Prehistoric archaeology

Methodology

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The study of the Early Stone Age in Eastern Africa, as at Olduvai, Koobi Fora or Melka Kunture, has allowed a precise statement of morphology and typology to be made. In particular, much has been gained from research on the percussion material and tools on pebble.

As has been often mentioned in articles and textbooks, the study of the lithic material on pebbles or cores has been clarified, modified and developed according to the various types and their frequency.

In this chapter dedicated to methodology, the following will be addressed:

I - definition of tool types and lithic material studied in this monograph.

II - definition of modules and indices used in the study of the lithic material.

Definition and method of analysis of tool types

We identify several tool classes: pebbles linked to percussion, flaked and trimmed pebbles, handaxes, cleavers, cores and tools on flake.

Only types present in the Oldowan are examined, namely the percussion material, flaked pebbles, cores, débitage and tools on flake. Handaxe typology is addressed only briefly.

Percussion material

For the past several decades, percussion material has been classified according to C. Van Riet Lowe (1952) and P. Biberson (1967). In addition, M.D. Leakey studied it under the general term "utilized material" in her book on Olduvai Gorge Bed I and Bed II (Leakey 1971). In France, R.A. Fournier of H. de Lumley's team, dedicated work on this subject using material from Terra Amata (Fournier 1973) and Vallonnet cave (Lumley *et al.* 1988). Finally, J. Chavaillon has presented a method for studying hammerstones and battered and broken pebbles. The following definitions and proposals come from Chavaillon 1979b.

1. Archaeological Mission Melka Kunture.

Hammerstones and battered pebbles

These are pebbles or stones with fairly numerous impact marks on one or several faces. The distinction between hammerstones and battered pebbles depends on the abundance or paucity of impact marks as well as on their distribution on the pebble.

A - Active hammerstone

This is the classic hammerstone of Prehistory manuals. It was hand-held and was directed at another pebble, bone or branch. It is a stone hammer or hammerstone. The shape can be regular or not, ovate or round, but can also have several facets. Impact marks are generally numerous. They can be scattered or grouped, for example at the extremities of an ovate pebble or at the meeting of several ridges.

B - Passive hammerstone

The active hammerstone delivers the blow and is mobile. By contrast, the passive hammerstone is not moved; the object to be smashed is projected onto the hammerstone. It is what is sometimes called an anvil when the dimensions are large.

The one is small and hand-held. It is sometimes quadrangular or polygonal in shape; the upper surface is more or less flat and the sides are abrupt or vertical. Impact marks are apparent on the sides and ridges.

The other is the anvil: it is a heavy block and generally has a large and stable base. There are abundant impact marks on the upper surface, ridges or end.

C - Pitted hammerstone

This can be an active or passive artefact, of small or large dimensions. It shows one or several concavities or pits a few centimetres in diameter and fairly deep. It is a hammerstone that has been used on the same spot several times.

D - Battered pebble

This is a pebble with fewer impact marks. It is a chance hammerstone used once or several times and rejected. It is a stone hastily taken to break a bone, a branch or nuts, but abandoned because its shape, weight, or nature is not quite suitable.

If hammerstones are authentic and incontestable tools, battered pebbles can be considered as temporary, sometimes accidental, tools.

It is not always possible to distinguish between a pebble battered by a person and one modified by river action when a camp site has been set up on a pebble beach. However, although we must be strict when it concerns a living floor, especially on a pebble beach, we cannot neglect the fact that the proportion of these artefacts and their functional qualities are useful indications for learning about the activities of Oldowan human groups.

Study of percussion marks

Both battered pebbles and hammerstones are studied in the same way under four main headings:

Percussion type

- percussion can be *punctate* or *punctiform*: impact marks very localised and sparse;
- percussion can be *linear*: for example, impacts marks along a ridge;

- percussion can be *diffuse*: these are crush marks that can be seen on one face or one end. Diffuse percussion, often seen on the same spot, can lead to the formation of pits.

Type of percussion marks

Marks can be small flake removals, scaling, or crushing that forms a pit when it is intensified.

Location of the percussion

Percussion marks can be located on a ridge, or on an extremity or on a flat surface. Percussion marks can cover nearly the whole pebble or be limited to a smaller area.

Impact mark distribution and importance

The marks can be concentrated in one, two or more zones.

Broken pebbles

These are pebbles with one, two, three or more fractures. We must be conscious of the fact that some pebbles may have been naturally broken. As with battered pebbles, we must be restricted to the collection and study of artefacts coming from living sites. In addition, only sharp fractures are accepted and fractures with rounded edges will not be taken into account. We have also excluded pebbles broken by spalling of the rock through chemical alteration or thermal action.

Classification is simple: broken pebbles with one, two, three and more fractures, and variable dimensions, weight and raw material.

The study of broken pebbles mainly consists of examining the fracture, that is to say its quality and position on the pebble.

The pebble is examined as it is, and not as it might have been before it was broken. Three attribute sets were examined.

A - Position of the fracture in relation to the main axis

This is the situation of the fracture regarding axis L, that is to say the maximum length considered in Length x width (L/w):

- the fracture can be *longitudinal*, that is to say parallel with the long axis or merging with the long axis;
- the fracture can be *transverse*, that is to say perpendicular to the longest axis;
- the fracture can be *oblique* and the angle formed by the longest axis and the edge of the fracture is acute.

B - Position of the fracture in relation to the L/w plane

This is the orientation of the fracture in relation to the L/w plane:

- the fracture can be *parallel* to the L/w plane. It represents then one of the pebble faces but, when partial, can only occupy one side;
- the fracture can be *perpendicular* to the plane and constitute one of the edges of the pebble.
- the fracture can be *inclined*. The angle formed by the surface of the fracture and one of the main faces of the pebble (in the L/w plan) is always acute or obtuse.

C - Morphological characteristics of the fracture

We can identify several characteristics to describe the state of the broken surface. It can be *flat*, *convex*, *concave*, *V-shaped* (that is to say angular) or *irregular*.

These three attribute sets allow for the definition of a fracture. They can be displayed in a table and show some characteristic associations.

Broken pebbles frequently bear impact marks: they can be abundant (on broken hammerstones) or few in number, in which case they are then often the marks of temporary use. The impact is sometimes visible on the edge of a pebble ridge. Usually the broken pebble is a battered pebble that has been fractured, possibly during use, and on which fragments have been scattered over a restricted surface. The refittings made are proof of it. Finally, we must point out that some broken pebbles can have impact marks obtained after the fracture. This is particularly clear when the marks occur on one of the broken surfaces.

When the pebble shows two or more fractures, we note whether those fractures are joined or not. When they cross each other we look at the angle formed by the two facets with an acute, right or obtuse angle.

Fractures can occupy the whole of a surface and constitute the edge of the pebble; they can also be partial.

Tools on pebble

Prehistorians such as H. Alimen, L. Balout, P. Biberson, J. D. Clark, J. Chavaillon, N. Goren, J.W.K. Harris, Glyn Ll. Isaac, M.D. Leakey, H. de Lumley, H.L. Movius, H. Roche, and C. Van Riet Lowe, have been particularly interested in the study of flaked, trimmed pebbles, and tools on pebble. Several classifications have been proposed, particularly those of L. Ramendo (1963), P. Biberson (1967), M.D. Leakey (1971), J. Collina-Girard (1975) and H. Roche (1980). F. Bordes mainly studied handaxes and tools on flake (Bordes 1961).

The classification presented here and used for the study of Melka Kunture sites is partly inspired by previously published classifications. We kept some types or only modified the term and we were sometimes led to create others (Chavaillon and Chavaillon 1981).

We should not forget that some pieces on pebbles were previously intentional cores: core-choppers, polyhedron cores, even core-rabots. Tool-making can also yield quite suitable flakes that have been retrieved and sometimes trimmed as side-scrapers, end-scrapers, notches, etc.

*A - **Choppers***

Our definition is the following: choppers are trimmed pebbles with a working edge formed by unifacial or bifacial removals. The classification is based on the situation and form of the working edge: it is primarily functional. This definition is identical to that of M.D. Leakey (1971) but it is clearly different from that proposed by H.L. Movius (1957) who sees pieces with unifacial removals as *choppers* and pieces with bifacial removals as *chopping-tools*: the priority is given to the technique. Among various types of choppers, listed below, several are close or similar to those described by M.D. Leakey at Olduvai Gorge. In addition, some definitions proposed by J. Collina-Girard (1975) are not very different from those presented here.

Our choice to use this typology is mainly functional: we clearly thought it more important to separate pieces with functions as various, for example, as a lateral chopper, a pointed chopper, and a chopper with a peripheral working edge, than to put all these pieces in two categories based on the unifacial or bifacial character of the removals. We must be conscious that hominids living a million and a half years ago who trimmed those pieces perhaps did not give to the unifacial and bifacial characteristics the value we give it today. The aim was, on the contrary to obtain a certain type of efficient tool.

Our classification is thus based first on the shape of the active part and on the function and, secondly, on the technique. We accepted eleven categories or sub-types, as follows:

1. *Lateral chopper* (Fig. 1, *1*): It is the one with the longest edge which is partly or totally trimmed; it is M.D. Leakey's *side-chopper*.
2. *Distal chopper* (Fig. 1, *2*): The utilized edge is on the width and not on the length of the pebble. It is the same as the *end-chopper* or J. Collina-Girard's transverse chopper (or chopping-tool).
3. *Chisel chopper* (Fig. 1, *3*): The working edge is narrow and is situated in the width/thickness plane, either perpendicular or oblique to the upper and lower faces. The main characteristic of this piece is to show a very narrow working edge. It is a *chisel-edged-chopper*.
4. *Two-edged chopper* (Fig. 1, *4*): This type of chopper shows two sharp working edges that are not contiguous and are generally opposed.
5. *Chopper with truncations* (Fig. 1, *5*): This is a piece generally showing a lateral or distal working edge, but truncated at one or the other extremity by one or two removals or fractures. In this category are P. Biberson's pieces with one or two truncations. These pieces are technically advanced.
6. *Pointed chopper* (Fig. 1, *6*): The working edge is formed by the meeting of two convergent edges creating a point. The section of the point can be lozenge shaped or triangular. The angle formed by the two working edges is always acute.
7. *Chopper with peripheral working edge* (Fig. 1, *8*): The working edge can occupy the whole or only part of the pebble perimeter (generally over 50%). The retouch can be continuous or discontinuous. Some of M.D. Leakey's *discoids* are placed in this category.
8. *Lateral-distal chopper* (Fig. 1, *7*): This is a chopper showing two working edges in the length/width plane, one lateral and the other one distal, but joined. It is the same type as that described by J. Collina-Girard.
9. *Passive chopper*: We could just as well call it a dormant chopper. It is mostly a heavy piece that, laid on the ground, received the material that was meant to be broken (wood, bone, and possibly stone) on the sharp working edge.
10. *Atypical chopper*: This is a piece that cannot be classified into any other category.
11. *Casually trimmed chopper* (Fig. 1, *9*): This is a piece with rough and rare retouch. They are pebbles or stones showing some kind of natural working edge. Very small removals or basic retouch were sufficient to make these objects quite efficient.

The second criterion is technical: first, the flaking is unifacial or bifacial; then comes the working order. We took P. Biberson's classification as a model, but without keeping all his subdivisions:

simple unifacial chopper: with a single removal.
multiple unifacial chopper: with two or several removals on the same face.
simple bifacial chopper: with a removal on each face, either opposed or not. The formula is 1+1.
simple-multiple bifacial chopper: with a removal on one face and two or several on the other one. The formulas are: 1+2 or 1+n.
multiple bifacial chopper: with two or several removals on each face, so the formulas: 2+2 or 2+n or n+n.

A third characteristic recognised for some choppers was the aspect of the working edge. In profile, it can be straight or sinuous; viewed face-on (generally in the length/thickness plane except for the chisel chopper), it can be angular, in a broken line (chevron shape), convex, concave or irregular.

We have also established the ratio of the working edge length in relation to the maximum length of the object (lateral chopper) or of its maximum width (distal chopper). Finally the length of the utilized perimeter(Pu) in relation to the total perimeter (Pt) is an interesting indicator, particularly for choppers with a

peripheral working edge. Other characteristics have also been examined, such as a thick base or a base trimmed by a removal, a fracture, etc.

*B - **Polyhedrons***

"These are objects on which removals are neither uni or bi-directional, but were effected from several directions". The classification used is mainly morphological and can comprise pieces with very different uses. We regard the "partial or total trimming" characteristic as secondary. We shall describe only six types out of seven, for bolas are not present at Gombore I.

1. *Polyhedron with preferential working edge* (Fig. 2, *1*): It is a polyhedron with multidirectional removals showing peripheral working along the edge, often equatorial, partial or total.
2. *Polyhedron with several working edges* (Fig. 2, *2*): It is a polyhedron showing two or more working edges, most of the time partial.
3. *Pointed polyhedron* (Fig. 2, *3*): It is a sort of pyramidal polyhedron. The removals converge towards one pointed extremity opposed to a stocky base. The section at the point is often trihedral. The point has impact marks.
4. *Prismatic polyhedron* (Fig. 2, *4*): This polyhedron has a pentagonal or hexagonal form that can even be quadrilateral. Its edges are often parallel. Many prismatic polyhedrons could have been cores.

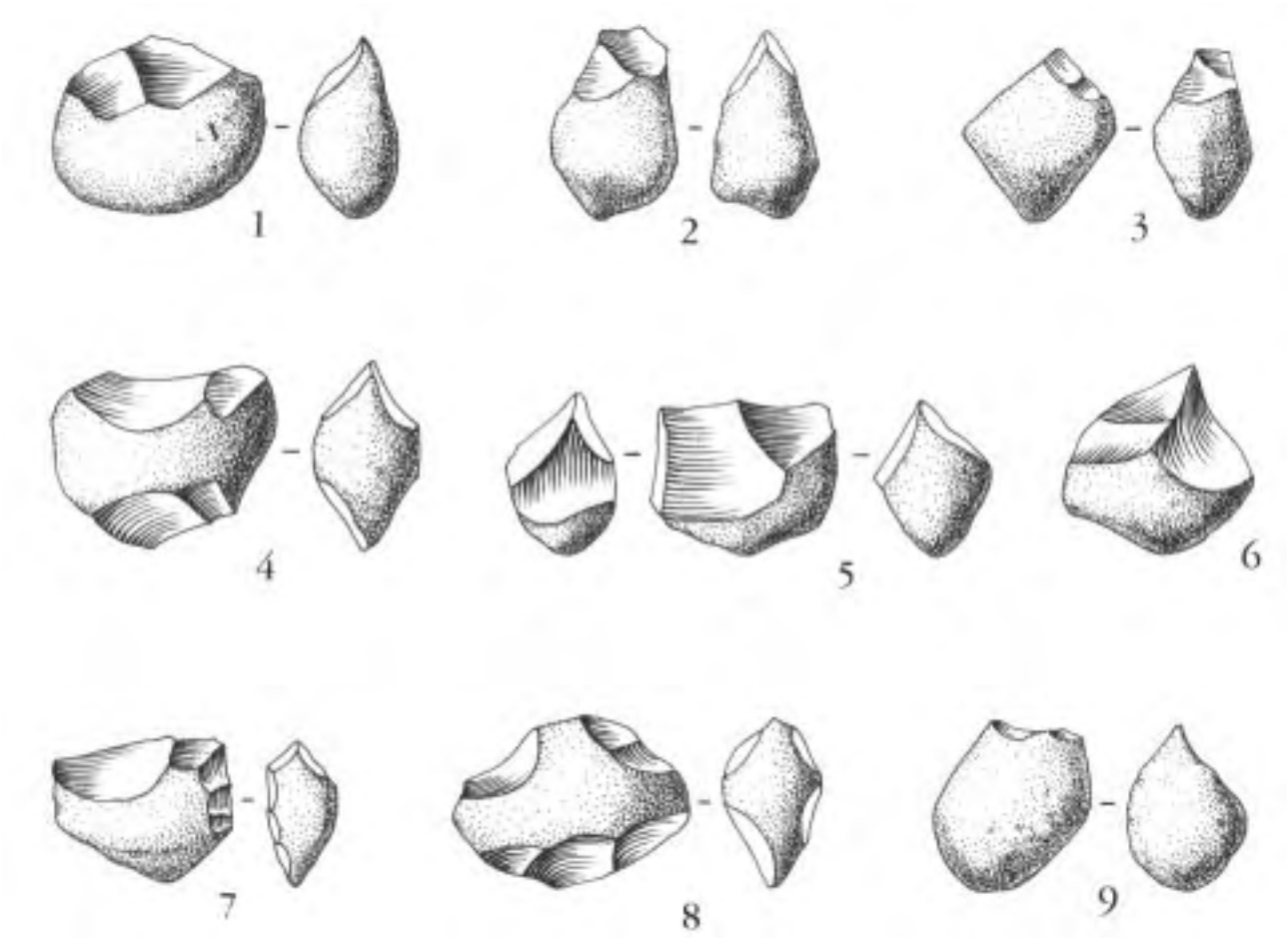

Fig. 1. The main types of choppers. 1: Lateral chopper; 2: Distal chopper; 3: Chisel chopper; 4: Two-edged chopper; 5: Chopper with truncation; 6: Pointed chopper; 7: Lateral-distal chopper; 8: Chopper with peripheral working edge; 9: Casually trimmed chopper. *Drawings by C. Chavaillon*

However, small, disorganised removals that could not have been usable flakes, as well as abundant impact marks on ridges, could indicate utilization other than that of simple cores.

5. *Spherical polyhedron* (Fig. 2, *5*): It is a piece with multidirectional removals forming a more or less regular polygon tending towards a sphere. It is like a facetted ball (Fig. 2, *6*; term used at Aïn Hanech, Algeria) on which ridges show obtuse angles (120° to 140°) marked by impact traces. These pieces can also have formerly been cores.
6. *Shapeless or sundry polyhedron*: It is a rag-bag category. They are pieces with multi-directional removals hard to link to other types.

*C - **End-scrapers on pebbles***

They are pieces classified no longer according to their form, but according to their assumed function. They mostly evoke similar tools trimmed on flakes. They comprise rabots and heavy end-scrapers.

- the *rabot* shows an active edge and a high front (Fig. 2, *7*).
- the *heavy end-scraper* has an inclined edge with a low front (Fig. 2, *8*).

These two tools have some characteristics in common, such as a flat or concave face, either cortical or retouched, on which impacts for the detachment of flakes created an abrupt and generally convex edge.

Secondly, we note partial utilization of the perimeter, with impact marks on the edge.

1. We have measured the angle value formed by the retouched edge and the flat face or platform.
   The *rabot* has an angle close to 90°.
   The *heavy end-scraper* has an angle often under 80° (close to 70°-75°).
2. We have also measured the height (h) of the plane front and of the end-scraper front. The ratio is the following (h x 100)/L. The length is L, or chord of the segment of the active part.
   The *rabot* shows a high front, with a high ratio 80°.
   The *heavy end-scraper* has a low front and the ratio is most often under 80°.

However, the most reliable criterion is the angle formed by the front of the end-scraper and the basal platform.

*D - **Various pebbles tools***

Some pieces, even if trimmed on pebbles, are reminiscent of tool on flake types and are functionally identical. People used the flat cortical face of a rather flat pebble as if it was the main flake surface of a flake. They are:

- *Beak on pebble*: A naturally flat surface or a fracture allows for the detachment of a series of more or less abrupt flakes to obtain a 'beak' flanked by two lateral notches.
- *Burin on pebble*: Often on a broken pebble, but the burin blow is clear and sometimes cuts into the cortical zone.
- *Notch on pebble*: This tool was manufactured on a flat pebble and shows identical characteristics to those on the flake equivalent.
- *Denticulate on pebble*: On a flat pebble one can see a lateral series of small notches, more or less joined, and that are generally rougher and larger than those on trimmed flakes.
- *Side-scraper on pebble*: The support is a flat pebble. A few retouch flakes in "*side-scraper style*" link these pieces to some Acheulian side-scrapers.

- *Truncated pebble:* A pebble usually broken transversely. A few removals or retouch flakes trim this fracture or truncation.
- *Unifacially trimmed piece*: A pebble that is broken longitudinally. The fracture was trimmed by a few flat and convergent removals.
- *Casually trimmed pebble*: A pebble that cannot be classified into the above series. Usually there are only one or two removals. This category also includes the group of badly defined pieces that were unfinished or unsuccessful.
- *Broken piece on pebble*: A pebble trimmed as a chopper, polyhedron or other tool that was broken. The typological attribution is not always easy, hence this rubric.

Archaic handaxes

"The archaic handaxe is a piece flaked on pebble or on block. It shows as the chopping-tool, alternate removals and winding edges, but is particular by a beginning axial symmetry. It is a thick piece, partially cortical with one or both extremities can be more or less pointed. The archaic handaxe is morphologically and technically an intermediary tool between the chopper and the handaxe. We wanted to consider it as a chronological marker" (Berthelet and Chavaillon, *in* Leroi-Gourhan 1988, p. 904).

For the study of archaic handaxes, we used the same ratio and index as that described for tools on pebble. However, we took characteristics specific to handaxes into account, such as:

The shape of the piece

Archaic handaxes can be circular, cordiform, oval, elliptic, pelecyform or irregular.

The position of the width and maximum thickness

François Bordes's indices and method (1961) were used for classification. However, we were interested in the position of both the maximum width and maximum thickness. According to F. Bordes (1961) "the ratio L/a expresses the position of the widest part of the handaxe in relation to its length (height) and rounded base" (Bordes 1988, p. 72). We have used an identical ratio for maximum thickness. Thus Bordes's L/a becomes L/aw for the position of the maximum width and L/at for that of the maximum thickness (Chavaillon 1979b). To describe the position of maximum width and thickness we summarised it with the aid of the following scale:

- the distal sector — if L/aw or L/at is under 1.25
- the mesio-distal sector — if L/aw or L/at is between 1.25 and 1.64
- the mesial sector — if L/aw or L/at is between 1.65 and 2.49
- the mesio-proximal sector — if L/aw or L/at is between 2.50 and 4.99
- the proximal sector — if L/aw or L/at is over 5.00

Extremities, faces and edges

- *The distal extremity* can be pointed, ogival, angular or semi-circular.
- *The proximal extremity* can be straight, angular, semi-circular or irregular.
- *The base* can be very thick, thick, thin or very thin.
- *The shaping*: taking into account primary and secondary removals (face A and face B), each face can be flat, convex or angular.
- *The section of the distal extremity* is either triangular, plano-convex or lozenge shaped.
- *The edges* can be straight, convex, very convex, concave or irregular.

Débitage

It is often difficult in the Early Stone Age, and especially in the older periods, to distinguish between a pebble tool from which the waste products could be utilized, and a core which functioned to provide flakes and was used as a tool afterwards. Hence the term core-chopper that is often used by Africanist prehistorians.

Another difficulty arising from the European terminology is that although the term "Levallois core" can be used because it corresponds with a very particular and well-known flaking method, the terms "Acheulian core" or "Mousterian core" cannot be used as they could be confusing.

Cores

We have accepted seven main typological categories out of eighty (Levallois cores being absent; Fig. 2, *16*) for the study of the Oldowan of Melka Kunture.

1 - *Unipolar core* (Fig. 2, *9*, *10*): Flakes are removed from a single edge that may or may not have been trimmed by one, two or more preliminary removals. They can be simple (single removal) or multiple (several removals towards the same direction and from the same edge). Flakes with a dihedral butt were obtained in this way.

2 - *Bipolar core* (Fig. 2, *11*): Flakes are removed from two edges, the striking platforms being as in previous cases, cortical, on a fracture or partially trimmed. The utilized edges are usually opposed but can also be located on different planes. Flakes may intersect or not. Each edge can have one or several flake scars.

3 - *Centripetal core* (Fig. 2, *12*): Flakes start on the periphery and converge towards the centre. The entire perimeter can have been used or only a part. The size of centripetal cores is very varied. The lower face, that is more or less rounded, can be cortical or can be trimmed by one or several removals (it is what is called in Europe a "Mousterian core"). The upper face is often flat or slightly convex.

4 - *Pyramidal core* (Fig. 2, *15*): Flakes, starting on the periphery, converge towards the centre of the core which takes the shape of a pyramid. Objects in this category are often quite elaborate and provided a relatively large number of flakes.

5 - *Polyhedral core* (Fig. 2, *13*): Flakes have been removed in several directions from several edges. It is sometimes difficult to classify an object as a "polyhedral core" rather than among "polyhedrons"; the same object could often have been one and then the other. The classification criteria for the former could be the dimension and thickness of the flakes produced, while for the latter, traces of utilization and impact on surfaces and ridges prove that the object was a tool in its final stage.

6 - *Prismatic core* (Fig. 2, *14*): Flakes have been removed from the same platform in rotation. The platform can be a natural flat surface, a fracture or the negative of a large removal.
This definition is similar to that for the rabot or thick end-scraper. It is probable that many rabots were first prismatic cores, but in the Oldowan series we noticed that to manufacture typical rabots, it was enough to detach a few small unusable flakes. Moreover, the abrupt edge of cores is sharp, without scalings or polish that would be indicative of possible utilization.

7 - *Shapeless core*: These cores go into no other category, but they can reveal some surprises. What may at first seem shapeless, can become a type if it is repeated.

8 - *Core fragment*: Finally, core fragments are grouped together. It is not always easy to distinguish them from broken pebble pieces.

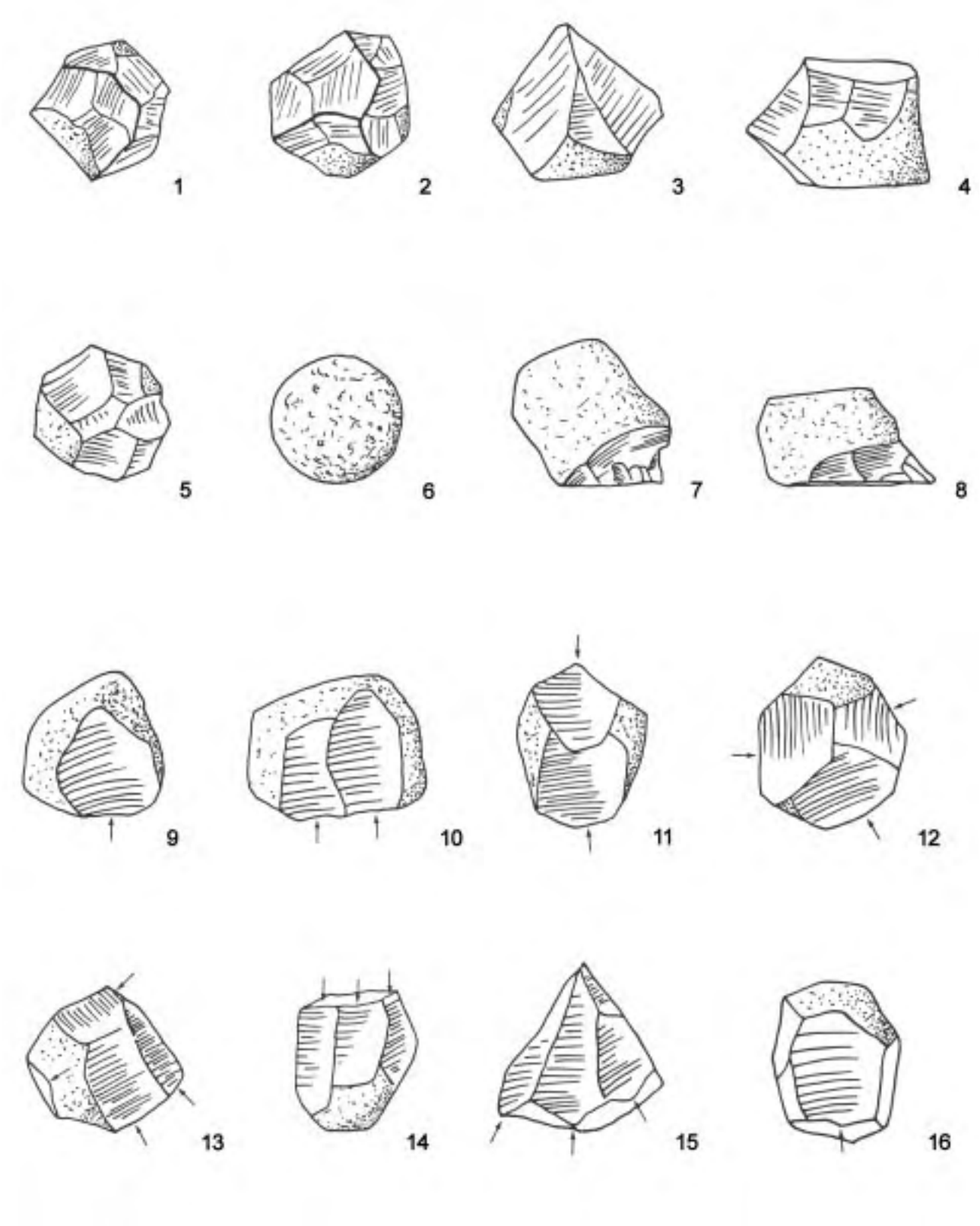

Fig. 2. Polyhedrons, heavy end-scrapers and cores. 1: Polyhedron with preferential working edge; 2: Polyhedron with several working edges; 3: Pointed polyhedron; 4: Prismatic polyhedron; 5: Spherical polyhedron; 6: Bola; 7: Rabot; 8: Heavy end-scraper; 9, 10: Unipolar core; 11: Bipolar core; 12: Centripetal core; 13: Polyhedral core; 14: Prismatic core; 15: Pyramidal core; 16: Levallois core. *Drawings by J. Chavaillon*

Débitage products

We have classified these artefacts in the categories *rough flakes*, *utilized flakes*, *retouched flakes* and *tools on flake*.

- *Rough flakes*: Are flakes that originate from the trimming of tools or cores. These flakes are without retouch and without visible traces left by possible usage.
- *Utilized flakes*: Are flakes which, even if without trimming retouch, have marks such as scaling or crushing that can be attributed to utilization.
- *Tools on flake*: We have distinguished between tools on flake or objects trimmed to give a certain type of tool, and various pieces on flake, a category in which flakes are typologically less clear.
- *Retouched flakes*: They are intentionally retouched flakes, where retouch is limited to a short extent of one or more edges.

Tools on flake

They include the main types used currently and are particularly close to the definitions proposed by F. Bordes (1961) and A. Leroi-Gourhan (1968). The references to F. Bordes's text are from the 1961 book, but for convenience we use the pagination of the fifth edition published by the CNRS Press in 1988.

1 - *Simple side-scrapers*: "Their edge is more or less parallel to the axis of the flake. The quality of the retouch is very variable" (Bordes 1988, p. 41). This retouch is rough, sometimes rather flat. They are straight, convex or concave side-scrapers.
2 - *Double side-scrapers*: "They are tools with two non adjacent edges retouched as side-scrapers. Various sub-types are theoretically possible" (Bordes 1988, p. 43) such as double straight-convex side-scraper and double biconvex side-scraper. These are the only sub-types encountered at Gombore I.
3 - *Convergent side-scrapers*: "They are double side-scrapers of which both retouched edges converge and meet one of the piece extremity, usually the distal extremity" (Bordes 1988, p. 43). At Gombore, we have straight convergent side-scrapers and convex convergent side-scrapers.
4 - *Déjeté side-scrapers*: "They are convergent side-scrapers where the axis of the tool is clearly inclined on the axis of the flake" (Bordes 1988, p. 44). This type was previously defined by R. Vaufrey (1955).
5 - *Transversal side-scrapers*: "They are considered because the edge retouched as side-scraper is opposed to the butt of the flake" (Bordes 1988, p. 44). At Gombore, we only have transversal convex side-scrapers and transversal concave side-scrapers.
6 - *Side-scrapers on ventral face*: "As their name indicates, they are side-scrapers where the retouch, instead of being located on the dorsal face of the flake, is on the ventral face. Naturally, these side-scrapers can be straight, convex or concave" (Bordes 1988, p. 44).
7 - *Alternate side-scrapers*: "They are double side-scrapers where the retouch concerns for one side on the dorsal face, and for the other one on the ventral face" (Bordes 1988, p. 46).
8 - *End-scrapers*: This is a"flake showing at one of its extremities... a continuous and non abrupt retouch determining a front more or less rounded, rarely straight" (Bordes 1988, p. 49). Following on from F. Bordes, we did not expect many types of end-scrapers, only typical end-scrapers and atypical end-scrapers which are "sufficient for Lower and Middle Paleolithic".
9 - *Burins*: Although rare in the Oldowan, these artefacts do exist and are defined as follows: "blade or flake showing, most of the time on the tip, one or several dihedral angles formed either by the inter-

section of two or several removals which plan is more or less perpendicular to the flattening plan of the tool, or by the intersection of one or several removals of this type and a retouched truncation or a fracture" (Bordes 1988, p. 50).

10 - *Awls - Beaks*: They are flakes "showing one or several straight points, lop-sided or curved, neatly cleared by bilateral retouches, sometimes alternate. An awl will be said atypical if one of the point sides is formed by a not retouched fracture or edge. Another type of atypical awl or beak will be formed by a thick or badly cleared point" (Bordes 1988, p. 51).

11 - *Alternate burin-beaks*: This is a tool on flake "formed by the intersection of two alternate retouched notches, one on the dorsal face, the other one on the ventral face. Their intersection determines an oblique ridge against the previous working edge of the flake" (Bordes 1988, p. 58).

12 - *Backed knives*: This is a tool on flake "of which one of the edges is formed by a rough not retouched working edge, (but which can show utilization traces) and the other one is either backed by abrupt and continuous retouches (typical backed knife) or by abrupt and continuous retouches only on a part of the ridge (atypical backed knife). The width of this back is variable..." (Bordes 1988, p. 51).
Natural backed knives "are flakes or blades showing a working edge on one side and on the other a cortex surface playing the part of a back obtained by retouch for the previous shapes. The cortex must be perpendicular or relatively slightly oblique on the flattening plan..." (Bordes 1988, p. 51).
There are mainly naturally backed knives at Gombore. In some cases this category comprises cortical backs, and in others the backing has one to three facets that were not formed after the detachment of the flake, but when it was still part of the core. In other words, they are marks left by the preparation of the core. Referring to "the flake with prepared back"of A. Leroi-Gourhan (1968), N. Chavaillon names this sub-type *prepared backed knife*; it is an artefact that is quite well represented at Gombore I.

13 - *Notches*: Various types are represented at Gombore I:
True notches: "They are made on the edge of a flake by multiple often thin retouches. They are more or less deep, more or less large" (Bordes 1988, p. 53).
Utilization notches: "Some small notches, little deep, are dues to one simple utilization, scraping for example a hard object...." (Bordes 1988, p. 53). Others, in contrast, are accidental.
Clactonian notches: "They are wide notches obtained with a single hammerstone blow, sometimes regularised by small secondary retouches which can also be dues to utilization" (Bordes 1988, p. 53).
Notches on distal extremity: These tools show "one notch on the distal extremity. It can be made by small retouches" (Bordes 1988, p. 54).

14 - *Denticulates*: These are tools on flake which show "on one or several non adjacent edges a series of contiguous notches made either by small retouches, or by large notches of clactonian type" (Bordes 1988, p. 54). We can distinguish: ordinary simple or double denticulates with micro-denticulations; transversal denticulates; sub-circular denticulates; denticulates on flake tips.

Various pieces on flake

These are pieces that are difficult to classify and that F. Bordes grouped among "various". They cannot be ignored because they are abundant. They are tools by chance in that they were unfinished, fruitless or clumsy attempts.

In this category of various pieces on flake we can put flakes or blades with retouch on the ventral surface, with alternating retouch, with abrupt retouch and with bifacial retouch. Finally, there are even more indeterminate pieces, for example objects with rare, irregular retouch, that cannot be categorised and that we have designated under the imprecise term of casually retouched flakes.

1 - *Pieces with retouch on ventral face*: They are close to the type defined by F. Bordes as having retouch on the ventral surface that is discontinuous and sometimes irregular.

2 - *Pieces with alternating retouch*: Sometimes these flakes show retouch alternating from one edge to the other, like a badly retouched alternate side-scraper; or the edge has alternating retouch, that is to say alternating from one face to the other one on the same edge.

3 - *Pieces with abrupt retouch*: If we eliminate pieces on which abrupt retouch seems probably to have been caused by trampling, by impact, or by the action of other natural phenomena, few objects are placed in this sub-type. They have a fairly thick edge, marked by particularly abrupt retouch, yet they are neither backed knives, nor side-scrapers, nor end-scrapers.

4 - *Pieces with bifacial retouch*: These flakes show rough, irregular and rare bifacial retouch on one of their lateral edges.

5 - *Casually retouched flakes*: This is a flake with only irregular, often discontinuous and rare retouch. It is difficult to place this object in the categories above, even if the retouch is bifacial, on the ventral surface or abrupt.

These pieces are not pseudo-tools, but they are rough shapes, chance tools, abandoned or damaged pieces, casually retouched or perhaps only used. However, as they cannot be classified among débitage products, they rather go into the "various" pieces categories indicated by F. Bordes.

Modules and indices

We group together here modules and indices that were used for the description of several typological categories. Most of these procedures are known, but it is nevertheless good to remember the definitions, uses and sometimes the origins.

Morphometric study

A - Dimensions

Maximum length, *width* and *thickness* of a piece is distributed according to two scales:

- One is according to arithmetic norms, every 10, for example.
- The other is drawn up according to semi-logarithmic norms and is the one most often reproduced.

Usually the total number of pieces is listed with its percentage, but often we have deliberately left out numbers, preferring to include only the percentage because it is more evocative.

B - Flaking modules

We have used the modules defined by A. Leroi-Gourhan: "The modules table is based on the consideration that a product over 15 cm long is very large and moreover that 1/1 in width is very wide. Flaking modules are applicable to trimmed products in the measure that the proportions of the original flake or blade are not spoilt" (Leroi-Gourhan 1968, p. 251).

There are 7 categories for length:

very small flake	length under 20 mm
small flake	length between 20 and 39 mm
flake rather small	length between 40 and 59 mm
average lenght flake	length between 60 and 79 mm

rather large flake	length between 80 and 99 mm
large flake	length between 100 and 149 mm
very large flake	length equal and over 150 mm

There are 8 categories for width:

very wide flake	ratio length/width under 1
wide flake	ratio length/width between 1 and 1.5
rather long flake	ratio length/width between 1.5 and 2
long flake	ratio length/width between 2 and 3
laminar flake	ratio length/width between 3 and 4
blade	ratio length/width between 4 and 6
thin blade	ratio length/width between 6 and 10
very thin blade	ratio length/width equal or over 10

C - Elongation and flattening indices

These easily calculated indices allow one to define with precision some morphological characteristics of the artefacts (Chavaillon 1979b).

1 - *The elongation index*: The elongation index is calculated with the ratio L/w:

L = maximum length and w = maximum width.

This index can be subdivided as follows:

Index	Aspect of artefact
1.00 to 1.06	Very short
1.07 to 1.14	Short
1.15 to 1.29	Rather short
1.30 to 2.19	Rather long
1.60 to 2.19	Long
> to 2.20	Very long

2 - *The flattening index*: It is the flattening index (L+w)/2t used by most geologists:

length L plus width w divided by 2 times the thickness.

The values of this index are distributed as follows:

Index	Aspect of artefact
1.00 to 1.24	Very thick
1.25 to 1.49	Thick
1.50 to 2.99	Rather thick
2.00 to 2.99	Rather flat
3.00 to 4.99	Flat
> to 5.00	Very flat

D - Sinuosity index

One of the essential characters of handaxes and choppers is the sharp working edge. Two criteria can intervene: the angle between the surfaces and the sinuosity (Chavaillon 1979b).

The sinuosity index is used to evaluate the average sinuosity of a working edge. To obtain it, we take into account the length, the depth (or thickness) and the number of curves. The length of the curve is measured between the extreme points of the curve or circle segment. The maximum length is measured. The depth is a function of the curvature: the higher the value, the deeper the curve. The maximum depth is

measured. The number of curves is counted from the proximal to the distal extremity, whether the curves are small or large. The index is calculated as follows with measurements in millimetres: $Is = \frac{Ls \times Ds}{Ns}$.

The values for this index were classified in the table below according to semi-logarithmic norms and distributed into sixteen groups (from 0 to 15) according to the categories of straight working edge, rather sinuous, sinuous and very sinuous.

A very sinuous working edge will have a high index (high length and depth, but low number of curves). Conversely, a nearly straight working edge will have short curves that are shallow but very numerous and the index will be low.

For handaxes and archaic handaxes the right and left edge are measured separately. Often one of the edges is casually worked, but the comparison of the right and left edge indices is undoubtedly instructive.

Index	**Value**	**Working edge**
Index 0	< 1.0	
Index 1	1.00 to 1.50	Sharp
Index 2	1.60 to 2.40	Straight
Index 3	2.50 to 3.90	
Index 4	4.00 to 6.2	
Index 5	6.3 to 9.9	Sharp
Index 6	10 to 15	Rather sinuous
Index 7	16 to 24	
Index 8	25 to 39	
Index 9	40 to 62	Sharp
Index 10	63 to 99	Sinuous
Index 11	100 to 159	
Index 12	160 to 249	
Index 13	250 to 399	Sharp
Index 14	400 to 629	Very sinuous
Index 15	> to 630	