), Nyabusosi (Texier, 1995), Gadeb (Clark and Kurashina, 1976), Middle Awash (Clark et al., 1984; de Heinzelin et al., 2000), Melka Kunturé (Chavaillon et al., 1978), Olduvai (Leakey, 1971) and Peninj (Isaac, 1965; Dominguez-Rodrigo et al., 2001a). Given the discoveries described at Peninj, the possibility of finding industries of the characteristics identified in the present work in other contemporary sites must be addressed. Otherwise, the industry from the ST Site Complex would be an exception and the technology used by hominids would just be anomaly.

Some indications that the complexity discovered at Peninj could be more widespread can be observed in some comments, such as Gowlett’s, who discussing about the Olduvai discoids pointed out that “they are bifacially worked around the whole circumference, radially flaked, and reasonably regular in shape. We could, tongue in cheek, regard them as the earliest Mousterian disc-cores, or they may be completed core-tools” (Gowlett, 1986: 251). These words show that Gowlett himself did not
really believe the background of his comments regarding the similarity of the Oldowan discoids to the flaking methods from the Middle Paleolithic, given their anachronism. Years later, Davidson and Noble (1993) argued about the meaning of the emergence of the Levallois method. These authors comment that Gowlett (1986) was very discreet in his comparison of the Olduvai materials with the Middle Palolithic stone tool technologies, given one of the most widely accepted views, which assumes a unilinear technological progress associated to the biological evolutionary sequence. It would begin with the Oldowan and would end with the leptolithic industries from the Upper Paleolithic. However, if assuming that the Olduvai Bed I and Bed II discoids are core artefacts similar to those documented in Middle Paleolithic contexts, then “the production of “prepared cores” seems to have been one of the earliest forms of stone working in the hominid experience, yet the conventional narrative has seen this as a phenomenon emerging after a million or so years of gradual elaboration of technological sophistication” (Davidson and Noble, 1993: 377). Thus if, “it is reasonable to suggest that the technique indicated by the flaking of discoids at the lowest levels of Olduvai became more important as the dominant means of producing flakes in the Mousterian” (Davidson and Noble, 1993: 378), it would not be too far-fetched to defend a similar lithic exploitation strategy for the Peninj Oldowan.

The analysis of an assemblage of similar chronology to those of Peninj, carried out by Texier (1995, 1997) at Nyabusosi, yields similar results. Texier states that “taking into account the age of this assemblage, it is quite surprising to note that numerous cores display a preferential surface of exploitation with a radial organization of debitage. In most cases, the cores also display carefully prepared striking platforms: technological features which are more familiar to us during the Middle Paleolithic rather than circa 1.5 Ma” (Texier, 1995: 650). In the Nyabusosi assemblage, a partial or peripheral striking surface was prepared by hominids with which an adequate angle to produce flakes from the principal flaking surface was obtained. The convex shape of the latter was maintained along the flaking process. To sum up, “if the knapper is able to organize a debitage and to produce one or several series of recurrent flakes at the expense of the same surface of exploitation and, if he is able to repeat these processes, this demonstrates that at this technological level, he has already a good skill and knows exactly the consequences of a strike given to such a core. To sum up, this is a minimal definition of the concept of determination” (Texier, 1995: 652).

Not many researchers are currently critical to the classical paradigm which still defends the technological simplicity of the Oldowan industry. However, it is likely that forthcoming works will modify this traditional interpretation. Current research in archaeological areas crucial for the understanding of the emergence of stone tool technology such as in Gona (Semaw, 2000) or West Turkana (Roche et al., 1999) and in later assemblages such as Nyabusosi (Texier, 1995) or Peninj (this paper) converge towards a similar idea: the Oldowan is more complex than has traditionally been considered.

Conclusions

The analysis presented in this work suggests that the industry from the ST Site Complex of Peninj corresponds mostly to flaking activities carried out at sites. This is inferred by the predominance of flakes and cores. The initial stages of the operational chain (raw material obtainment, initial core flaking) are absent. These unrepresented phases were probably carried out outside the ST Site Complex area. This process must have included not only the initial reduction of cores, but also posterior flaking stages, since the percentage of flakes showing some cortex is always low. However, flaking activities in situ are clearly documented as suggested by the presence of Siret fractures, the abundance of flakes and cores and the presence of hammerstones. These flaking activities were very likely related to carcass processing behaviors, as indicated by the close spatial association of bones and stone tools and the presence of cut-marked bone specimens (Dominguez-Rodrigo et al., 2002). In summary, the operational chain represented in the ST
Site Complex is partial, with several stages missing. Some missed stages can be attributed to taphonomic processes, such as the low percentage of debris. Others, such as the scarce representation of cortical elements are due to behavioural processes.

It is difficult to evaluate the uniqueness of Peninj in the African Oldowan stone tool technology during the early Pleistocene. However, we think that Peninj shows the main features that are common to complex technological strategies, such as planning the core flaking process following a pre-determined exploitation method and maintaining the same reduction process during all the flaking sequence. This system is aimed at obtaining pre-determined detached pieces. This is obtained by the reactivation of the convexities through the systematic rejuvenation of the cores. This pre-determination is similar to the Levallois method, which modifies raw materials from a volumetric conception of cores. It is not our intention to claim that the Oldowan from Peninj is identical to the classical Levallois method as observed in the Nile, the Near East or France. Clearly, they are not the same exploitation method. However, the cognitive processes, the technical knowledge and the manual dexterity behind both strategies are the same.

As suggested by Pigeot (1991) and Slimak (1998–1999), discoids methods, the Levallois method and other similar methods must be grouped in a unique method defined as recurrent centripetal. In fact, it is very likely that their wide geographic and chronological distribution are due to a stable mechanism and economic variables (Brantingham and Kuhn, 2001; Otte, 1995). Irrespective of this, all these methods require what is called technical pre-determination. That is, the tool maker must have a template image previous to tool elaboration and must also have the technical dexterity to obtain the product thus conceived through a previous preparation of the core, by following a flaking sequence that is adapted to each flaking step. This assumption makes it necessary to explicitly recognize the presence of mental abstraction and planning templates -and, therefore, a great cognitive potential- in the minds of hominids.

All this is documented in the ST Site Complex of Peninj. The hominids that occupied the lake Natron basin 1.6–1.4 M.a. had the technological dexterity and the cognitive skills necessary to exploit rationally the highly appreciated lithic resources. This case renders it necessary to revise the technology of traditional Oldowan industries and the cognitive and behavioural inferences for Plio-Pleistocene hominids drawn thereof.

Then, maybe the gradual evolution of stone tool industries very often tightly linked to the biological evolution of hominids (i.e., Foley and Lahr, 1997) must be criticized in favor of a more punctuated approach.

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