STONE AGE REFERENCE COLLECTION

SARC

IKARUS BOOKS

A GUIDE TO THE TYPOLOGY, TECHNOLOGY AND STUDY METHODS OF THE STONE AGE

ROGER GRACE

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IKARUS BOOKS

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A guide to the typology, technology and study methods of the Stone Age

This eBook is based on the award winning SARC website enhanced with 17 videos, 6 interactive graphics, 8 quizzes, and 200 illustrations

typology

Science of classifying stone tools by form, techniques and technological traits. Must include duplication of the technique by first observing the intentional form, then reconstructing or replicating the tool in the exact order of the aboriginal workman. Shows elements of culture. Typology cannot be based on function." (Crabtree 1982.57)

scrapers

"Scrapers ... are unifacially retouched tools with a steep, wide-angled edge that is suitable for a number of tasks, including scraping hides, planing wood or bone, and cutting like a knife" Whittaker 1994., 27

Scrapers are the most common type of tool found from the Middle Palaeolithic onwards. Any tool with scraper retouch on any edge, or combination of edges is a scraper.

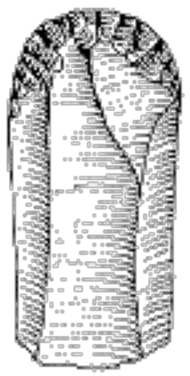
End scrapers

Scrapers that are made on the end of a flake or blade. The re-touched end may be the proximal end or the distal end, but the vast majority of end scrapers are made on the distal end, as this does not require the removal of the bulb of percussion.End scrapers are further defined by the shape of the retouched end, being either concave, straight or convex.

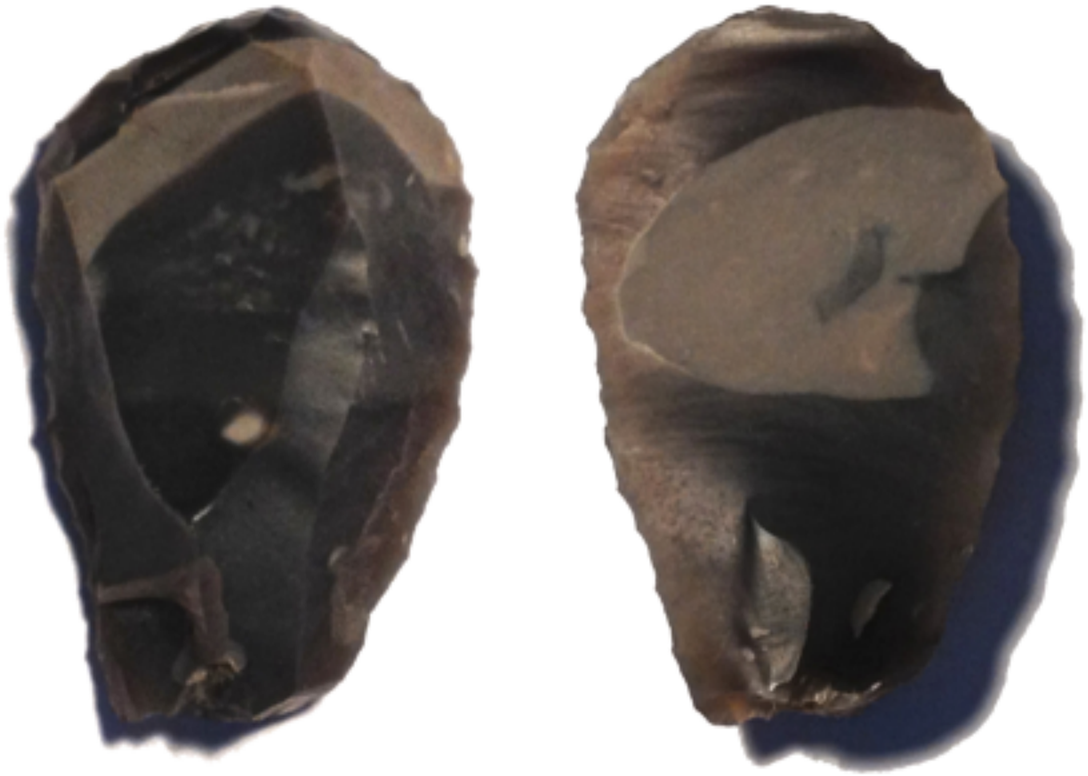
When an end scraper has been made on a flake that is wider than it is long, it is sometimes referred to as a transverse scraper.

convex end scraper

end scraper which has a retouched end that is convex in form.



convex end scraper



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transverse scraper

An end scraper made on a flake that is wider than it is long.

straight end scraper

An end scraper which has a retouched end that is straight in form. If the tool blank is a blade, and the retouch is abrupt retouch rather than scraper retouch it would be called a truncated blade.

on a flake   on a blade or truncated blade

straight end scraper on a flake

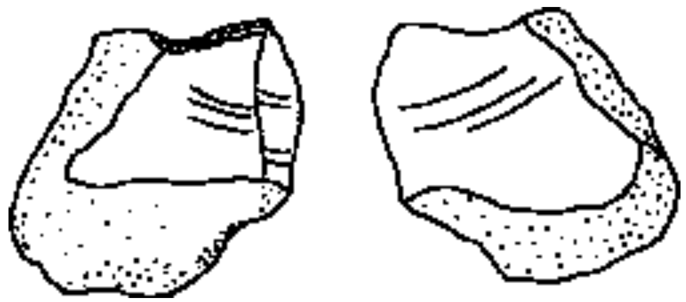
An end scraper which has a retouched end that is straight in form, made on a blank that is a flake. If the tool blank is a flake, and the retouch is abrupt retouch rather than scraper retouch it would be called a truncated flake. Also see Brézillon 1977, 122. on types of truncation

concave end scraper

end scraper which has a retouched end that is concave in form.

concave end scraper on a flake

An end scraper which has a retouched end that is straight in form, made on a blank that is a flake.



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nosed end scraper that is retouched to form a projection, hence 'nosed'.

In this example the 'nose' is retouched on the proximal end

INTERACTIVE 1.1 nosed end scraper

INTERACTIVE 1.2 convex end scraper

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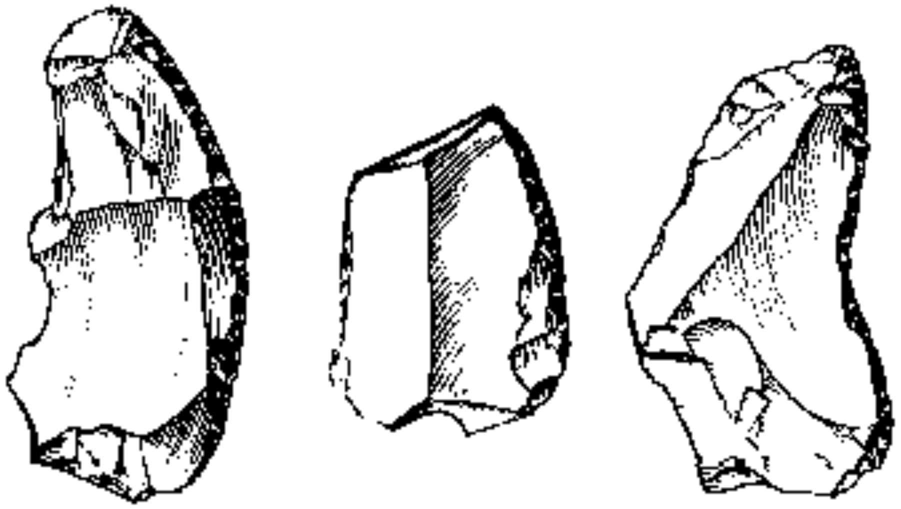
Side scrapers

Scrapers that are made on the side of a flake or blade. The retouched side may be the left edge or the right edge, or even on both in which case it would be called a double side scraper. Side scrapers are further defined by the shape of the retouched edge, being either concave, straight or convex.Side scrapers may be made on blanks that are blades or flakes.

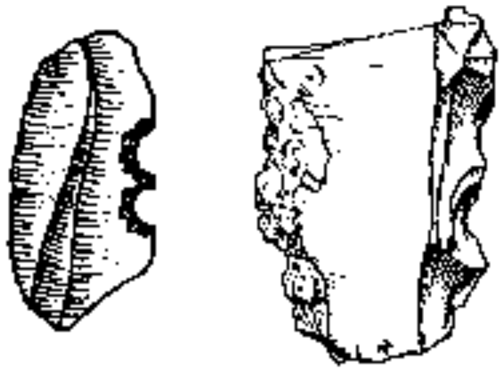


Notch

A notch is a side scraper with a short concavity retouched into an edge.This may be achieved by a single blow.

Denticulate

A denticulate is a side scraper with a serrated edge. Extreme denticulates are made up of a series of interconnecting notches.



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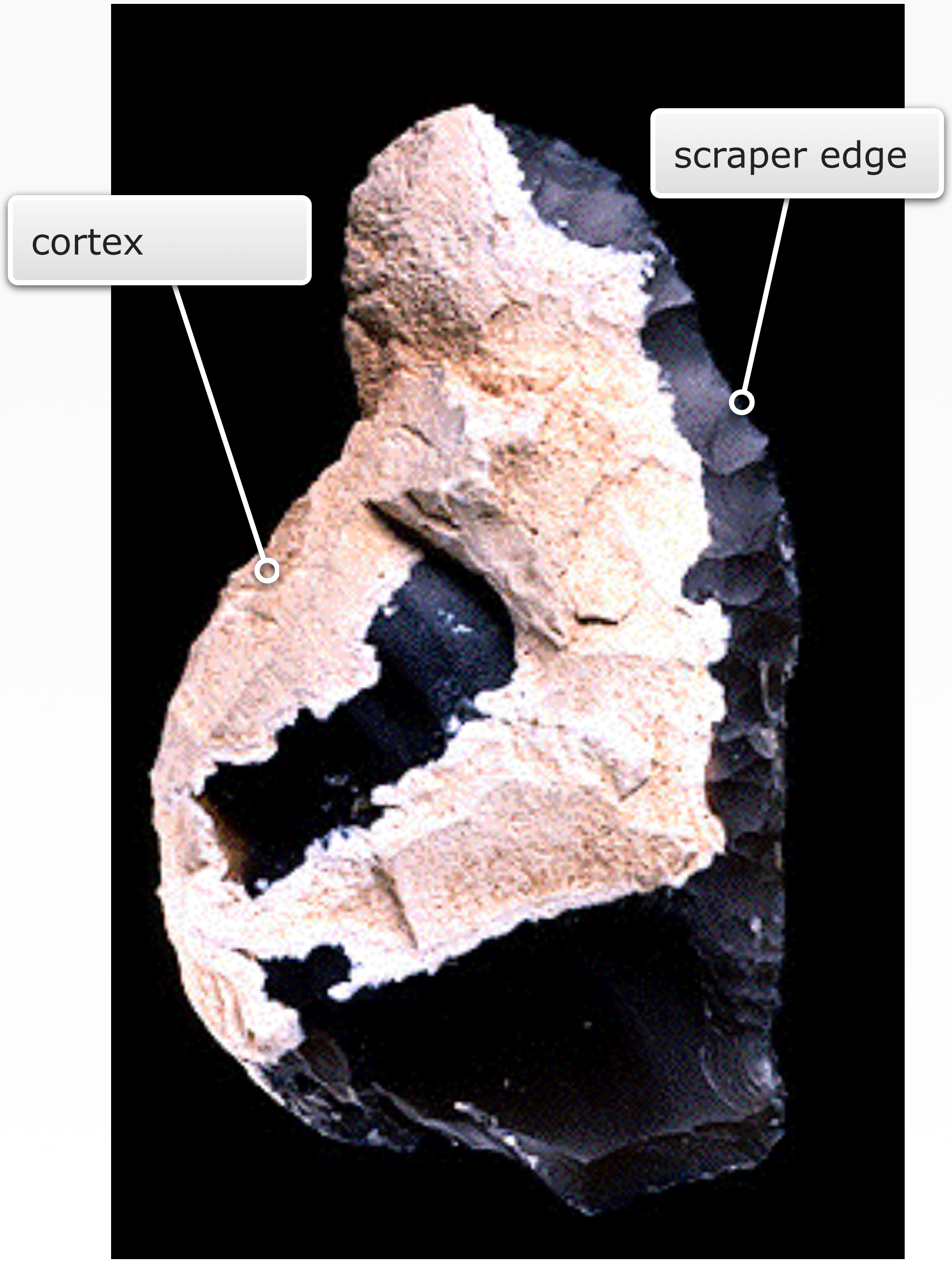
INTERACTIVE 1.3 convex side scraper



What type of scraper is this ?

- **A.** sidescraper
- **B.** transverse
- **C.** convex endscraper ✓
- **D.** straight endscraper

Check Answer

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projectile points

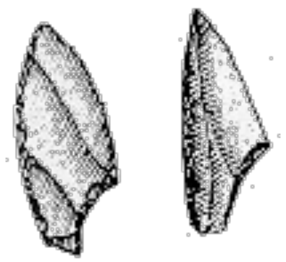
1. single edged point
2. transverse point
3. tanged point
4. transverse point
5. tanged point
6. bifacially retouched points.
7. bifacial leaf-shaped point
8. bifacial triangular point
9. bifacial lanceolate point
10. barbed and tanged point
11. tanged point interactive graphic

Projectile points are tools that were hafted as points in arrows.

There are many types e.g. single-edged points, transverse points, tanged points, bifacial points.

single-edged point

Single-edged points are projectile points that have two retouched edges. The edges are formed by abrupt retouch and are usually modified along one full edge and are diverging from the base to an edge. The shortest retouched edge must be < 60 % of the longest retouched side. (Helskog et al.1976., 25).



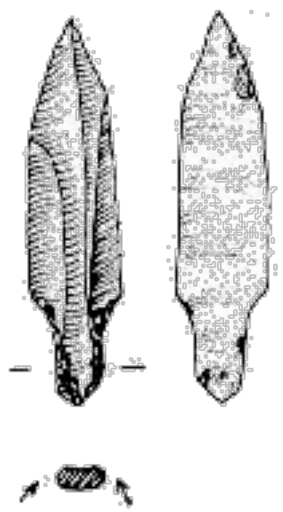
transverse point

Transverse points are projectile points that do not form a point but have a straight or angled "cutting" edge. They are often made from a medial section of a blade or bladelet so that the "cutting" edge is the original edge of the blank. i.e. they are oriented transversely to the axis of percussion.

tanged point

Tanged points are projectile points that have a tang at one end to facilitate hafting. A tang is made by retouching one, or more usually both edges, in order to create a projection that is thinner than the width of the blank. This projection is then fitted into the arrow shaft.

Tanged point - A1 are projectile points that are made from naturally pointed blade blanks that have no, or little, retouch except for the tang which is created by direct retouch.



Tanged point - A2 are projectile points. They are most common in the production of tangs for projectile points, particularly in the A2 and B types of Neolithic typology (Helskog et al.1976., 26).

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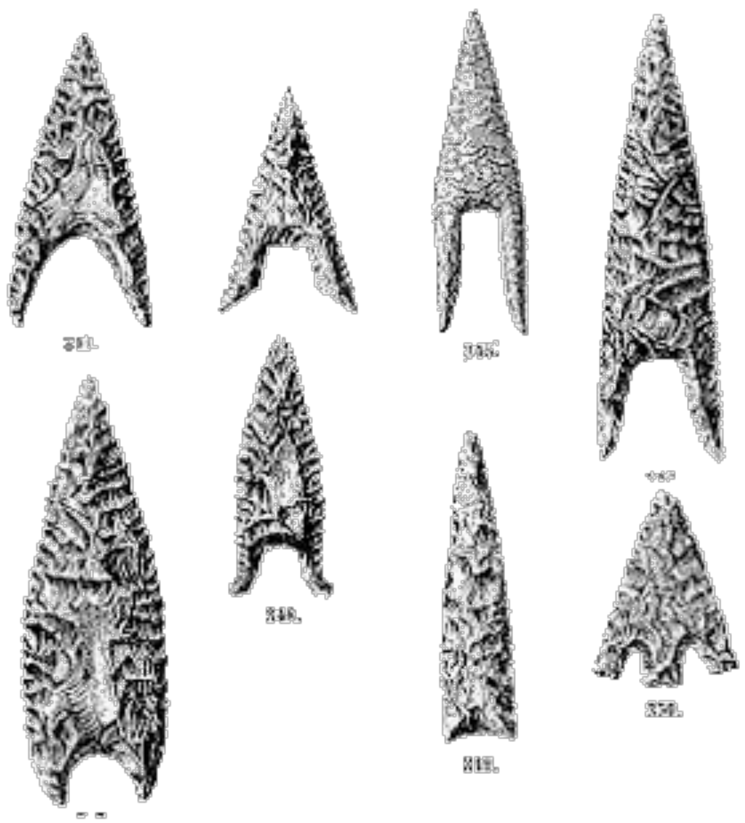
tanged point - A2 are projectile points. They are most common in the production of tangs for projectile points, particularly in the A2 and B types of Neolithic typology (Helskog et al.1976, 26). Tanged points- A2 have alternate retouch position

Tanged point - A3 points are simple tanged points made on blades. Only the tang and occasionally the point are retouched. The tang is made by inverse abrupt retouch. A-points are normally attributed to the Early Neolithic.



tanged point

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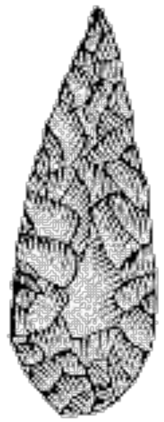
Interactive 1.4 tanged point

bifacially retouched points.

Bifacially retouched points are projectile points that are retouched on both surfaces, often with invasive retouch covering most of both surfaces. They are divided into types by shape. e.g.. bifacial leaf-shaped point, bifacial triangular point,bifacial lanceolate point. They may be tanged or have barbs, or both, as in a bifacial barbed and tanged point.



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bifacial leaf-shaped point

Bifacial leaf-shaped points are bifacial projectile points that are retouched on both surfaces and shaped like a leaf.

bifacial triangular point

Bifacial triangular points are bifacial projectile points that are retouched on both surfaces and triangular in shape.

bifacial lanceolate point

Bifacial lanceolate points are bifacial projectile points that are retouched on both surfaces and lanceolate i.e. elongated leaf shaped.

barbed and tanged point

Barbed and tanged points are bifacial projectile points that are retouched on both surfaces with barbs and tang.

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q2

What type of projectile point is this?

- A. single edge point
- B. transverse point
- C. tanged point ✓

Check Answer

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microliths

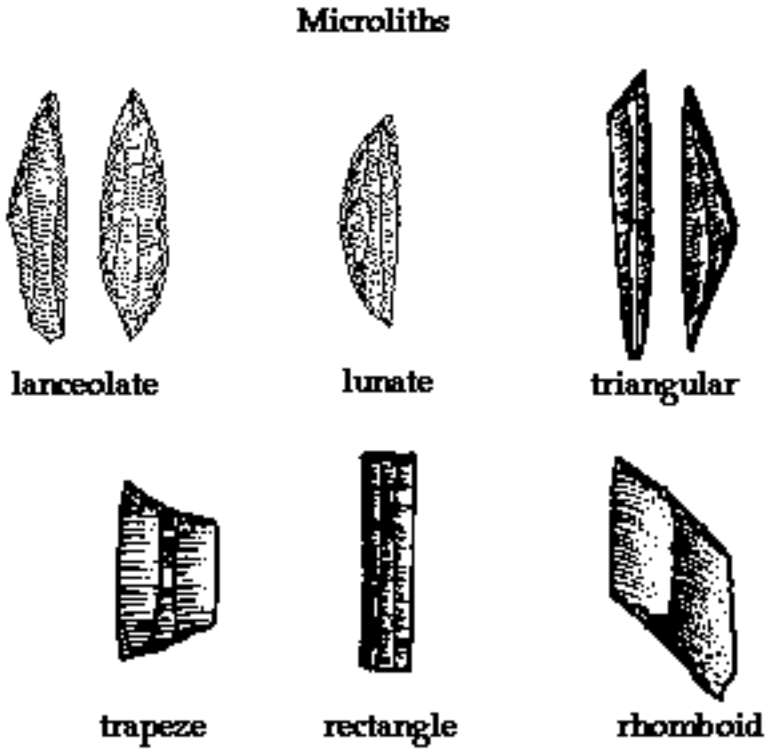
1. lanceolate microlith
2. lunate microlith
3. triangular microlith
4. trapeze microlith
5. rectangle microlith
6. rhomboid microlith

microliths

Very small geometric-form tools commonly used in composite tools. Formed from prismatic blades, using the sharp unmodified lateral edges as the cutting edge.(Crabtree 1982, 43)

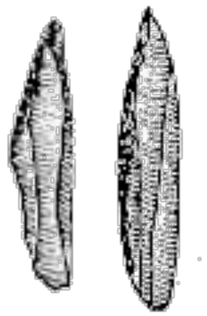
Microliths are very small stone artifacts usually made from sections of small blades. They were too small to be used by themselves and would have been set into wooden or bone handles to make composite tools, some of which have been found. Whittaker 1994. 37

Microliths are often made on blanks produced by the microburin technique. Though microlith is often used for any small retouched tool a more strict definition is that the bulb of percussion was removed i.e. the microlith was made on a section of a blade/bladelet, and that at least two adjacent edges should be retouched. For geometric microliths this means that the shape was deliberately made into a geometric shape. Otherwise naturally tapering blades that are retouched may be classified as triangular microliths, when the triangular shape is merely fortuitous.



lanceolate microlith

Lanceolate microliths are microliths retouched to a point, usually with oblique retouch. They are synonymous with 'obliquely blunted points' of the English Mesolithic.

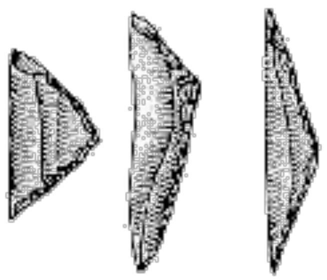


lunate microlith

Lunate microliths are retouched to a half moon or crescent shape.

triangular microlith

Triangular microliths are microliths retouched to a triangular shape. They can be sub-divided into scalene and isosceles triangles.



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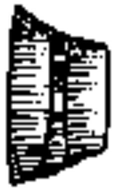
trapeze microlith

Trapeze microliths are microliths retouched to a trapeze shape.



rectangle microlith

Rectangle microliths are microliths retouched to a rectangular shape.

rhomboid microlith

Rhomboid microliths are microliths retouched to a rhomboid shape.

What type of microlith is this?

- **A.** rectangle
- **B.** trapeze ✓
- **C.** rhomboid
- **D.** lunate

Check Answer

also see how microliths are made

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burins

1. simple burin
2. dihedral burin
3. burin on a break
4. burin on a truncation
5. multiple burin
6. also see burin technique

BURINS

A burin is a chisel-like implement derived from a flake or blade; the modification of other implements by using the burin technique to remove the edges parallel to their long axis and/or transversely or obliquely. Generally forms a right angle edge on one or both margins. The specialized flake removed as a result of the burin break is called a burin blade or burin spall (Crabtree 1982, 27).

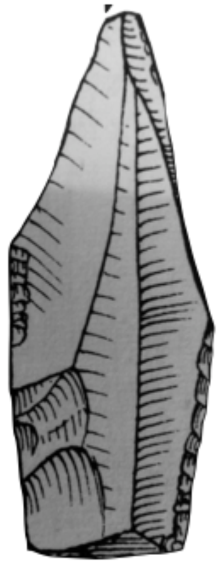
A burin is a tool which can take many forms but all are made by the burin blow technique. This has been defined as the action of making the ´sides´ of a burin.

A burin spall can be defined as "the part of a flake, blade, or bladelet detached by burin blow technique" (Tixier 1974, 9).

"The 'sides' of a burin consists of one or more burin facets, that is, flake scars each of which is produced by striking a piece off a flake, blade or bladelet, which may or may not have been prepared to receive this blow. The piece which is struck off is usually long and narrow, and is called the 'burin spall'." (Tixier 1974, 9)

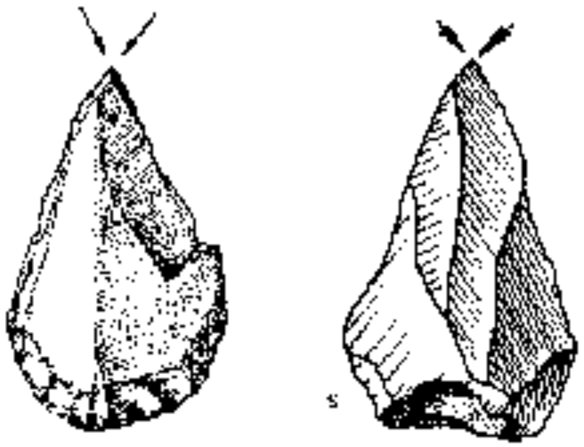
simple burin

where one burin facet has been removed



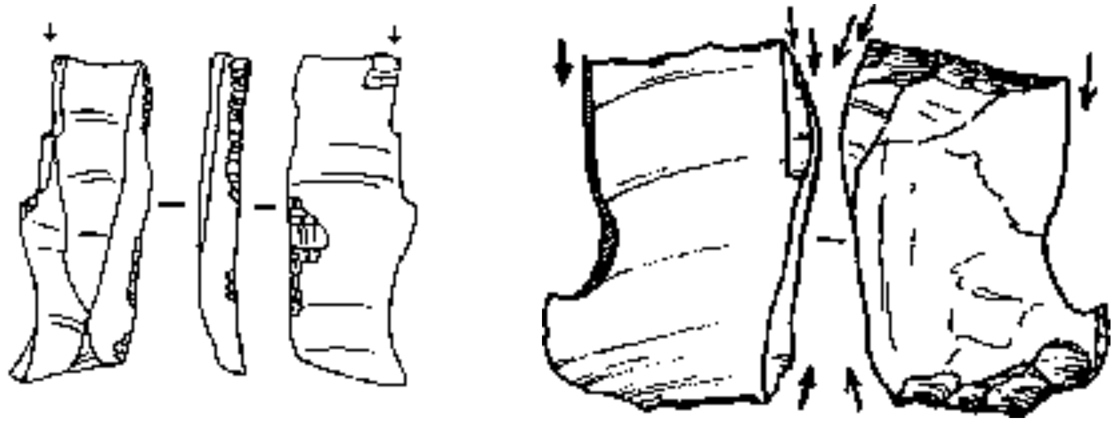
dihedral burin

A dihedral burin is a burin that is made by two (or more) intersecting burin facets so that a point is formed.



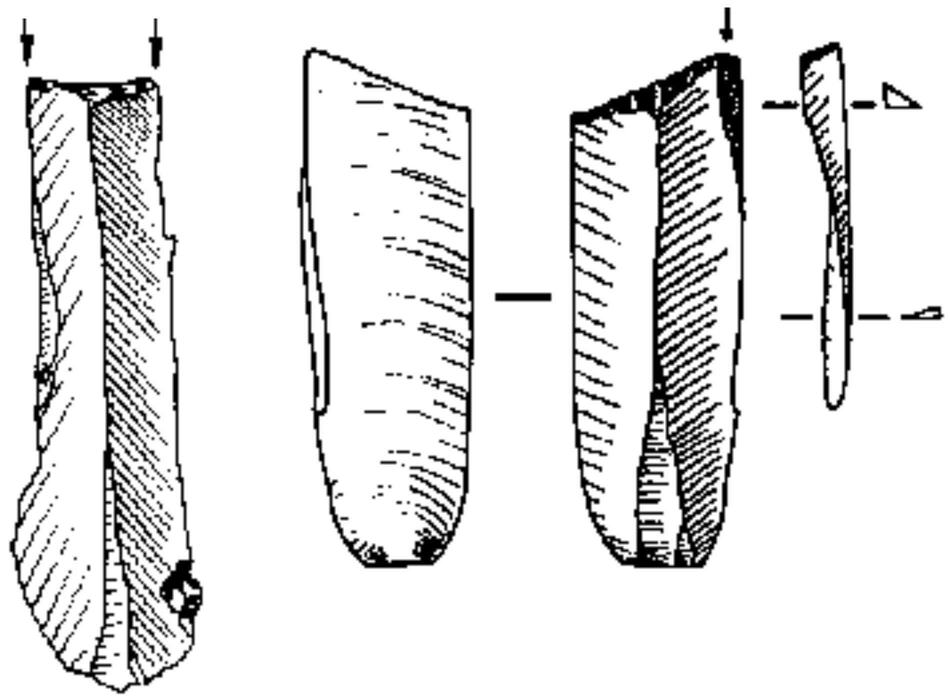
burin on a break

A burin on a break is a burin where the burin blow was made on to a break surface. Often a blade is broken to provide a platform for the burin blow.



burin on a truncation

A burin on a truncation- similar to a burin on a break except the platform has been retouched i.e. the blank has been truncated by retouch rather than simply broken.



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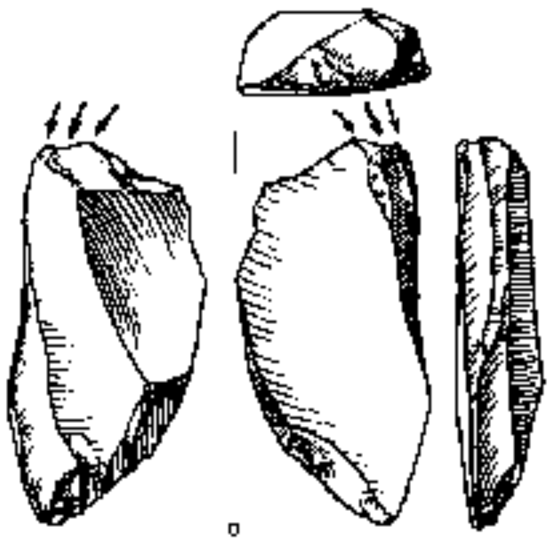
multiple burin

- when a number of burin blows i.e. more than two, have been made at the same place.



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What type of burin is this ?

- A. dihedral
- B. on a break
- C. multiple

Check Answer

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piercers/borers

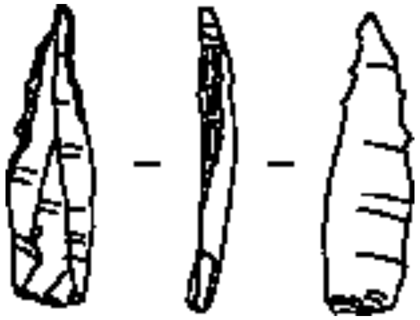
1. piercer on a blade
2. piercer on a flake
3. drill bit

PIERCERS/BORERS

Tools that have been retouched to a point. Piercers can be made on a flake, blade or a core:

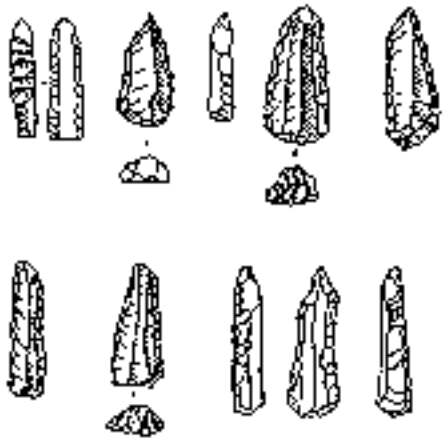
There is no real difference between a piercer and a borer- piercers whose retouched part is short tend to be called borers.

piercer on a blade
is a piercer made on a blank that is a blade

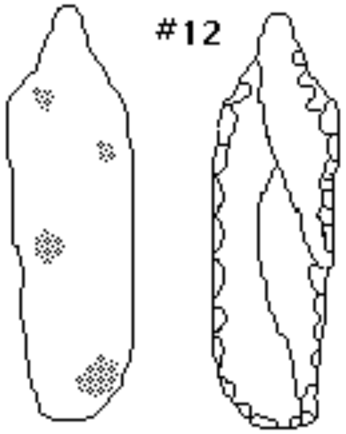


piercer on a flake
is a piercer made on a blank that is a flake

drill bit
A drill bit is a piercer or borer that is short and whose morphology indicates that it could have been hafted and used as a drill. It is relatively easy to detect use-wear on drill bits as they have the diagnostic features of rounded points, which can sometimes be seen by the naked eye, and often striations around the point indicating a rotational motion. see Grace 1990 b. and Unger-Hamilton et al 1987.



drill bit x 3



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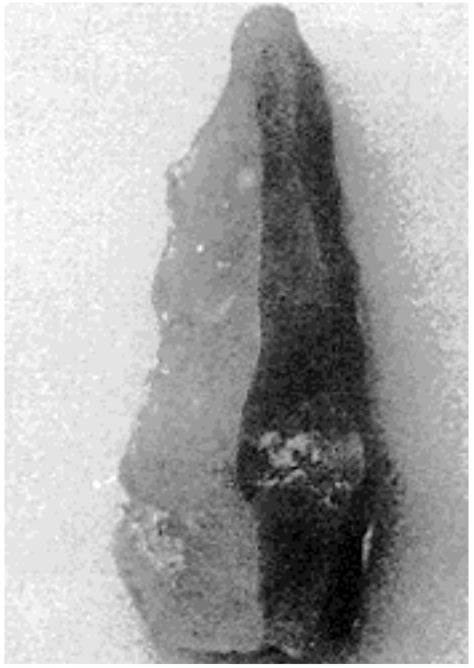
piercer

What type of tool is this ?

- **A.** piercer
- **B.** borer
- **C.** drill bit



Check Answer

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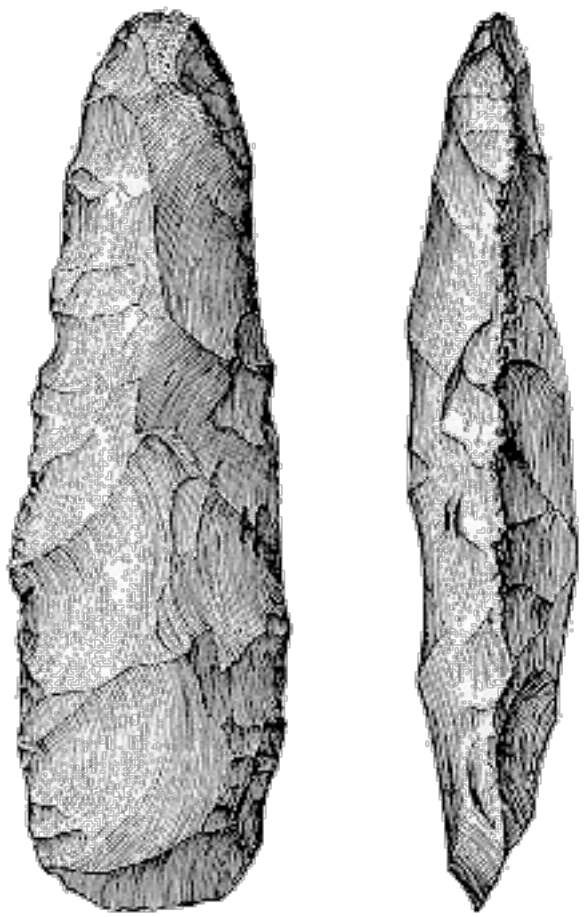
axes

flake Axe

Definition and terminology in accordance with Andersen et al 1975: 16-19, although not the minimum measure (4 cm). The flake axe is made on a large flake, and some of its original surface must be part of the edge. The edge may be modified on one side by edge flaking (ibid, 10). If both sides of the edge are secondary to the flake, the artifact is classified as a core axe. (Bjerck 1983, 17)

core Axe

Definition and terminology in accordance with Andersen et al 1975: 16-19. The surface of most core axes is fully covered by negative removals. Core axes may be made on flakes and have parts of the flakes original surface, but if so, this is not part of the edge of the artifact. In the opposite case the artifact is classified as a flake axe. The edges of core axes must be made by edge removals and/or removals from edge towards the neck?.



hafted core axe

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sickles

1. crescent sickle
2. blade sickle

sickles

Tools used for gathering cereal crops. The earliest sickles were made as composite tools by mounting microliths into hafts. Later ones where made from a single blank carefully re-touched to fit a haft.

Two main types: curved or crescent sickle blades and straight sickles made on blades.

crescent sickle

Curved or crescent shaped sickle blades, often with bifacial invasive retouch-hafted in wooden or bone hafts.

blade sickle

A blade sickle is a straight sickles made on a blade which is then hafted.

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knapping tools

KNAPPING TOOLS

Tools used in the manufacture of debitage.

Hammerstones used for striking nodules to remove flakes, or used for retouching blanks into tools. These can be identified by crushing and abrasion on the ends.

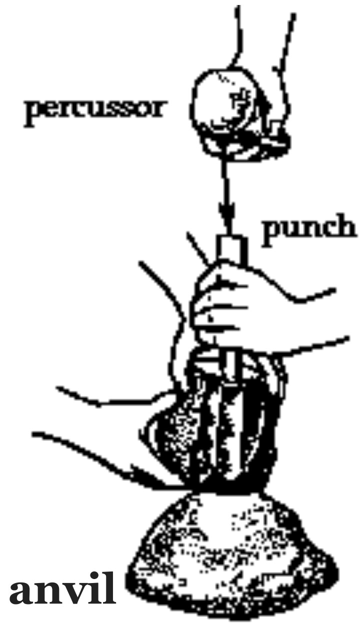
Other knapping tools such as antler or bone percuussers are assumed from experimental replication, but are usually not preserved.

hammerstone

Hammerstones used for striking nodules to remove flakes, or used for retouching blanks into tools. These can be identified by crushing and abrasion on the ends.

anvil

Anvils are the stones on which cores are placed for bipolar technique and can retain crushing and abrasion in the middle rather than on the ends, from this process.



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palaeolithic hand axes

1. abbevillian
2. cleaver
3. ficron
4. amygdaloid
5. micoquian
6. sub-triangular
7. triangular
8. lanceolate
9. cordiform
10. discoid
11. ovate
12. backed handaxe
13. limande
14. chopper

PALAEOLITHIC HAND AXES

Classification of Hand axes

The classification of handaxes is based on their shape (morphology).

This morphology can be quantified with a series of measurements

Ratios are calculated from these measurements.

L/A: L [maximum length] / A [distance from point of maximum width to base] expresses the position of maximum width in relation to the length

N/M x 100: N [width halfway up the axe] / M [maximum width] expresses the roundness of the sides.

M/E: M [maximum width] / E [maximum thickness] expresses the thickness relative to width, or 'refinement' of the axe.

if M/E < 2.35 then axe is THICK

if M/E > 2.35 then axe is THIN

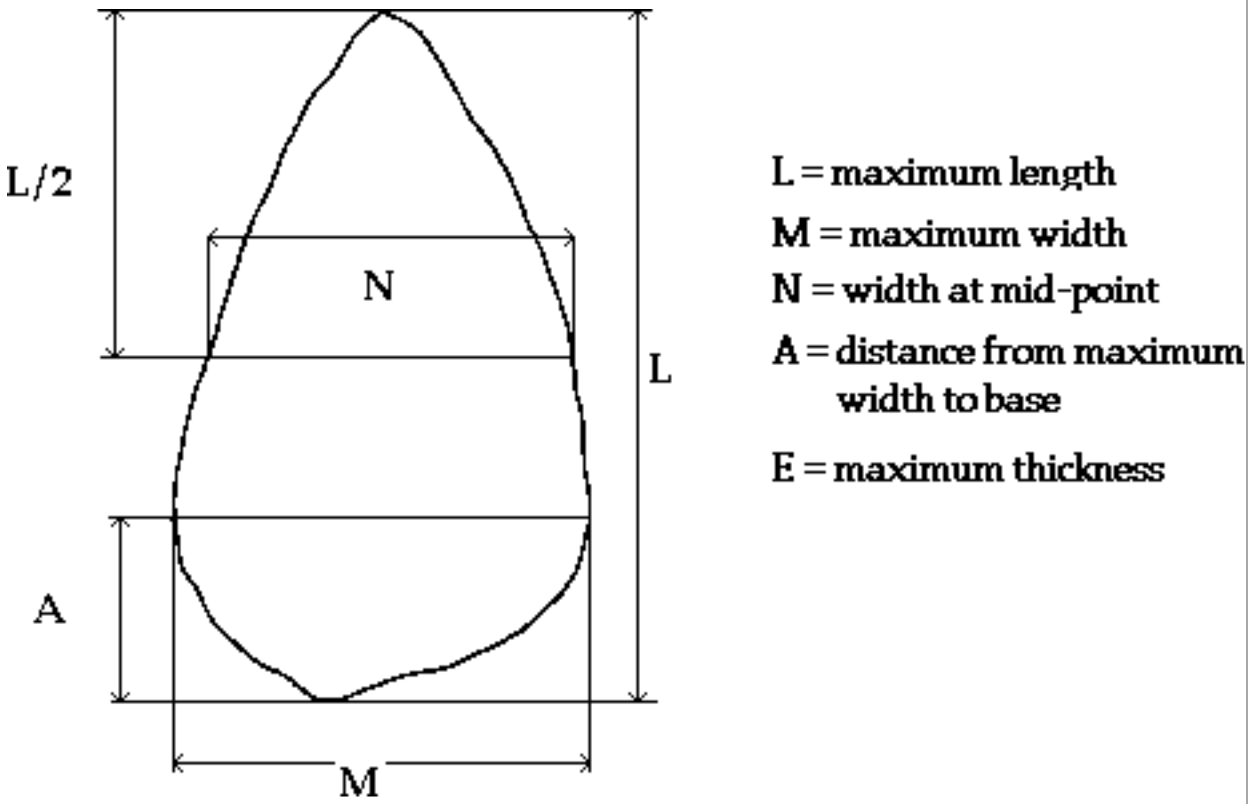
L/M: L [maximum length] / M [maximum width] expresses the elongation of the axe.

examples of how L/M can effect the classification of the hand axe.

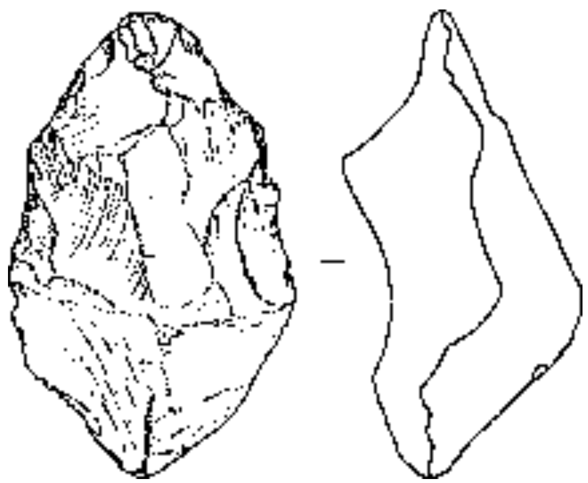
an L/M > 1.5 would make a cordiform axe an 'elongated cordiform' an L/M > 1.5 would make a triangular axe an 'elongated triangular'

an L/M > 1.6 would make a ovate axe a 'limande'

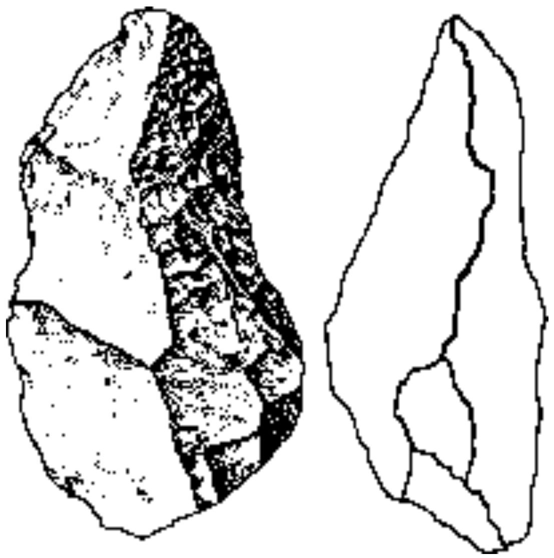
an L/M < 1.3 would make a ovate axe a 'discoid'



ABBEVILLIAN primitive form (Olduvai)



ABBEVILLIAN



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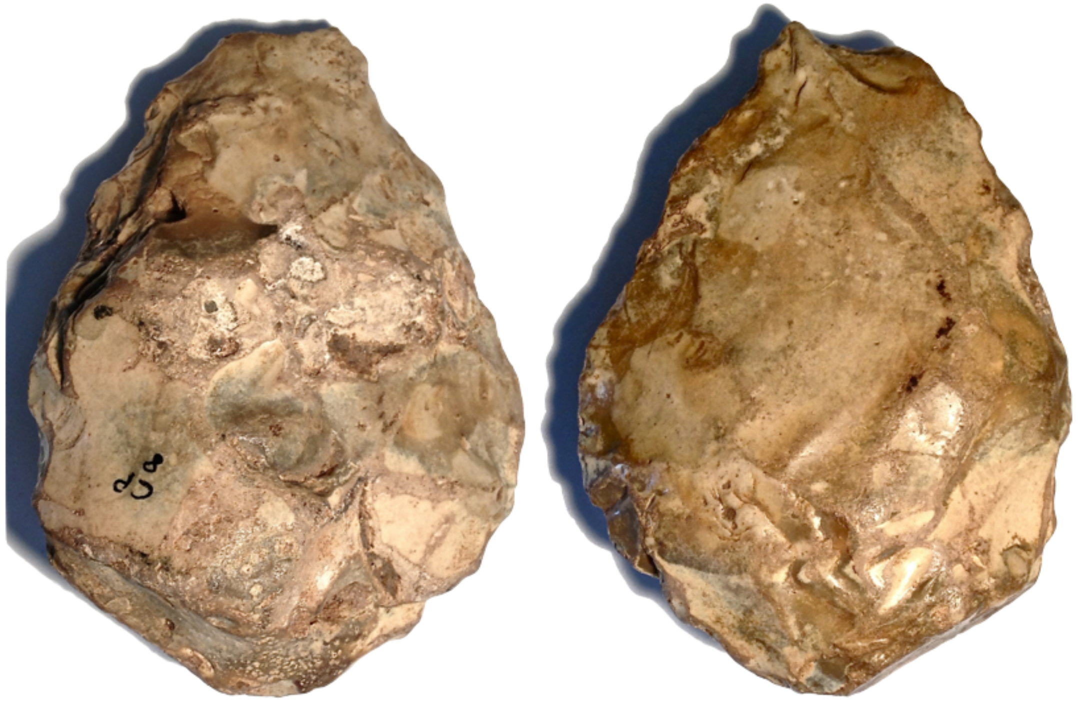
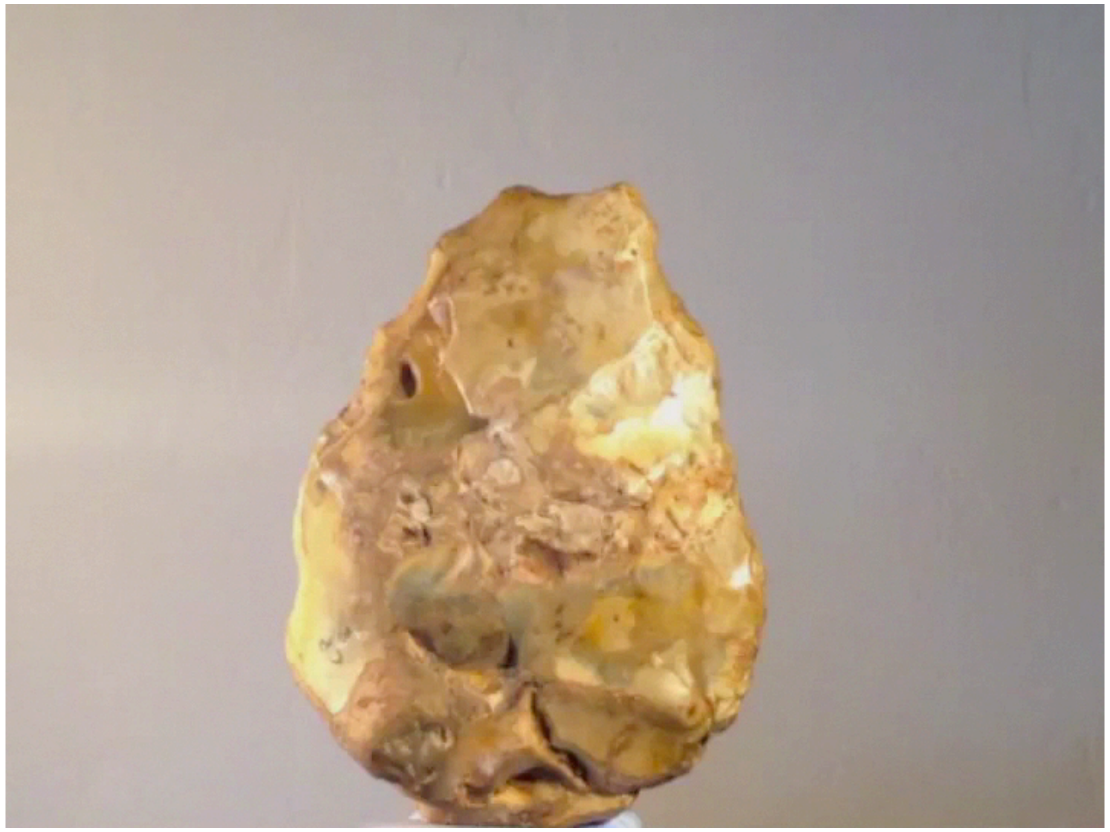
handaxe- Abbevillian



MOVIE 1.1 **Abbevillian handaxe**



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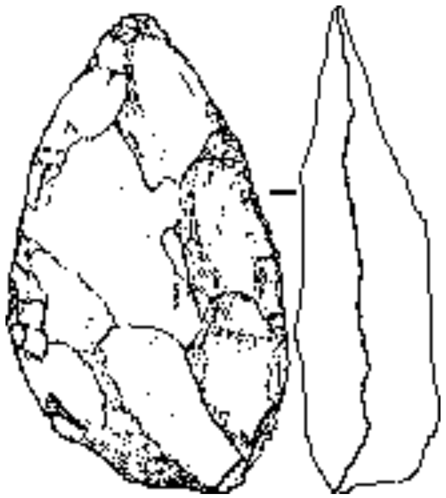
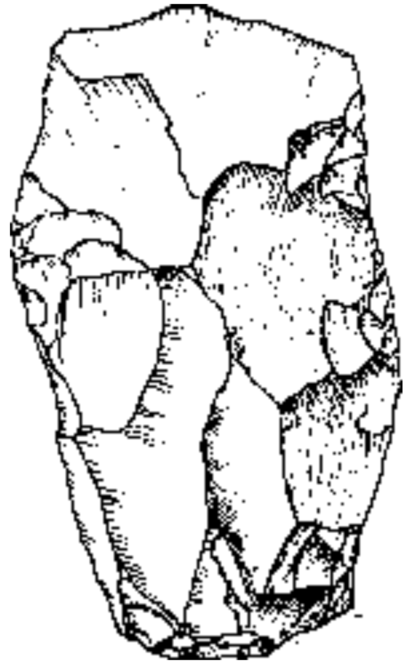
CLEAVER

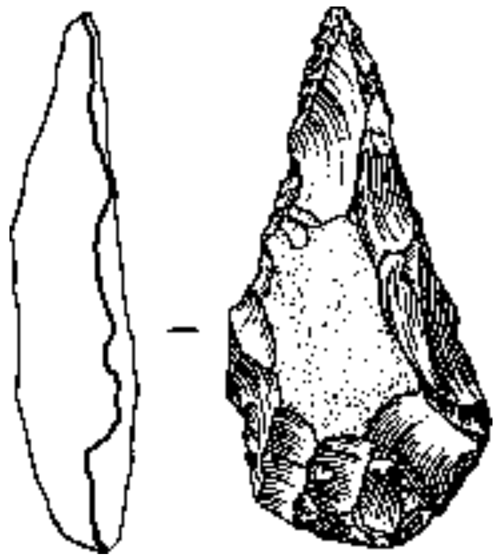


FICRON

AMYGDALOID



MICOQUIAN



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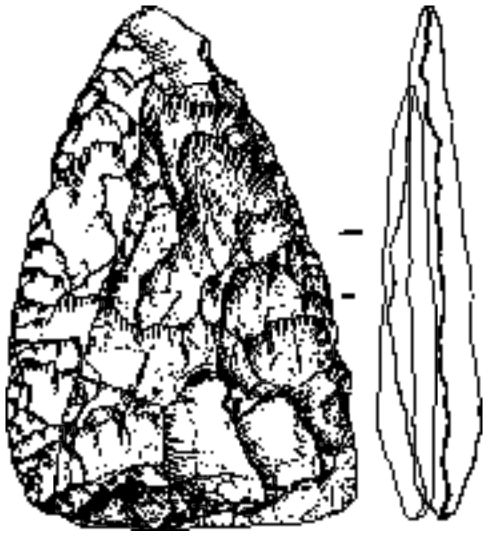
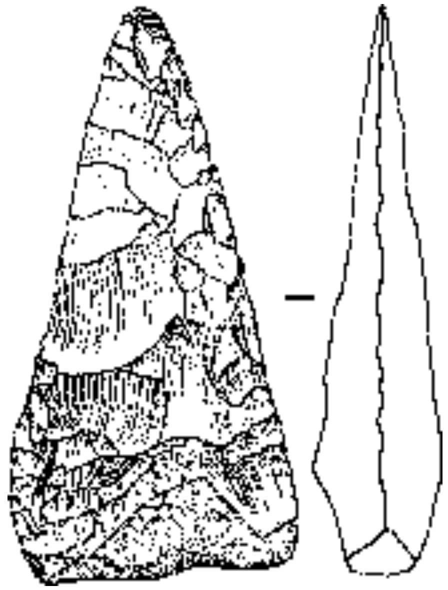
SUB-TRIANGULAR



MOVIE 1.2 **sub triangular handaxe**

with broken tip

TRIANGULAR



triangular handaxe

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Movie 1.3 triangular handaxe

LANCEOLATE

CORDIFORM

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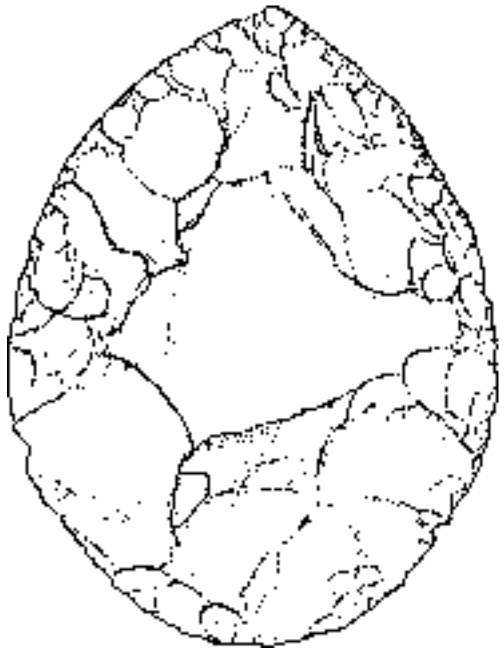
Movie 1.4 cordiform handaxe

Movie 1.5 cordiform handaxe

DISCOID

OVATE



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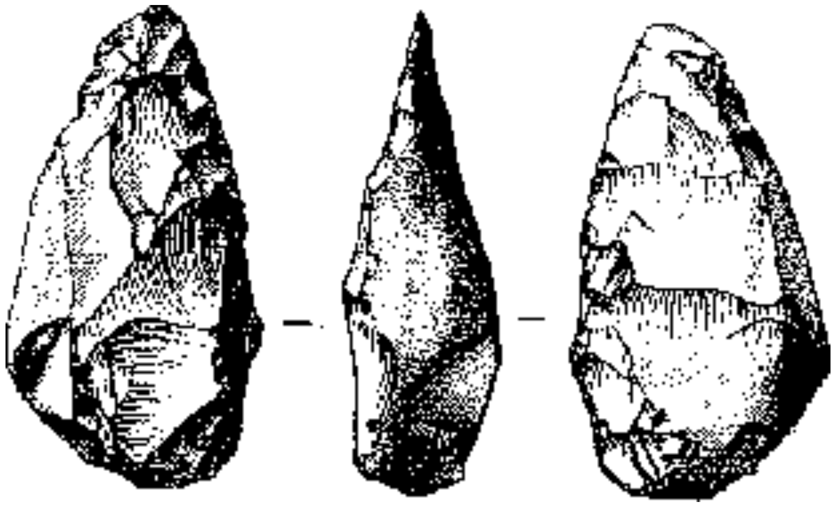
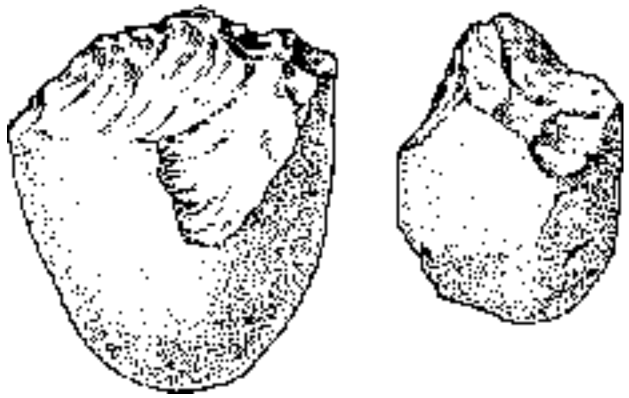
BACKED HANDAXE



LIMANDE

CHOPPER



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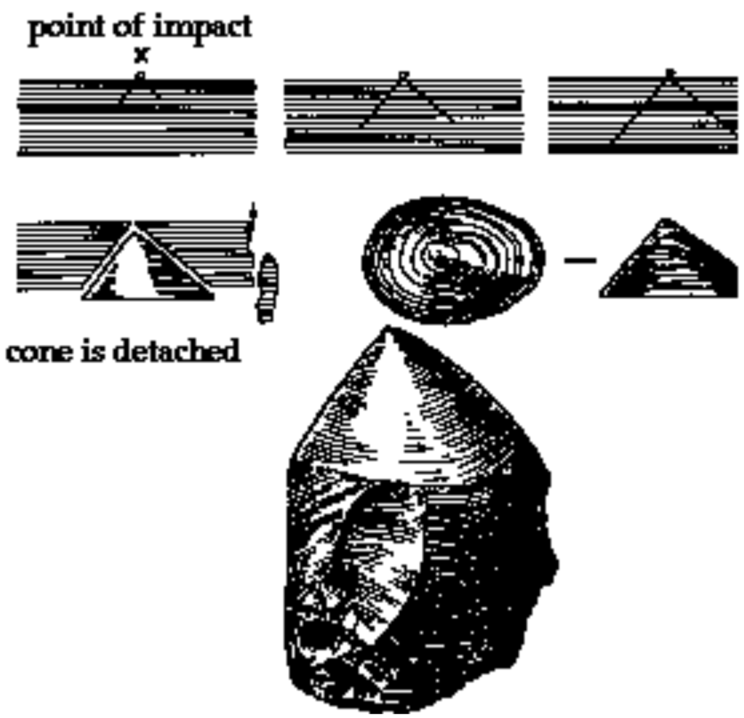
technology

"Technology: The study of techniques. Science of studying and interpreting the combined or distinct attributes of individual techniques. Implies a systematic control of minute and distinguishable detail" (Crabtree 1982., 50).

Using the technological approach, "lithic artifact are no longer exclusively considered as more or less ´characteristic´ objects to be described and classified. Instead these artifacts are also seen as evidence of human behavior in its technical, economic, and even social dimensions. Thus, the technological approach...overcomes...the classic dilemma of "culture versus function" posed by each tool" (Pelegrin 1990, 116).

The graphic illustrates the types of fracture resulting from a mechanical blow delivered to a small area - the point of impact or point of percussion.



At a light blow has produced a crack which only penetrates a small distance.

The stronger the blow the further the conical fracture penetrates, until finally the detached cone falls away . The ideal cone fracture is very difficult to achieve and is very rarely found.

The normal case of mechanic fracture, both in intentionally worked material and in natural breakage, is the detachment of a flake from the side of a block. In intentionally struck material this block is called a core and can be made from a variety of different materials of which flint, chert, quartz, quartzite, obsidian, jasper, mudstone and rock crystal are some of the more common types.

debitage

DEBITAGE

A French term, used directly in English publications, that has been defined as follows: The intentional action of breaking a block of raw material (hard rock) in order to use the products (flakes, blades, bladelets) as they are, or to convert these into tools by retouch. ´Debitage´ also comprises the results of this action (Tixier 1974, 14).

It has also been defined as:

Residual lithic material resulting from tool manufacture. Useful to determine techniques and for showing technological traits. Represents intentional and unintentional breakage of artifacts either through manufacture or function. Debitage flakes usually represent the various stages of progress of the raw material from the original form to the finished stage. (Crabtree 1982., 32).

Blank

Blank is a term used to describe a usable piece of lithic material of adequate size and form for making a lithic artifact, such as unmodified flakes of a size larger than the proposed artifact, bearing little or no waste material, and suitable for assorted lithic artifact styles. The shape or form of the final product is not disclosed in the blank (Crabtree 1982 27). It is possible to have a number of blanks in the early stages in the manufacturing process before the stage of being converted to a preform is reached.

Preform

A preform is the term used to denote a piece in the initial shaping stages for the formation of a tool. A preform is an unfinished, unused form of the proposed artifact. It is larger than, and without the refinement of, the completed tool. It is thick, with deep bulbar scars, has irregular edges, and no means of hafting. Generally made by direct percussion. Not to be confused with a blank (Crabtree 1982, 49).

Debris

Debris are the waste materials such as are found in quarrying or mining waste, which have little or no definitive characteristics (Crabtree 1982, 32). Debris is also commonly used to describe materials from a site which are considered to be waste materials from a production process. For example, materials found in a dump could be considered to be debris.

Detritus

Detritus is the waste of disintegrated rocks, such as accumulated waste at a natural exposure, having little or no diagnostic value (Crabtree 1982, 32). An accumulation or the remains of broken and natural (i.e. unworked) rock. This is not a term normally used in connection with humanly struck material.

Flake

Any piece of stone removed from a larger mass by the application of force, either intentionally, accidentally, or by nature. A portion of isotropic (homogenous) material having a striking platform and bulb of force (or bulb of percussion) at the proximal end. The flake may be of any size or dimension, depending on which technique was used for detachment (Crabtree 1982, 36).

A fragment of hard rock intentionally detached from:

- a core in the course of preparing or rejuvenating it: which is then called a core preparation or core rejuvenation flake
- a core with the intention of later turning it into a tool by retouch it:
- a tool in the course of shaping it by retouch: then called a retouched flake (Crabtree 1982. 14).

Flakes have two faces: a dorsal and a ventral. The dorsal surface can be partly or totally covered by cortex, but normally shows the scars from removals which were made before this flake was removed from the core.

The ventral surface contains only the features related to the detachment of this particular flake.

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Flakes also have two ends: a proximal and a distal. The proximal end contains the features of the point of impact and detachment or the point of percussion. Opposite this is the distal end.

Flakes and blades are oriented with the dorsal surface up and the proximal end (which can only be determined from the ventral surface) down. The left and right edges of the artifact are set from this orientation and remain as such, regardless of which way the piece is turned.

It is common for the dorsal surface to bear traces of negative scars from previous removals. These are called dorsal scars and are separated by a ridge which is created at the junction between two removals.

The ventral surface contains virtually all information pertaining to the detachment of this particular artifact from the core. The small section of platform retained from the core is now called the butt. The main surface of this face shows a swelling, or bulb, arising from a point just below the striking platform or point of percussion. Other features include concentric ripples, or lines of force, which show the direction of percussion, and irregular straight fissures, both of which radiate from the point of percussion.

A particularly important feature which can occur on the ventral surface is the bulbar scar, or érrailure. This is a small negative (concave) scar of irregular shape on the bulb marking the place from which a small chip springs away at fracture. As this feature is very common on humanly struck materials and is rare on naturally produced flakes it is a useful guideline to use when examining stray specimens which could be natural (see Patterson 1983, 300).

flake

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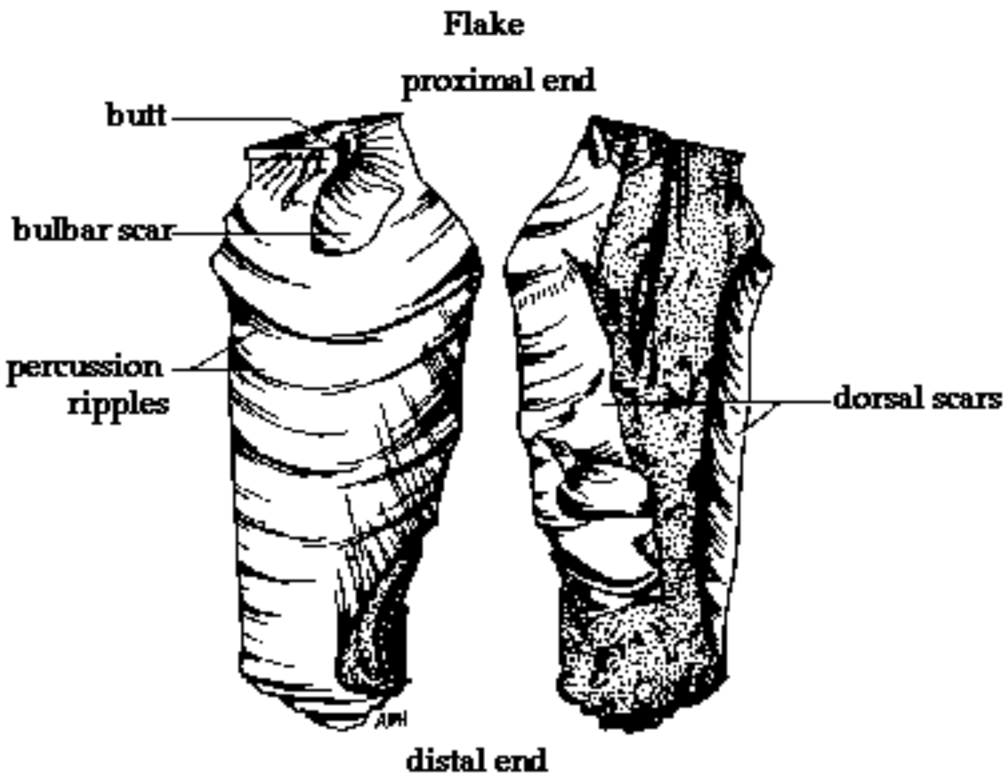

MOVIE 2.1 features of a struck flake

A **chip** is a small flake. The exact measurable limits for this artifact vary, depending on the typology in use in the area of investigation, but are normally less than 20 mm. A chip is considered to be too small to have been selected as a possible blank for tool production.

blades

Blades are flakes with more or less parallel lateral edges which, when complete, would have been at least twice as long as wide (Owen 1982, 2).

Specialized flake with parallel or sub-parallel lateral edges; the length is equal to, or more than, twice the width. Cross sections are plano convex, triangulate, sub triangulate, rectangular, or trapezoidal. Some have more than two crests or ridges. Associated with prepared cores and blade technique; not a random flake (Crabtree 1982,16).

A blade is technically defined as any flake that is more than twice as long as it is wide, with more or less parallel edges. Whittaker 1994, 33.

Blades may be produced with hard hammer technique, but most often soft hammer and indirect percussion is used. The exact measurable limits for a blade vary widely. These are normally defined by whichever typology is currently in use in the area of investigation. There is general agreement on the length/width ratio of > 2, however, the maximum width can be set anywhere between 8mm (Helskog et al 1976.), 10mm (Hahn 1977, 44 and Hahn 1982, 26-27), 11mm (Taylor 1962, 425-426), and 12mm (Tixier 1974 7). There are normally no maximum length measurements for blades.

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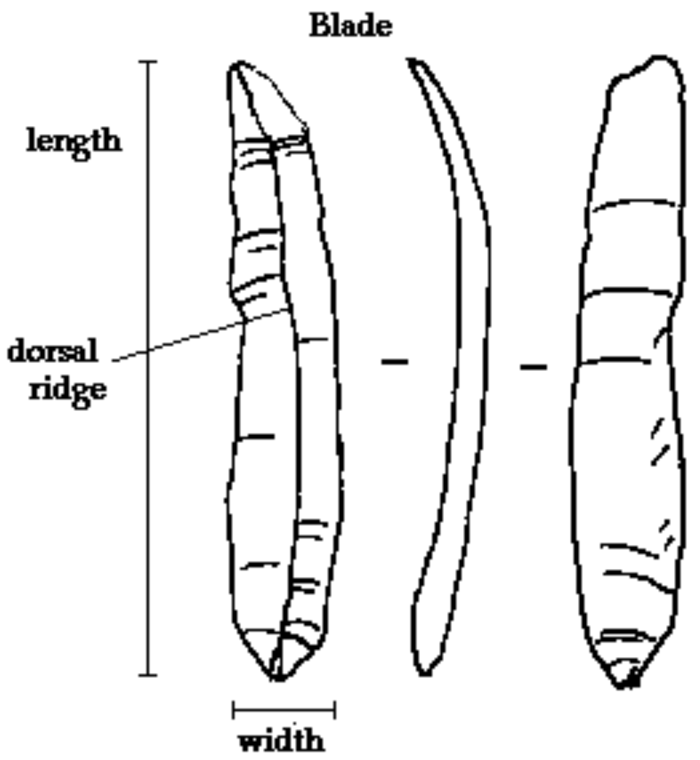
Blades are oriented exactly the same as flakes, with the bulb of percussion down and the dorsal surface up.



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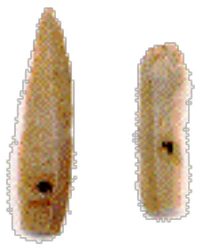
bladelet

Simply stated microblades are small blades (Owen 1982, 2). These artifacts, which are also called bladelets, suffer the same problems regarding varying size restrictions as blades.

The minimum width limit for a blade is the maximum acceptable width for a bladelet or microblade. This is between 8-12mm, depending on the typology in use. However, in some instances the maximum permissible length for this group has also been subject to discussion (see Tixier 1974 , 7-8). N.B. in Norway a blade is a bladelet (mikroflekker) if it is less than 8mm. in width. The standard maximum width for a bladelet is 12 mm.



knapping fragment

A knapping fragment a product of the knapping process which has identifiable negative scars and is irregular in shape. The distinguishing feature is that it is impossible to determine the final plane of detachment from the core (i.e. its ventral surface). Terms such as splinter or chunk are also used to describe this artifact, however, as these are general descriptions, and are used in other connections, their use is not recommended.

A knapping fragment is not a section of an artifact, such as a flake, which still has an identifiable dorsal and ventral surface even when it is incomplete or fragmentary. This would be called a broken flake as opposed to a knapping fragment.

platform rejuvenation flake

A platform rejuvenation tablet (or core rejuvenation flake) is the result of the process by which the exhausted or ruined core platform would be removed as a tabular flake thereby establishing a new platform (Crabtree 1982,, 50). (Also see Owen 1982, 219). The removals around part or all of the edge of these artifacts often causes them to be mistaken for scrapers. It should be noted that the origin of these abrupt negative scars is from the dorsal surface and has been executed before the piece was removed from the core.

flake from a polished axe

A flake from a polished axe is a flake which has retained a portion of the surface of an intentionally polished tool on part or all of its dorsal surface. These flakes can be the result of damage to a polished axe or can occur from the reduction of the damaged tool (for example, when it is used as a core to extract the remaining usable raw material). When examining flakes detached from a polished tool it is imperative to check that the polish is intentional (i.e. smooth, flat, and with characteristic polish striations) and is not simply the gloss from agents such as plant deposits or the natural weathered outer surfaces of the raw material.

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These forms of gloss are distinguishable in that the supposed ´polish´ often fills surface concavities (something that is not possible with intentional polish).

crested blade

A straight ridge is necessary to guide the removal of the first blade from a core. If a natural ridge is not present, one can be produced by flaking on the core face. Such a ridge is created by extensive flaking perpendicular to the length axis of the core. The removal of this primary ridge blade, or crested blade, leaves straight scars on the core face which serve as guides for further blades (see Owen 1982, 3).

Crested blades have also been described as follows: First blade removed from a core. Bears bi-directional flake scars on the dorsal surface, the result of the worker preparing a ridge to guide the blade (Crabtree 1982,, 41).

MOVIE 2.2 how crested blades are made

index

crested blades

Parts of debitage

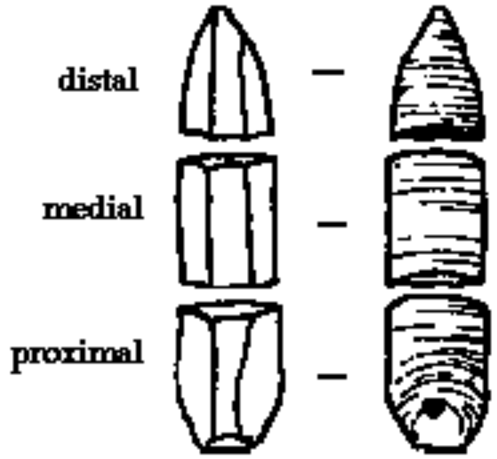
Parts are broken or fragmentary flakes and blades which can be classified into three parts: the proximal part, medial part (or middle) and distal part sections.

The proximal part is the proximal end of a flake or a blade and is the section containing the bulbar end of the fragment, or the part that received the blow which detached it from the core. This often includes all or parts of the butt, bulb of percussion and the initial lines of force or ripples radiating from the point of impact.

The medial part is the medial, or middle, section of a flake or a blade can be in many fragments or parts. These fragments can be oriented by identifying the direction of percussion by the lines of force, or the ripples, and the fissures on the ventral surface.

The distal part is the distal portion of a flake or blade is opposite to the proximal, or bulbar section, and is the end of a piece. It can terminate in a number of ways (see feathering, step and snap fracture, hinge and plunge). It is possible to correctly orient these fragments from the ventral surface by identifying the direction of percussion, by the lines of force, or ripples and by the fissures.

nomenclature of debitage parts



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What kind of blank is this ?

- A. flake
- B. blade
- C. chip

Check Answer

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platforms

PLATFORMS

A platform is the surface area receiving the force necessary to detach a flake or blade. It can be either natural or prepared (Crabtree 1982., 49). See cores.

There is disagreement as to whether the term platform should be restricted to use in defining the striking area of a core or whether it should also be used to describe that section of the top of a core which is retained on a flake or blade which is commonly called a butt.

In the opinion of Tixier 1974, 14 and Bordes 1961, 5 a platform should not be confused with a butt - a butt being the section of a flake, blade, or bladelet that is part of the striking platform which is detached (from the core) by the blow of the striker or by pressure flaking. Therefore, a platform would only be found on a core and a butt on a flake, blade or bladelet.index

corticated butt

A corticated butt (i.e. a butt with cortex on it) bears the original unmodified surface of a totally unprepared platform. Flakes with this type of butt are normally considered to be primary flakes from the initial stages of core preparation.

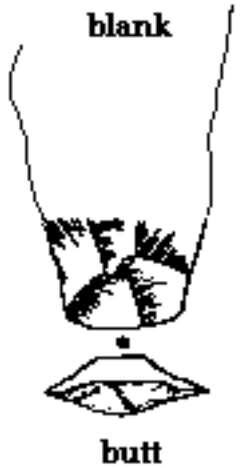
plain butt

A plain butt shows a section of the negative scar from the single flake used to prepare the platform. It is the simplest form of platform type; one flake has prepared the entire knapping surface. This is the most common way of preparing a platform for flake removals, although it is also found on blade cores.

prepared butts or platforms

A platform on a core can be prepared in a number of ways but the most common is by the removal of a number of small detachments, or platform preparation flakes, from across the surface of the platform. These differ from rejuvenation flakes or tablets in that here the purpose is to prepare the surface of a platform through the application of small controlled chips or flakes and not by the removal of the entire platform of a core. Regardless of the form applied, platforms are prepared to roughen the surface and increase the probability of a successful well-positioned and exact removal. Platform preparation is often encountered on more elaborate core types such as blade cores. (See Newcomer 1975, 97-102 and Owen 1988 3-7).

Platform preparation leaves distinct traces on the butt of an artifact. This preparation can take many forms but the most common result in a dihedral butt, faceted butt (or scarred butt), or a punctiform butt. (see Tixier 1980, 105, fig. 47: 3, 4 and 9).



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dihedral butt

A dihedral butt is formed when the detachment blow is struck on the platform at the junction, or the ridge, between two removals.

prepared faceted butt

Faceted or scarred butts are formed by striking on a platform prepared by numerous removals. This type of preparation is particularly useful in roughening the surface and increasing the probability of a successful well-positioned and exact removal. This type of platform preparation is often encountered on more elaborate core types such as blade cores. (See Newcomer 1975,, 97-102 and Owen 1988, 3-7).

prepared punctiform butt

Punctiform butts result from the careful preparation of both the platform and front of a blade core. The use of indirect percussion is necessary to assure an exact blow is delivered to the tiny area left for striking after the preparation is complete.

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hammer mode

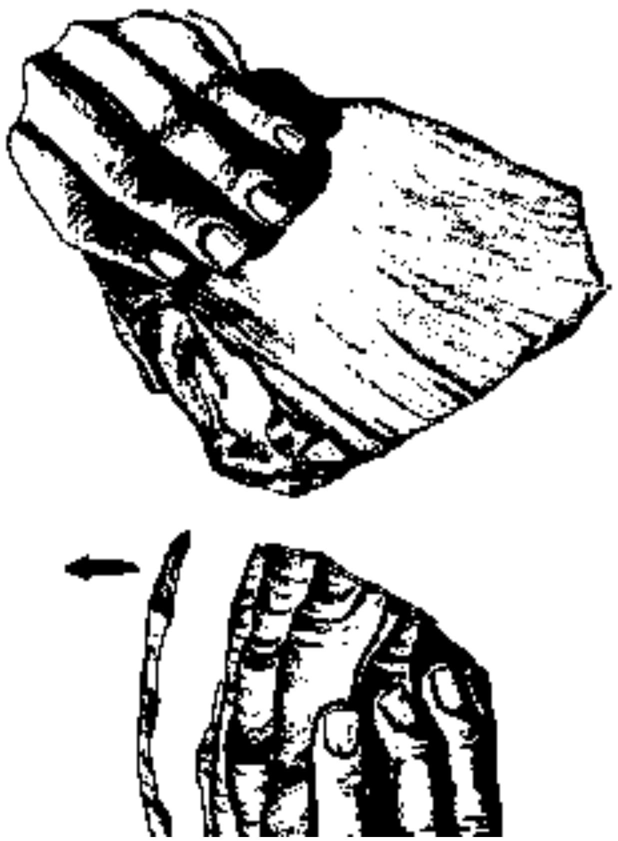
HAMMER MODE

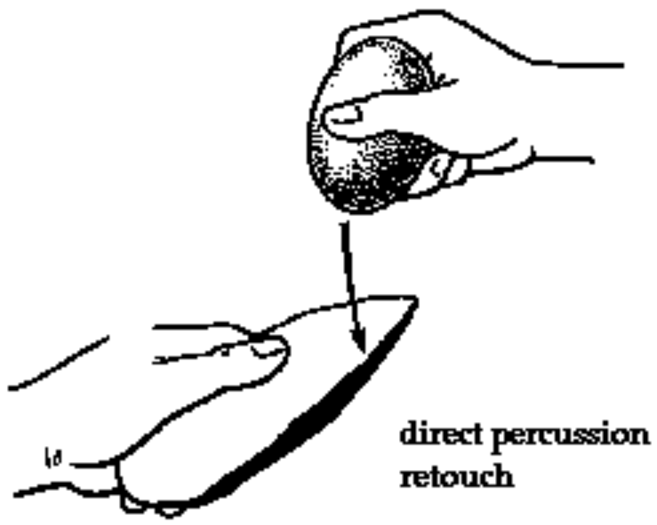
To detach a flake or a blade it necessary to use an implement called a hammer or percussor. These can be harder or softer than the material being flaked. Examples of materials used for hard hammers are pebbles of dense stones such as quartzite or flint, with soft hammers being made from antler, horn, bone, ivory or wood.

Different stages in artifact manufacture can require several different flaking tools and methods. Various experimental studies have shown that the use of these different hammers can be identified (for example, Bordes 1947, 1948; Bordes & Crabtree 1969; Crabtree 1967; Newcomer 1971, 1975; Ohnuma & Bergman 1983, Tixier 1980). Although it is fairly easy to distinguish hard hammer from soft hammer it is more difficult to recognise percussors of different materials (example, soft stone and antler) within the same group (Ohnuma and Bergman 1983, 161-170).

direct percussion

Direct percussion or simple percussion takes place when the hammer, which can be hard or soft, is applied directly to the piece being worked. This does not necessarily result in rough or crude flaking. As has been demonstrated by experimentation a skilled knapper can produce well-formed and even elaborate artifacts using this production technique (example, Newcomer 1975, 99-101).





indirect percussion

Indirect percussion is a technique which involves striking a punch-like object with a hammer or percussor. The tip of the punch is rested on the platform of the core at the point intended to receive the blow. It is important to keep the core immobile during the striking process. When using this technique it is also advisable to prepare the core platform to prevent the punch from slipping.

"In indirect percussion a punch of antler or wood or other hard material is placed on the platform and struck with a hammer, instead of striking the stone directly with the hammer. This allows the force to be directed very precisely, an important factor in making blades, which require a carefully prepared core with an even platform and regular ridges for the blades to follow." Whittaker 1994., 33.

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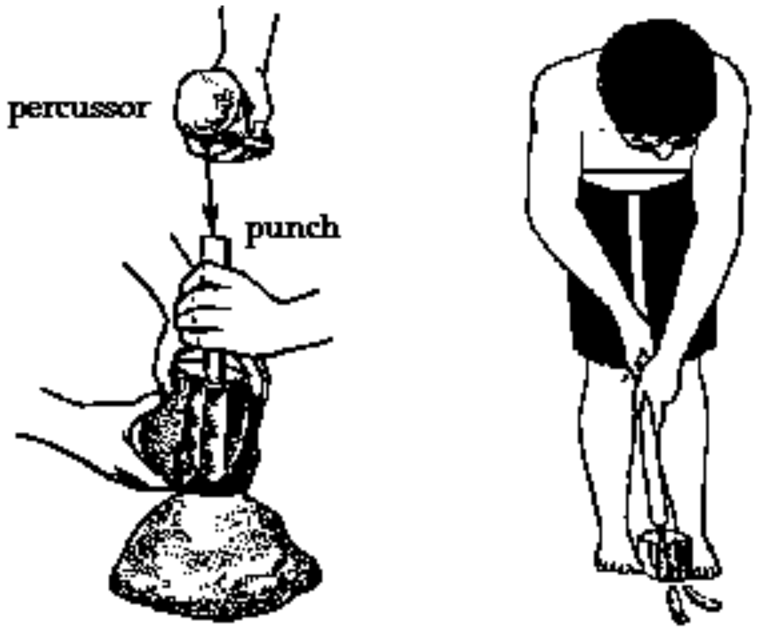
indirect percussion



hard hammer

"Hard hammer percussion - that is, striking the tool with another stone to remove flakes." Whittaker 1994., 27 The following are indications of the use of a hard hammer or percussor:

-unlipped and often large butt and pronounced bulb of percussion.

-a clear cone and marked point of percussion.

-pronounced conchoidal fracture marks on the bulb.

-clear concentric percussion rings and fissures. see Ohnuma & Bergman 1983.

hard hammer

Movie 2.3 basic flint knapping with hard hammer

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soft hammer

The following are indications of the use of a soft hammer or percussor:

-vague cones of percussion and diffuse bulbs of percussion.

-narrow butts which are often punctiform or with a lip. Lipped butts have a small overhang on the ventral surface at the edge of the butt (Owen 1988, 218). see Ohnuma & Bergman 1983

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breakage patterns

1. intentional break
2. manufacturing snaps

BREAKAGE PATTERNS

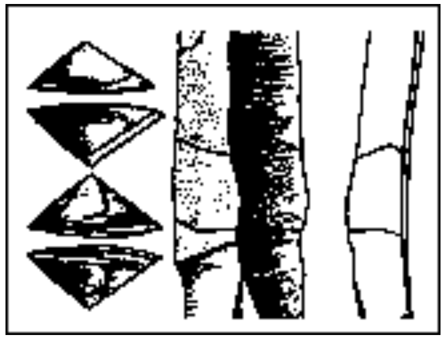
Numerous studies have been undertaken in an attempt to separate intentional from accidental snaps or breakage (for example, Bergman et al 1987, Kobayashi 1985, Owen 1982, Roche & Tixier, 1982). Although distinct features are associated with intentional breakage patterns, such features can also occur from natural agents such as trampling and soil movement.

intentional break

"A method of producing a transverse fracture to sever flakes or blades. Pressure or percussion force is applied from the ventral toward the dorsal side" (Crabtree 1982., 53).

Normally undertaken to reduce the size, or remove unwanted sections, of an artifact (such as the bulbar end or the distal end). This is surprisingly difficult to accomplish directly by hand with any degree of accuracy (Owen 1982, 78-79).

Either a hard hammer or soft hammer can be used. This leaves characteristic features of a normal detachment, such as a bulb, lines of force, etc. (Owen 1982,, Roche and Tixier 1982).



manufacturing snaps

Manufacturing snaps can occur in many different ways. Some examples of these are:

-snaps from buckling of the artifact during detachment from the core (Cotterell & Kammiga 1987, 700)

-breaks that occur during attempts to truncate the artifact, called languette fractures (Lenoir 1975; Roche & Tixier, 1982, 71)

-damage that occurs when inappropriate amounts of force are applied to an artifact.

An example of this is transverse snaps which occur during the application of retouch, particularly from pressure flaking (Roche & Tixier, 1982, 69). Manufacturing snaps are often caused by inadequate core preparation or the application of inappropriate amounts of force, however, faults in the raw material can also be the culprit.

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SECTION 5

knapping features

1. hinged flake
2. hinged negative removal
3. plunge
4. plunged negative removal
5. miss-strike rings
6. feathering
7. step fracture

KNAPPING FEATURES

Various features can be observed on some artifacts that indicate errors in preparation or judgment on the part of the knapper. Identifying these occurrences can assist in forming a picture of the knapper's individual abilities. For example, all knappers occasionally misjudge a blow but indications of repeated poor judgment can denote the work of a beginner or a novice (Bodu et al 1987; Pigeot 1990; Ploux 1991).

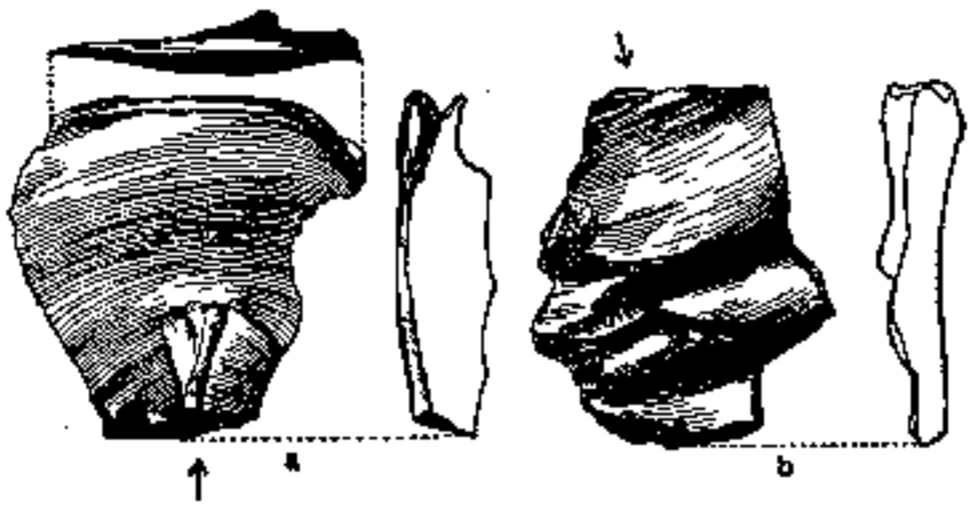
The following are some knapping errors and features that indicate poor core preparation or maintenance.

hinged flake

A hinge detachment occurs when the plane of the fracture, "turns abruptly outwards and leaves the edge of the flake blunt and smoothly rounded. These fractures are particularly liable to be mistaken for polishing ..." (Trustees of the British Museum, 1968, 29).

Hinging occurs because the angle of detachment is incorrect (i.e. at 90 degrees) and the face of the core is concave or straight. (Se Cotterell and Kammiga 1987, 700-701 and Crabtree 1982., 37).

It is the exact opposite of a plunge fracture.



hinged negative removal

This occurs as the characteristic "hook" on the face of a core when a hinged flake has been detached. It requires an intentional correction blow to be applied to rid the core face of this feature, which will continue to occur repeatedly if the platform and the face of the core are not adjusted. As noted by Cotterell and Kammiga 1987, 701. hinged flakes and hinged removals on the face of a core are "undesirable" elements.

plunge

Plunging occurs when the fracture plane turns abruptly towards the centre of the piece and takes away part of the core. The two main characteristics are a very concave ventral surface, and a thickening at the distal end. (Tixier 1974, 19). This occurs when the angle of detachment is too acute on the platform and the face of the core is too convex (Cotterell and Kammiga 1987, 701). (Also see Roche and Tixier 1982, 72-73). This is the exact opposite of hinged flake.

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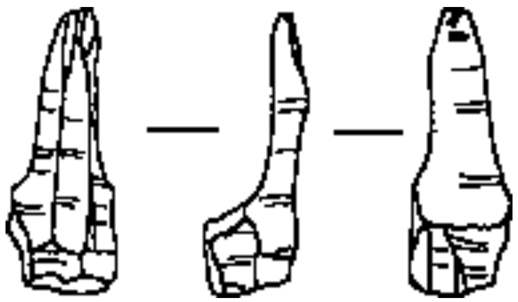
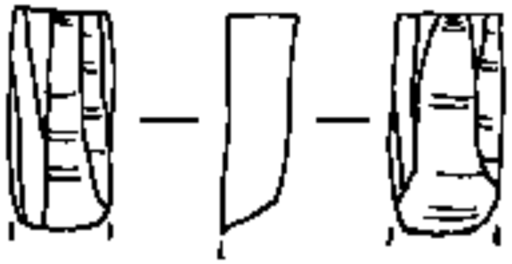
plunging fracture



plunged negative removal

The negative detachment from a plunged removal leaves a highly characteristic scar. When this occurs on a blade core it is often detected by the full removal of the opposite platform. This is a knapping error, which, to quote Tixier 1974, 19, anyone who tries flaking experiments will discover sooner or later to their cost.



miss-strike rings

A miss-strike ring is an opaque circle that can be found near the point of impact or percussion on the butt of a detachment or on the core platform. It occurs when a blow is struck which is not sufficient to detach a flake or a blade and "appears as a small circle, probably surrounded by a patch of discolouration due to the interference of the crack with the passage of light through the flint"
(Trustees of the British Museum, 1968, 26).

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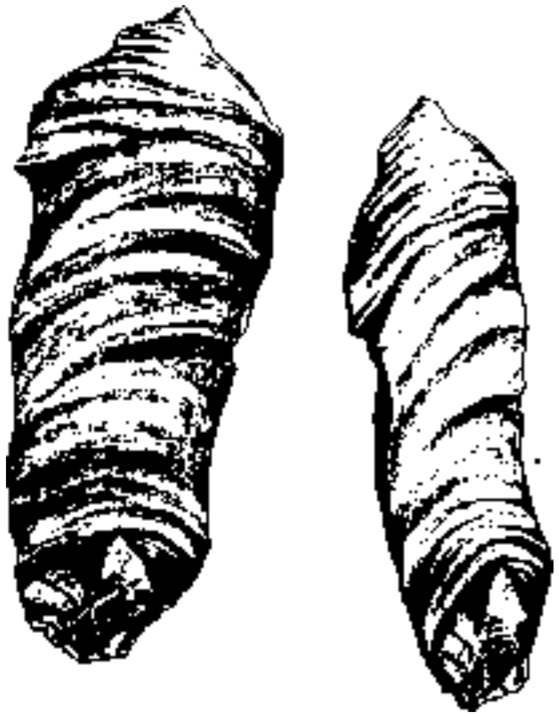
feathering

"A technique which produces a flake which terminates in an edge with a minimal margin. Produces blades or flakes with edges and distal ends which are very sharp. Feathered edge leaves slight ridges on the objective piece, a characteristic of precision collateral flaking" (Crabtree 1982, 33-36). Although feathered edges are thin and sharp they are also easily broken. (Also see Owen 1988, 220).



step fracture

A flake or flake scar that terminates abruptly in a right angle break at the point of truncation. Caused by a dissipation of force or the collapse of the flake (Crabtree 1982, 53). Cotterell and Kammiga 1987, 700 claim it can be caused by the flake buckling during detachment.

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retouch types

1. scraper retouch
2. parallel retouch
3. sub-parallel retouch
4. fine retouch
5. abrupt retouch
6. scalar retouch
7. invasive retouch

RETOUCH TYPES

There are 7 main types of retouch. These have been defined by Tixier, Inizan and Roche 1980, 92 and Bordes 1961, 9-10 as scraper retouch, parallel retouch, sub-parallel retouch, and scalar retouch, with additions noted by Brézillon 1977, 109 of fine retouch, abrupt retouch, and invasive retouch.

To indicate where the retouch is found on an artifact another set of terms is used.

See position of retouch.

scraper retouch

This type of retouch is called scraper or normal retouch as it is one of the most common types found in the manufacture of tools. It can be formed by hard hammer or soft hammer percussion Furthermore, it is often direct and modifies the edge which then tends to form an angle of approximately 50 degrees with the ventral surface. It is also sometimes referred to as semi-abrupt retouch.

parallel retouch

Parallel retouch type is the detachment of long, thin, evenly spaced removals (Bordes 1961, 9-10; Tixier, Inizan and Roche 1980, 92). This is normally considered to be restricted to use in producing more elaborate tool types, such as daggers or knives.

This type of retouch can be applied to produce a number of special effects, particularly when it is placed obliquely, transversely or in the form of a chevron.

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sub-parallel retouch

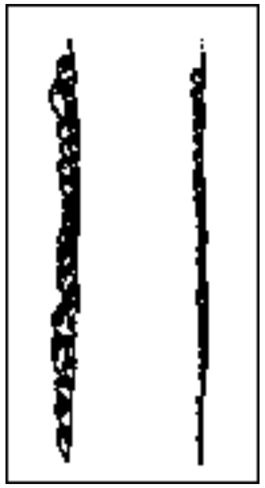
Sub-parallel retouch type is very similar to parallel retouch only it is not as precise or as even (Bordes 1961, 9-10; Tixier, Inizan and Roche 1980, 92).

Again the retouch is applied by pressure flaking which, in common with all retouch, is applied to the surface opposite the one facing the knapper.

fine retouch

Fine retouch type is made by applying a line of small (i.e. a few millimeters in size) evenly-spaced removals to the edge of the blank. This normally does little to the outline of the piece - it is most often used to correct minor irregularities to the natural shape of the artifact. See Brézillon 1977, 109 and 1 1 4 .

It is necessary to check carefully that this retouch type is not confused with edge damage. Fine retouch must be composed of evenly-spaced, well-formed, continuous removals which are normally restricted to one surface (i.e. the dorsal or the ventral). Edge damage is, by definition, irregular, erratic and is frequently found on both surfaces.



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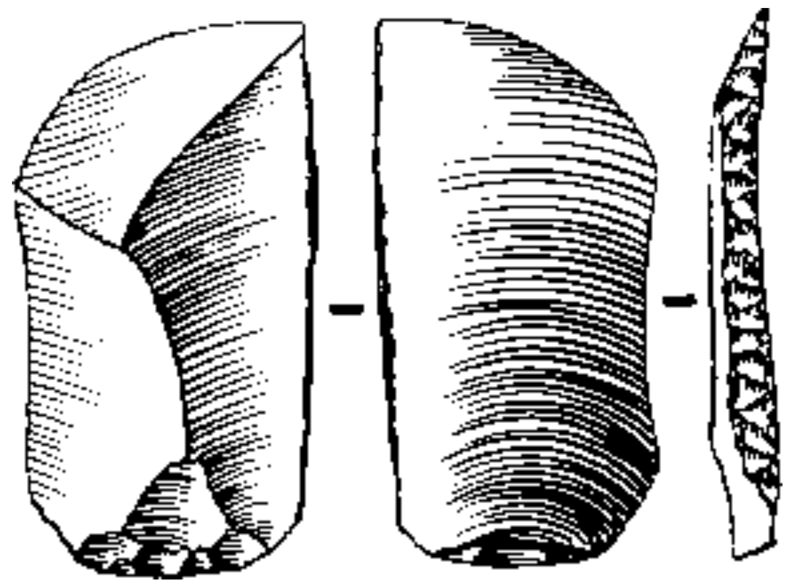
abrupt retouch

Abrupt retouch type is applied at between 70 and 90 degrees on the edge or end of an artifact. It is produced in two ways: with and without the use of an anvil. These have been defined as follows:

"Normal abrupt retouch. This is retouch, only slightly or not at all scaled, where the removals form a neat right angle with the ventral surface and clearly reduce the width of the piece, thus squarely removing the cutting edge of the edge or edges it occupies, forming a 'back'" (Tixier 1974, 20).

"Abrupt retouch on an anvil. This is abrupt retouch where the removals start from both surfaces of the piece and form a back. ...it appears that (a piece was) placed on an anvil then retouched all along the edge, the removals made by the counterblows of the anvil only beginning at the point where the piece comes in contact with the anvil..." (Tixier 1974, 21). This form of application is often characterized by crushing along the surface of contact with the anvil.

Abrupt retouch completely removes the original cutting edge of a blank. When this is applied to a lateral edge it is called backing; if applied to the distal end the piece is considered to be truncated flake or a truncated blade Truncation can be an end in itself or a means to further production. Due to the steep angle to the ventral surface formed by this application this type of retouch is normally used for shaping and blunting rather than for sharpening a blank. See Brézillon 1977, fig. 20, h and i; and 108, 110, 115, 118-122.



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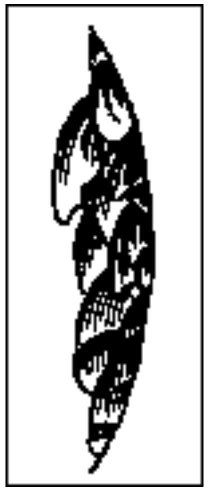
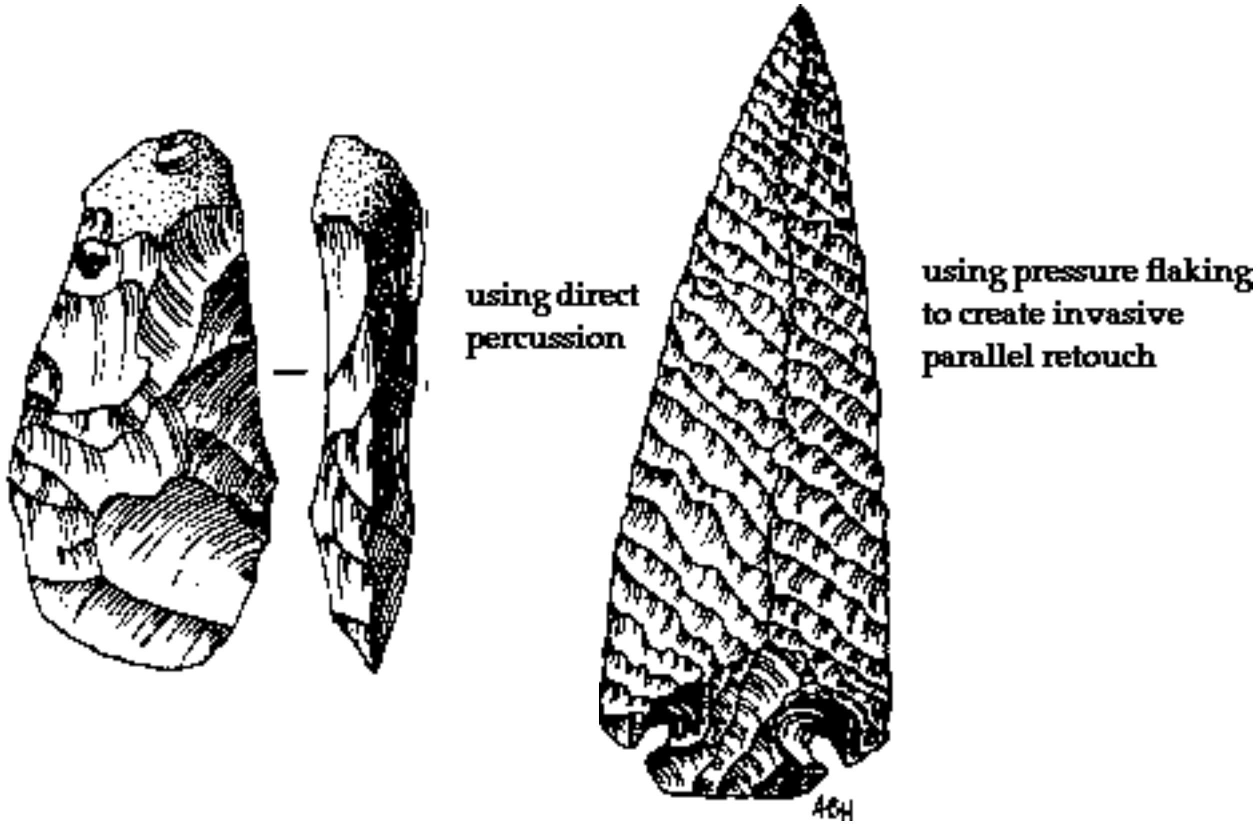
scalar retouch

Scalar retouch, or scaliform retouch type, is a semi-abrupt form which fractures on the end of the removals in steps or scales. It is a more extreme form of scaled retouch and the depth and angle of the detachments imply the use of a dense or sturdy percussor (Bordes 1961, 9-10; Tixier, Inizan and Roche 1980, 92). It has been successfully duplicated by using the central section of a wooden baton percussor and striking abruptly onto the edge chosen for modification. Scalar retouch can be applied to thin blanks, but because of the depth of the removals a thick blank is often used. Scalar retouch is also called Quina retouch as it application is characteristic of this Middle Palaeolithic, or Mousterian, industry. See Brézillon 1977, 112.



invasive retouch

Invasive retouch position is the term used to describe the application of retouch that covers most, or all, of an artifact. In the lower Palaeolithic handaxes are produced with invasive bifacial retouch using direct percussion. In later periods invasive retouch is often achieved by using the long flake removals of parallel retouch and/or sub-parallel retouch, which are thought to be applied by pressure flaking. It differs from other retouch positioning in that it is applied with the purpose of shaping the entire artifact - others are restricted to modifying the edges. Invasive retouch can be applied unifacially, bifacially or can be limited to selected areas of an artifact.



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What kind of retouch is this ?

- A. scraper
- B. abrupt
- C. invasive
- D. scalar

Check Answer

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position of retouch

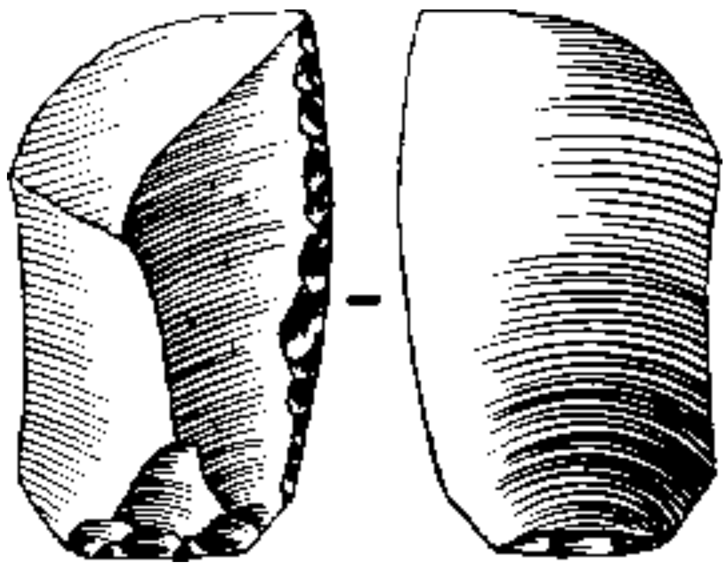
POSITION OF RETOUCH

The following terms are used to define where retouch is found, or to indicate the position of the retouch, with regard to the surfaces of a flake, blade or microblade: these are direct retouch position, inverse retouch position, alternate retouch position, alternating retouch position, bifacial retouch position and invasive retouch position. These terms are used by Tixier 1974, 14, 15, 3, 4 and 21) Tixier, Inizan and Roche 1980, fig.41 and p. 87, 100) and Brézillon 1977, fig. 20 and p.110-111). Another set of terms are used to describe the type, morphology and technology of retouch.

See retouch types

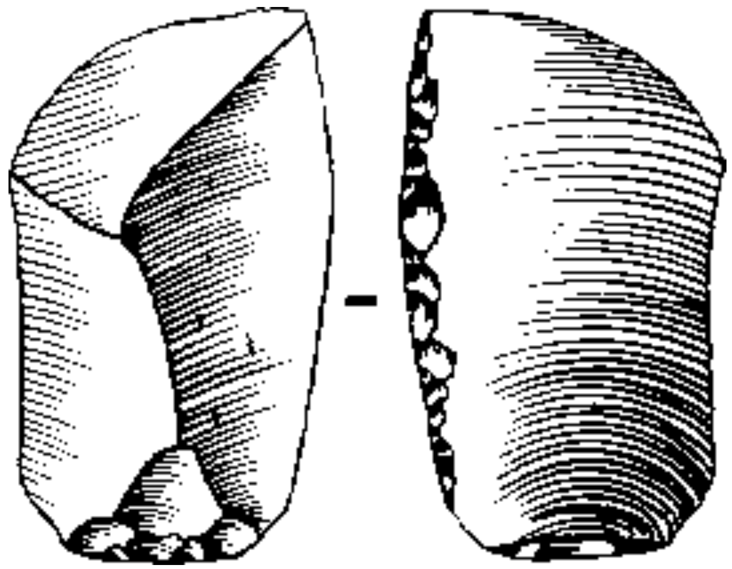
direct retouch

Direct retouch position has been defined as "retouch in which the...removals start from the ventral or bulbar surface. Also called normal retouch" (Tixier 1974, 14). It is called normal retouch as it is the most common retouch found and is the easiest to apply - the knapper works from the ventral surface, which forms a flat striking platform, onto the convex dorsal surface. As illustrated it can only be seen from the dorsal surface and leaves no traces on the ventral face.



inverse retouch

Inverse retouch position is the opposite of direct retouch position in that it is formed "when removals start from the dorsal surface" (Tixier 1974, 15). It is more difficult to apply than direct retouch in that the knapper must work from a convex surface on to a flat surface. No traces of it can not be seen from the dorsal face - it is only visible from the ventral surface.



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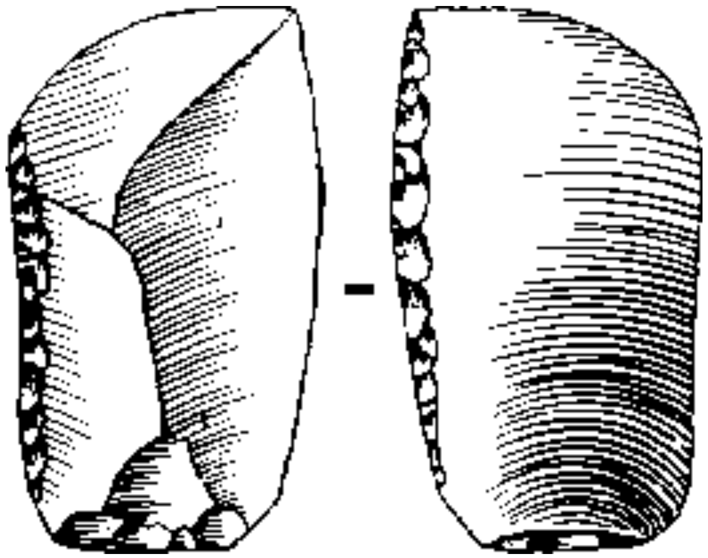
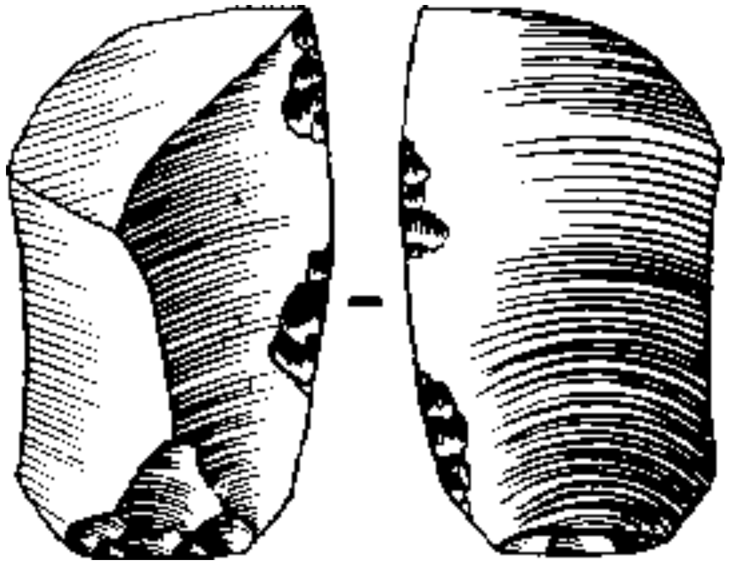
alternate retouch

Alternate retouch position is "retouch which is worked along part or all of both edges of a piece, starting from the dorsal surface on one edge and from the ventral surface on the other edge" (Tixier 1974, 3). It can also be described as a combination of the use of direct retouch position along one edge of a blank and inverse retouch position along the other edge.



alternating retouch

The term alternating retouch position was introduced by Bordes 1961, 29 to describe the retouch found on a group of side scrapers. It has been defined by Tixier 1974, 3 as "retouch which starts alternately from one surface then from the other on the same edge of a flake, blade or bladelet. When identifying this retouch it is essential to assure that it is consistently regular and continuous. As Bordes 1961, 45 warns, this is the most common form of ´retouch´ to be found on pseudo-tools. Strips of edge damage also often appear to alternate from one side of an artifact to the other.



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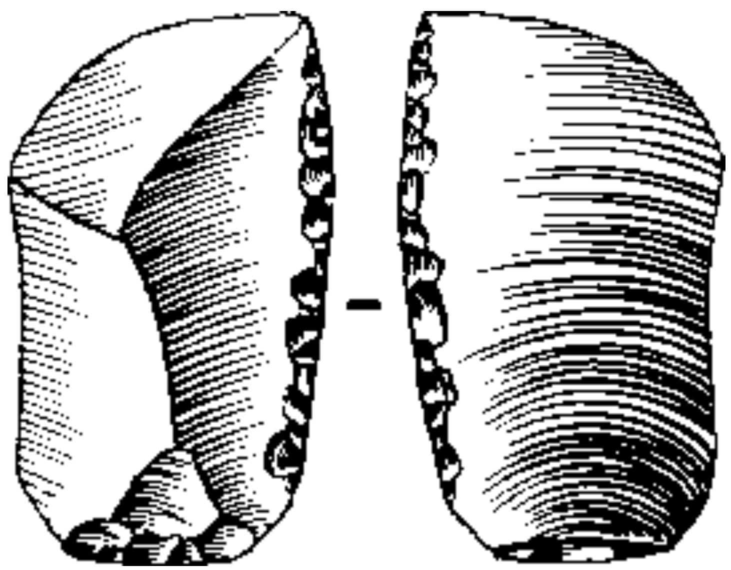
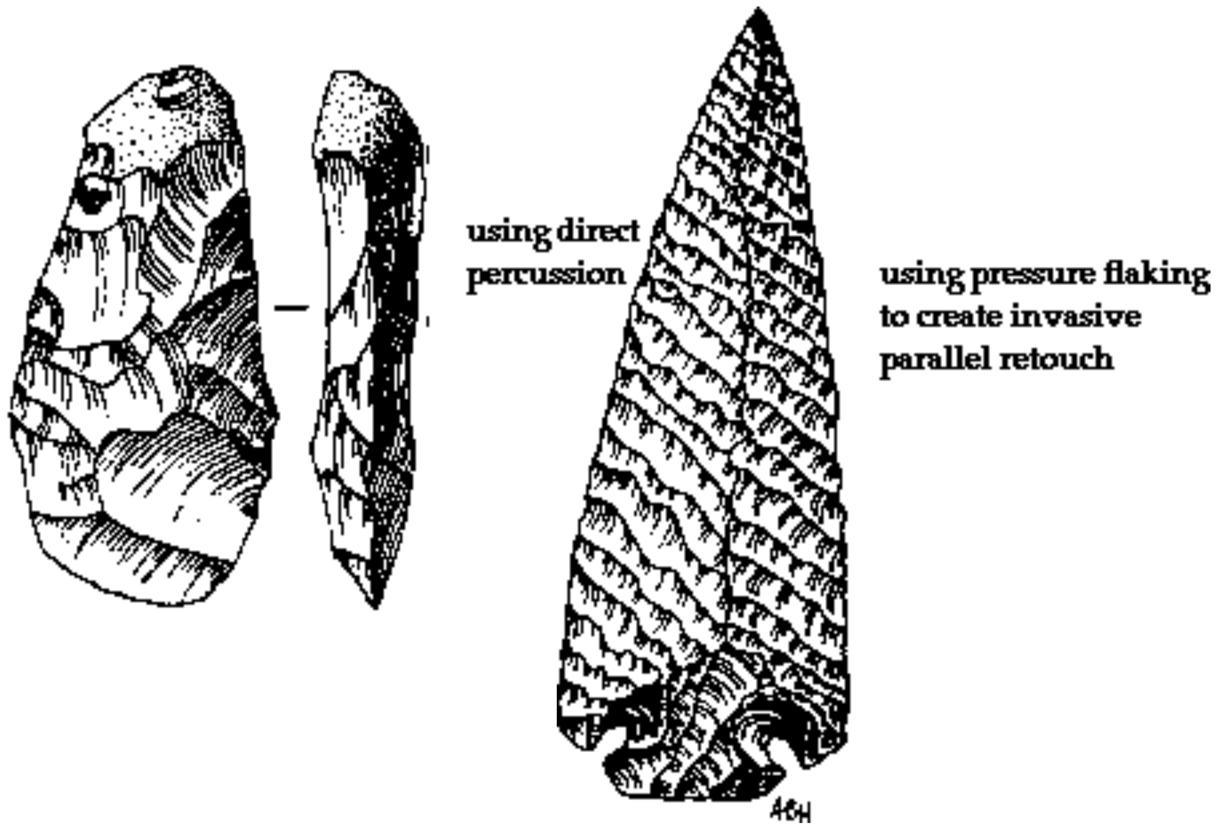
bifacial retouch

Bifacial retouch position is produced when direct retouch and inverse retouch are applied along the same section of the same edge of an artifact (in opposition to alternate retouch, where this combination is found along opposite edges). It has been defined by Tixier 1974, 4 as "retouch worked on both surfaces of an object, covering each surface partially or totally." It is possible to ascertain the last surface to be worked by determining which set of retouch scars are complete and which set are cut by these detachments.



invasive retouch

Invasive retouch position is the term used to describe the application of retouch that covers most, or all, of an artifact. In the lower Palaeolithic handaxes are produced with invasive bifacial retouch using direct percussion. In later periods invasive retouch is often achieved by using the long flake removals of parallel retouch and/or sub-parallel retouch, which are thought to be applied by pressure flaking. It differs from other retouch positioning in that it is applied with the purpose of shaping the entire artifact - others are restricted to modifying the edges. Invasive retouch can be applied unifacially, bifacially or can be limited to selected areas of an artifact.



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What is the position of this retouch ?

- A. inverse
- B. alternate
- C. direct ✓

Check Answer

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special techniques

1. pressure flaking
2. burin technique
3. micro-burin technique
4. levallois technique
5. groove and splinter technique
6. burin technique movie
7. micro-burin technique movie
8. levallois technique movie
9. groove & splinter technique movie

SPECIAL TECHNIQUES

There are a number of special techniques used to produce some tools.

pressure flaking

Pressure flaking is the process of forming an artifact by removing surplus material, in the form of chips and flakes, by a pressing force rather than by percussion (Crabtree 1982, 49).

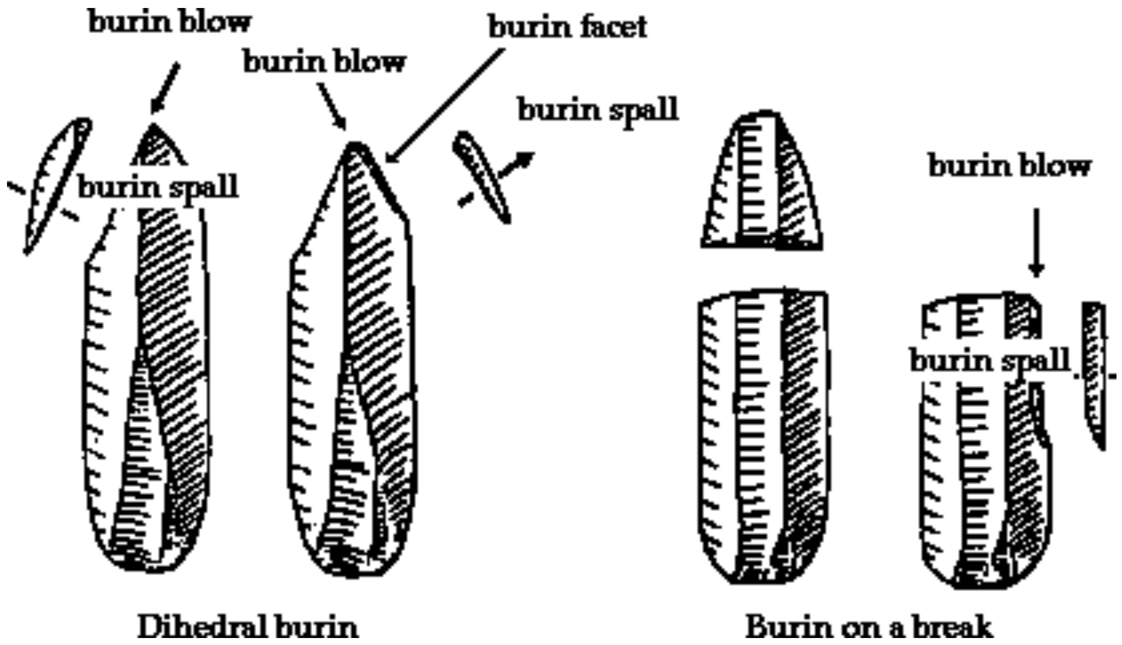
"Pressure flaking involves removing flakes from the edge of a tool by pressing against it, usually with an antler or bone tool, instead of striking it. Pressure flaking is generally used for the final retouch on tools that were begun by other techniques." Whittaker 1994, 33.

photo by Alan Williams

burin technique

Burin: A chisel-like implement derived from a flake or blade; the modification of other implements by using the burin technique to remove the edges parallel to their long axis and/or transversely or obliquely. Generally forms a right angle edge on one or both margins. The specialized flake removed as a result of the burin break is called a burin blade or burin spall" (Crabtree 1982, 27).

The negative scar produced by the removal of a burin spall is calleda burin facet. A burin is a tool which can take many forms, but all are made by the burin blow technique. This has been defined as the action of making the ´sides´ or facets of a burin.



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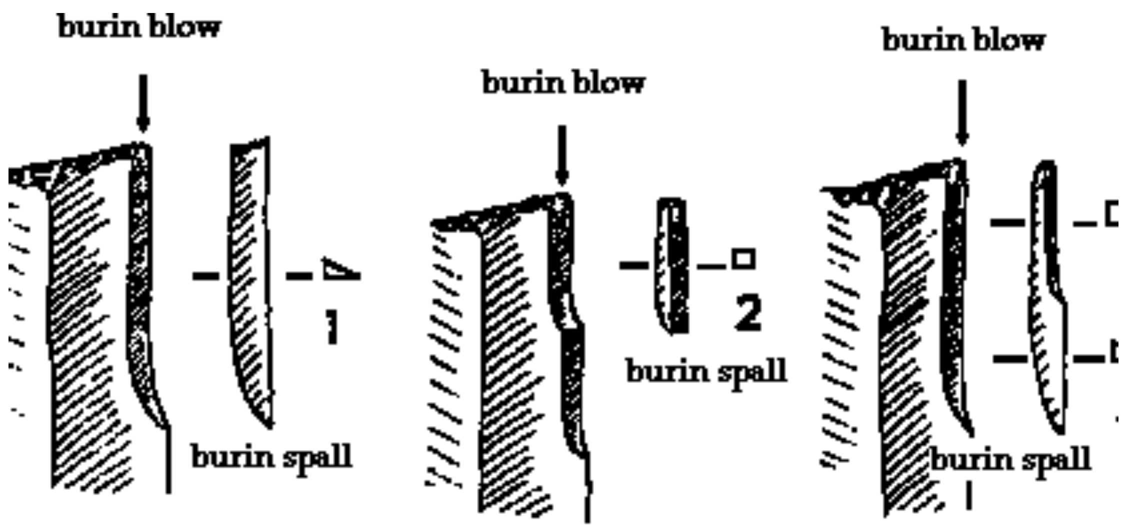
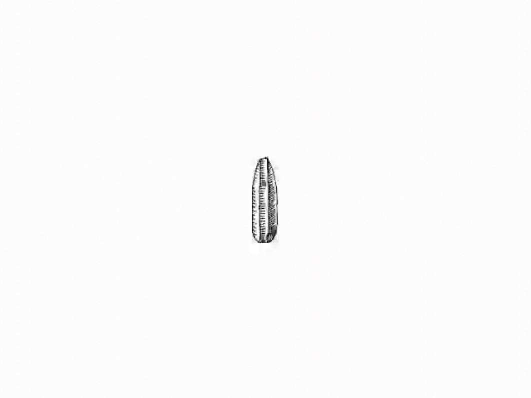
A burin spall can be defined as "the part of a flake, blade, or bladelet detached by burin blow technique" (Tixier 1974, 9).



Burin on an edge of a truncated blade with different kinds of burin blows

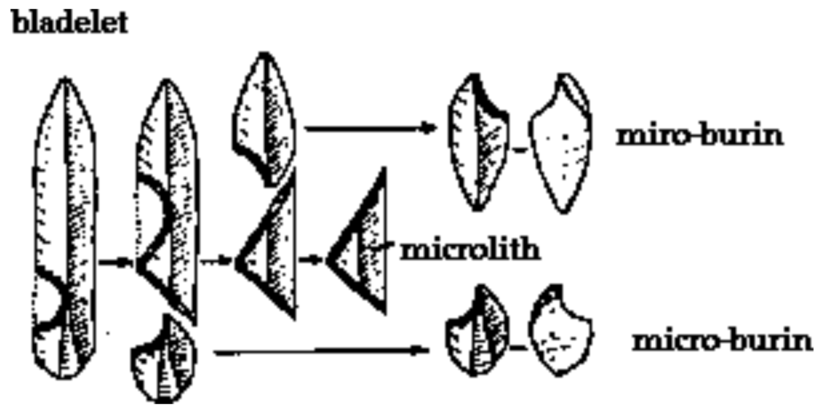
MOVIE 2.4 burin technique sequence



micro-burin technique

"Micro-burin: Waste product not intended for function. Usually the proximal or distal end of a blade. Residue of geometrical microlith industries." (Crabtree 1982, 43)

"Micro-burin Technique: Method of severing blades to make geometrical microliths. Technique requires first weakening the blade by marginal notching and then breaking it at the notch." (Crabtree 1982, 43) Also Brézillon 1977, 1 Micro-burin technique can be acheived by use of an anvil



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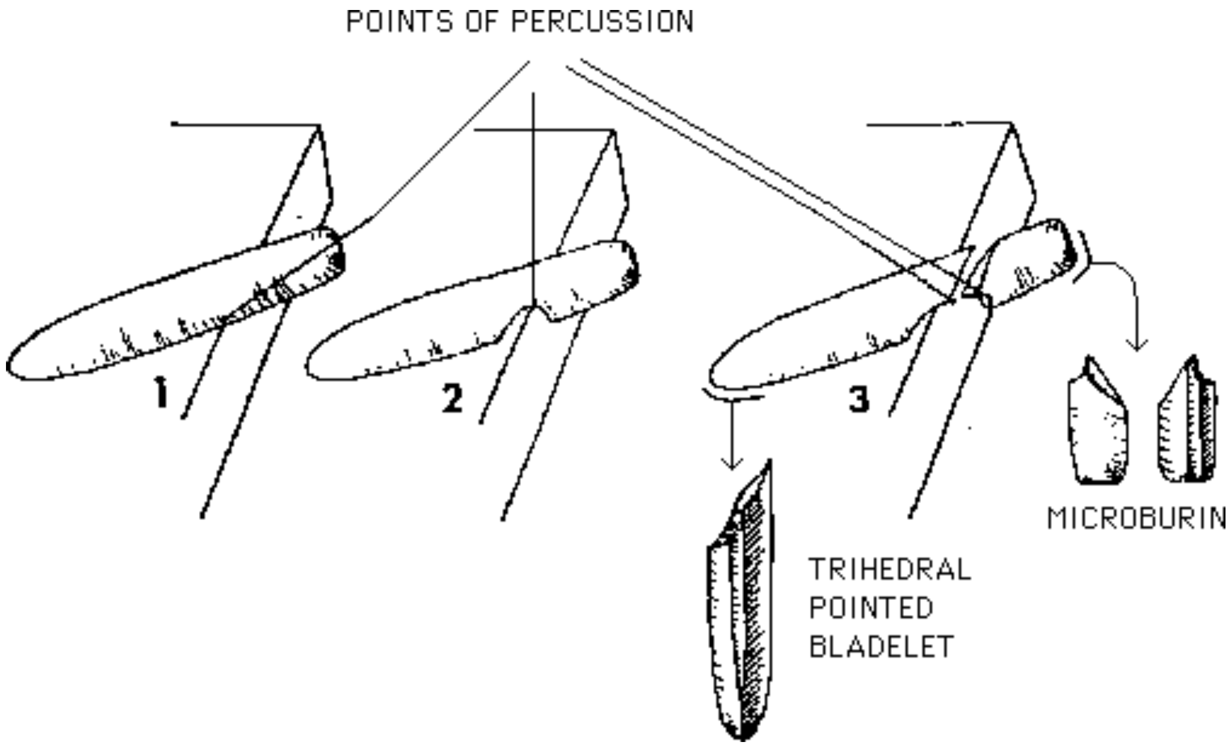
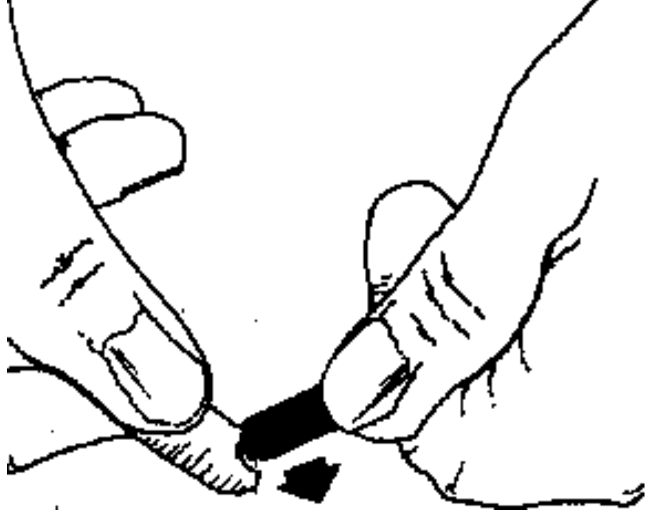
Movie 2.5 How micro-burins are made

Micro-burin technique can be achieved by use of an anvil



or by pressure



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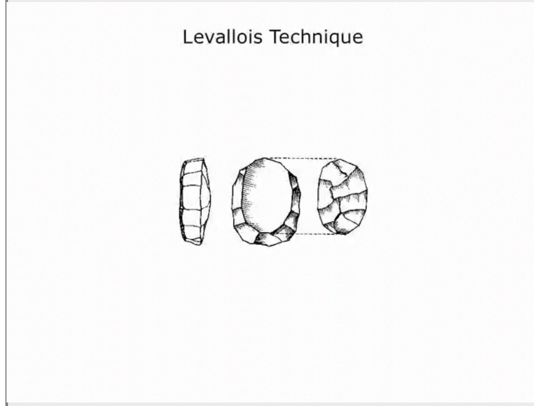
levaillois technique

Levallois is the name archaeologists have given to a distinctive flint knapping technique, which makes up part of the ancient Acheulean and Mousterian artifact assemblages.

The stone tool making technique involves flaking pieces off the edge of a large piece of flint until it is shaped like a turtle shell, and using the core to make tools. The Levallois technique is thought to have been used by Neanderthals in Europe beginning about 250,000 years ago, and then perfected during the Mousterian of 100,000 years ago.

Levallois core

Movie 2.6 levallois technique



Levallois point

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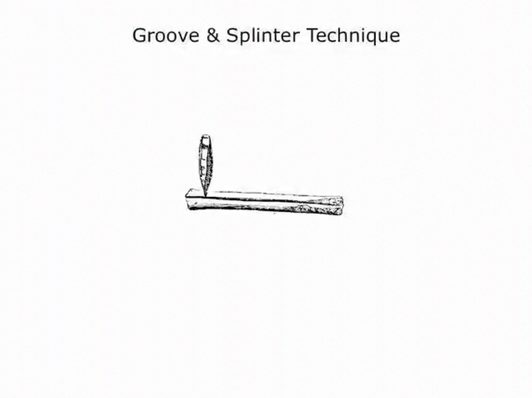
groove and splinter technique

Groove and Splinter technique is a method of extracting a piece of antler from antler tines which can then be used to make antler artefacts such as points and harpoons. This technique can be reconstructed from the waste material that has been recovered from sites where preservation is good e.g. Stellmoor and Star Carr

Movie 2.7 groove & splinter technique



splinters removed from antler tine

http://capra.group.shef.ac.uk/1/carsing.html

It has been assumed that burins where predominately used for this grooving process. However, replication of the technique along with the examination of grooved antlers from Star Carr has demonstrated that, at least in the case of Star Carr, the burins cannot have been used for this purpose. Measurements of the width and depth of the grooves and demonstrated that the burins simply would not have fitted into the grooves and so cannot have been used to incise the grooves. (Mertens 1986). The awls, often assumed to be boring tools, did fit the grooves. In experimental replication the awls, being narrower and pointed, proved ideal for the task of incising the antler. The burin facets were most suitable for using in a scraping motion for the manufacture of harpoons and points. Microwear analysis confirmed that the use wear on the burin sample from Star Carr was consistent with the facets being used to scrape antler.

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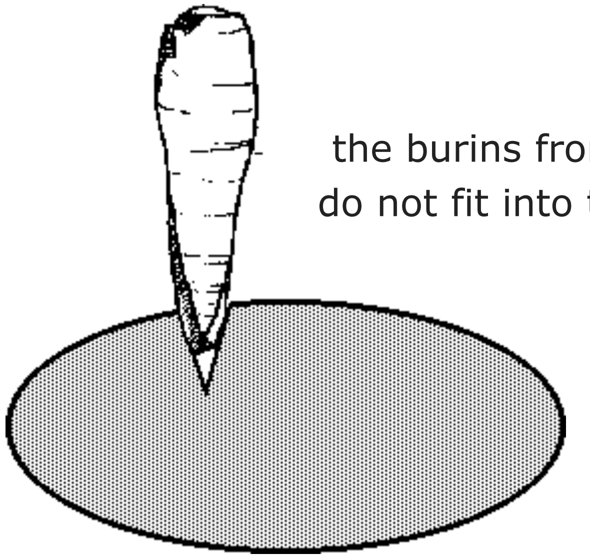
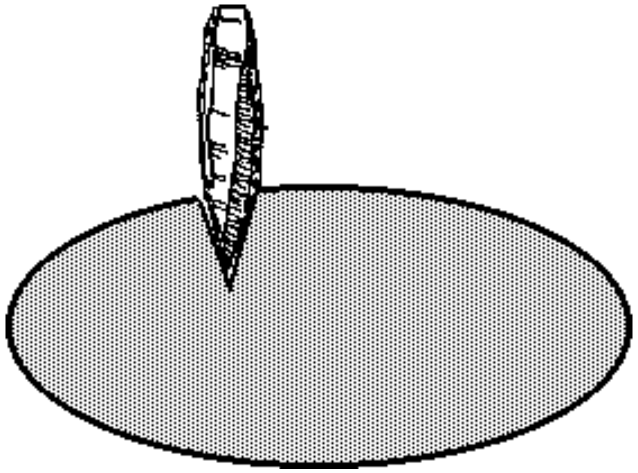
grooving with a burin



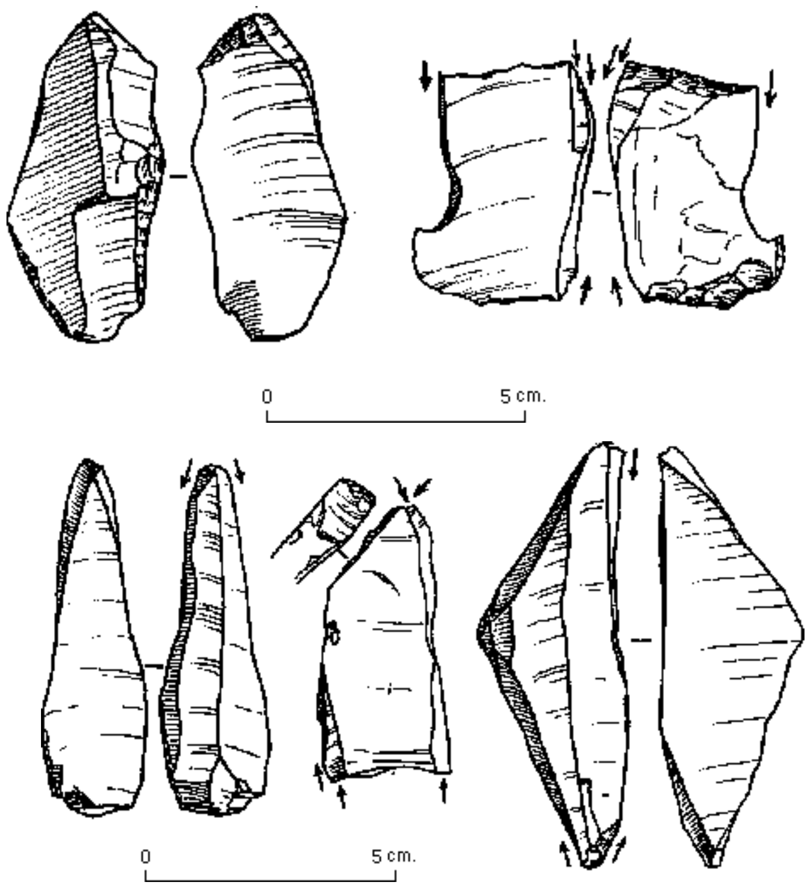
the burins from Star Carr
do not fit into the grooves!

grooving with an awl

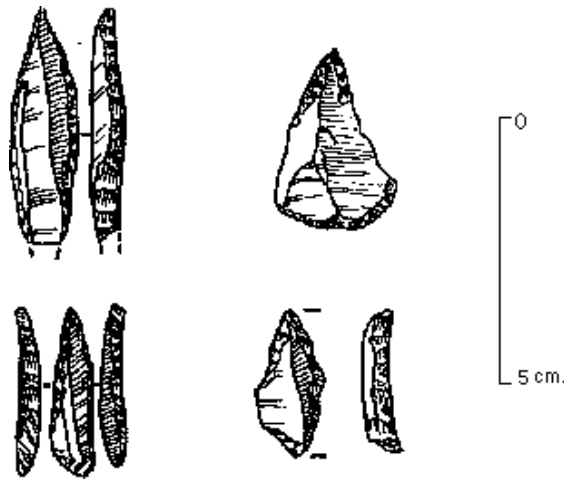


the awls do fit and are far better for grooving than burins in experimental replication of the groove and splinter technique. (Mertens 1986)

burins from Star Carr



awls from Star Carr



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raw materials

Raw material refers to the stone from which debitage, tools etc. are produced. A number of raw materials were used in pre-history, the most common feature of these materials is that they have the property of conchoidal fracture thus enabling the knapper to control the core and produce predictable outcomes of the knapping procedure

natural alteration

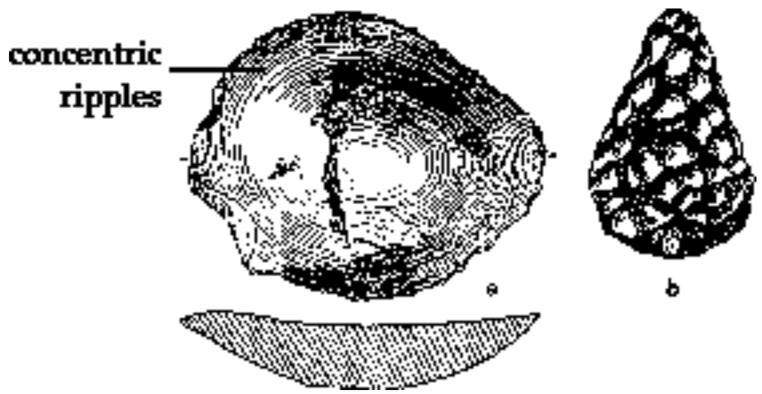
1. heat fracture
2. frost fracture
3. patination
4. desert polish
5. starch fractures
6. fire-cracked rocks
7. ballast
8. edge damage
9. patination interactive graphic

NATURAL ALTERATION

Lithic material can altered by natural processes so that they sometimes resemble tools. Such lithics are known as eoliths. Also some lithic material can appear to be polished by agencies such as wind and sand, often referred to as desert polish. Also debitage can be altered by natural processes such as heat, frost and patination.

heat fracture

"Pot lids are plano-convex flakes that leave a concave scar. These are the result of differential expansion and contraction of isotropic material but are minus the compression rings of force lines usually associated with these conditions. Generally they are a natural occurrence rather than intentional results of man-made flakes" (Crabtree 1982., 49).



frost fracture

Frost fracture is caused by water within the flint (or in cracks in the flint surface) freezing and so expanding. When the water melts pieces of flint break off the nodule. This freeze-thaw action can continue through the depositional history of artifacts. Also natural nodules of flint may be 'flaked' by frost action to give the appearance of being deliberately knapped, e.g.starch fractures

patination

"Many cherts and flints will patinate, developing a weathered surface as water and sometimes chemical stains work their way into the flint and as silica and other materials are leached out, producing a thin patina or rind of a different color" Whittaker 1994. , 70

In southern Britain the patination is usually a blueish colour.

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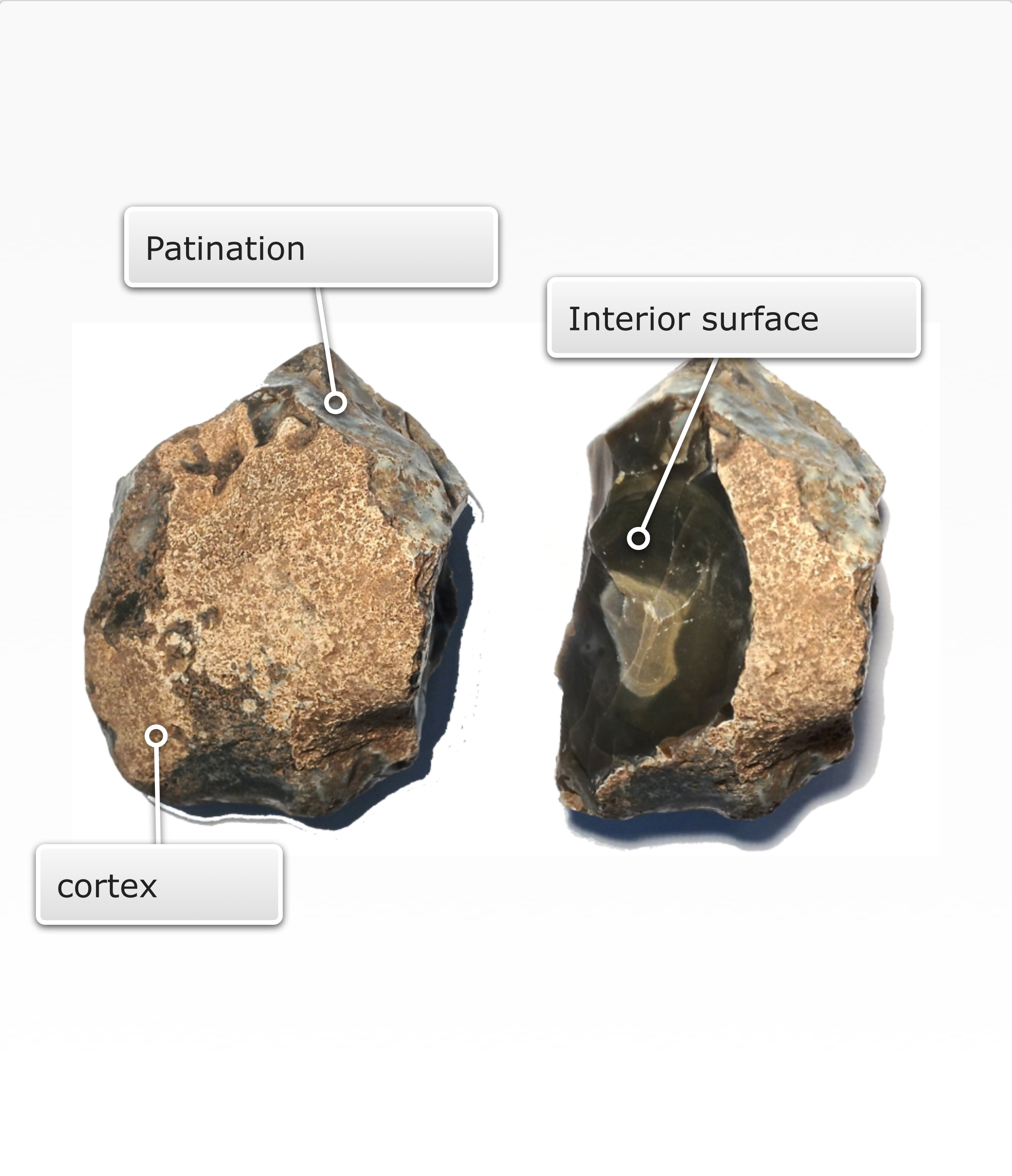
If the patinated nodule is flaked then the original black surface of the flint is revealed.

Interactive 3.1 **patinated nodule with flake removed**



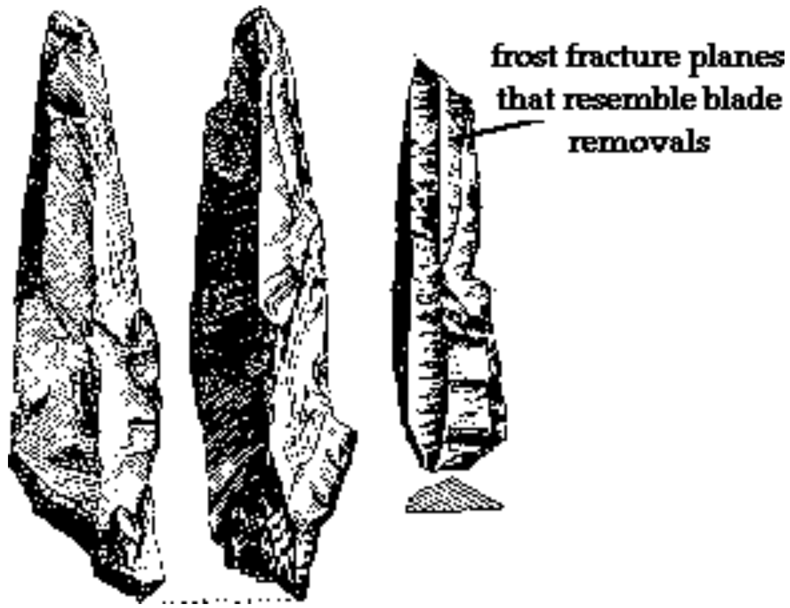
desert polish

Desert polish is created by a combination of wind and sand. The movement of sand across exposed flint surfaces polishes the surface to a high gloss that can be seen by the naked eye. It can have the appearance of sickle gloss except that the polish is all over the surface.

sickle gloss is a use wear polish created by using tools for cutting cereals and therefore is a use-wear polish. It is visible to the naked eye, but only occurs on the used edge, not all over like desert varnish.

starch fractures

Starch fractures occur from freeze- thaw action along planes in the flint sometimes appearing as if blades have been deliberately removed and sometimes leading to such natural objects being classified as blade cores.



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fire-cracked rocks

Fire-cracked rocks are produced by the heating of water in the flint which then forces off pieces. The same process as Heat fracture often resulting in pot lid fractures. The same process as Heat fracture often resulting in pot lid fractures. Futher heating will cause severe cracking of the flint surface and changes in colour first blue, and then as the temperature increses, white.

ballast

Flint that may appear to be humanly struck can sometimes be ballast, that is flint that was used as ballast on ships which has subsequently been discarded.

edge damage

When flakes have been removed from the edge of a blank by natural processes this can (and often is) confused with re-touch. There are various sources of edge damage:

Trampling during occupation of the site;

Post depositional movement in the sediment;

Rough handling during excavation, e.g.. trowel damage; Storage conditions, e.g.. 'box damage' (if flints are kept loose in a box they can rub together often causing fractures along the edges.

"Edge damage: The removal of material from edges by natural processes, spontaneous retouch, soil movement, trampling etc." as opposed to, "Edge wear: The removal of material from edges by flaking and/or rounding by use." (Grace 1989, 114) It is impossible to reliably tell the difference between edge damage and edge wear without using special techniques such as use-wear analysis.(see Grace 1989, Grace1990a, Grace 1993., Kamminga 1982 , Keeley 1980., Semenov 1964)

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nodules

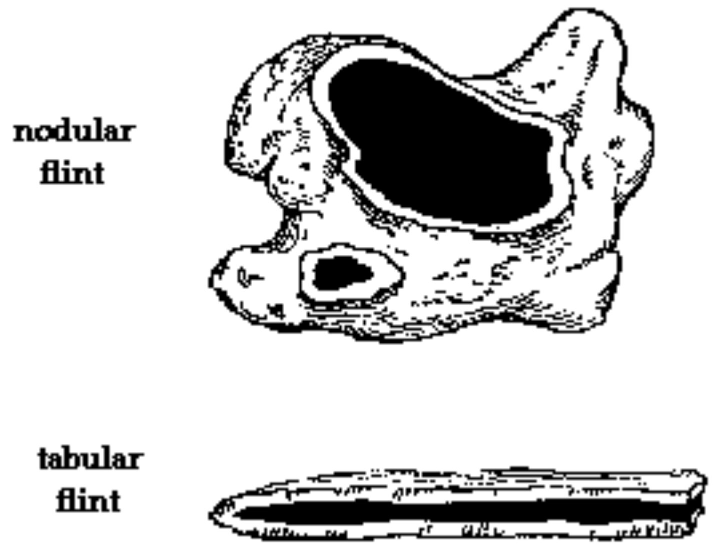
1. flint
2. obsidian
3. slate

NODULES

Most lithic raw material is procured as nodules (nodules have rounded edges but can be in various shapes as opposed to a cobble which is rounded and roughly spherical).

Flint is most often found in this form but there is also tabular flint that is procured from vertical or horizontal seams.

Other lithic raw materials may be procured from eroded out material. Raw material such as slate will come in parallel-sided slabs.



flint nodule

obsidian nodule

slate nodule

index

silica

1. flint
2. chert
3. quartz
4. rock crystal
5. chalcedony
6. jasper

SILICA group.

In this group are included those minerals whose composition does not depart significantly from SiO2. Some varieties are crystalline and include quartz, tridymite and cristobalite; others, generally grouped as chalcedony, are cryptocrystalline. Opal is amorphous.

(Hamilton et al 1976, 128)

flint

Colour: Blue-grey, grey, to nearly black when fresh, but weather to a whitish, powdery crust (patina).

Texture: Very fine-grained and smooth; conchoidal fracture. Rough on weathered surfaces.

Structure: Flint and chert form rounded nodules of widely differing forms, but chert also forms massive beds. Flint nodules are often hollow and may contain a fossil, such as a sponge or echinoid.

Mineralogy : Composed of silica, mainly the variety chalcedony. Some authors distinguish flint and chert compositionally but the differences, if any, are slight.

Field relations: Flint and chert nodules occur typically in limestone and chalk. They are usually patchily distributed but often concentrated along one bedding plane. Their origins are not fully understood; but some appear to be secondary replacements of the host rock, whilst others may represent primary deposition on the sea bed of colloidal silica. (Hamilton et al 1976, 204)

flint nodule

flint flake

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chert

The name chert is used to describe bedded, massive chalcedony, and the name flint is reserved for the black, nodular variety commonly found in chalk.(Hamilton et al 1976,130)

quartz

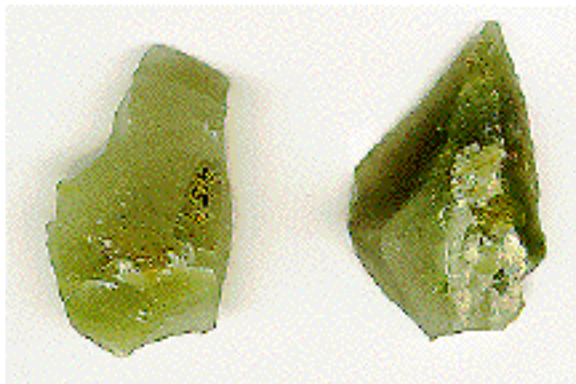
Quartz is composed mainly by SiO_2, and its structure is crystalline.

Quartz occurs in many varieties. Rock crystal is colourless quartz and sub-varieties include ghost quartz in which growth stages are marked by inclusions, and rutilated quartz (sagenite), which contains hair-like rods of rutile. Amethyst is purple; milk quartz is white; rose quartz is rose-red or pink, and is usually found massive rather than as crystals. Citrine is yellow and transparent and resembles topaz. Smoky quartz (sometimes called cairngorm) is smoky brown to nearly black. Some quartzes contain impurities that not only impart a colour but render them opaque. Ferruginous quartz is an example of this and is commonly brick-red or yellow.

Distinguishing features: Crystal form, conchoidal fracture, vitreous lustre, hardness.

Occurrence: Quartz is one of the most widely distributed minerals. (Hamilton et al 1976, 128)

quartz flakes



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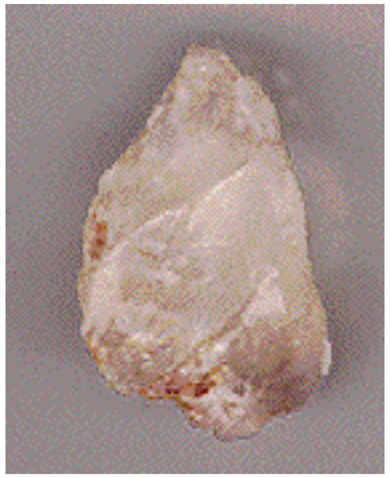
rock crystal

Rock crystal is quartz in crystalline form and is translucent. It has conchoidal fracture and therefore ideal for making tools.

rock crystal worked core



chalcedony

Chalcedony is the name given to compact varieties of silica which comprise minute quartz crystals with sub-microscopic pores. There are two main varieties: chalcedony, which is uniformly coloured, and agate which is characterised by curved bands or zones of differing colour."
(Hamilton et al 1976, 130).

It has conchoidal fracture and therefore has the same knapping qualities as flint.

Flint, chert, carnelian, and jasper are all varieties of chalcedony.

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jasper

Jasper is opaque chalcedony and is generally red, but yellow, brown, green and grey-blue varieties occur. Jasper is rarely uniformly coloured, the colour is often distributed in spots or bands. Hamilton et al 1976, 130)

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igneus rocks

1. obsidian
2. rhyolite
3. obsidian point movie

IGNEOUS :igneous or volcanic rocks

The so-called crust of the Earth is about 35 km thick under the continents but averages only some 7 km beneath the oceans. It is formed mainly of rocks of relatively low density. Beneath the crust there is a layer of denser rock called the mantle which extends down to a depth of nearly 3.000 km. Much of the molten rock material which goes to make up the igneous rocks is generated within the upper parts of the mantle. magma This material, which is called magma, migrates upwards into the Earth's crust and forms rock masses which are known as igneous intrusions. If magma reaches the Earth's surface and flows out over it, it is called lava. Within some lavas, fragments of dense, green-coloured rocks are sometimes found which consists principally of olivine and pyroxene. These fragments are thought to represent pieces of the mantle, carried upwards by the migrating magma.

The overwhelming majority of lavas consist of the black, rather dense rock called basalt, and most eptrologists consider that the primary molten rock material which comes from the mantle has a composition which is near to that of basalt. Although basalt is the most abundant of the lavas, granite is by far the commonest of the intrusive igneous rocks. Granite is mineralogically and chemically different from basalt and for many years geologists have wrestled with the problem of how the two rock types are related. If basalt is assumed to derive from the mantle, is it likely that granite, which is of a quite different composition, could also come from the mantle? Nowadays it is considered that granite may be produced in two ways; either from basalt, or from crustal rocks. When basalt magma starts to crystallize in the upper mantle, or the lower part of the crust, the overall composition of the crystals is not the same as the overall composition of the magma. This means that the liquid part will have a composition different from that of the original magma, and the further the crystallization process goes the greater will be the difference in composition between the liquid and the crystals. If the crystals and the liquid should now be separated by some mechanism, then rocks of two types will result, and each will have a composition different from the original basalt. This process, called differentiation, is capable of producing a great range of rock types, one of which is granite.

The second and perhaps more important way of producing granite is thought to operate within the crust itself. When mountain chains are formed, considerable thickness of crustal rocks are squeezed and thickened, and probably the base of the crust bulges down into the mantle. At the same time large volumes of magma move up into the crust. The effect is to heat the base of the crust to temperatures high enough to melt the rocks, so producing more magma. This new magma, which has the composition of granite, is mobile and moves up into the higher levels of the crust where it cools and solidifies as large granite intrusions, which are found in most mountain belts. These two processes account for the majority of igneous rocks.

The recognition and naming of igneous rocks involves an assessment of grain size and the recognition and estimation of the relative amounts of the constituent minerals. Additional information is obtained from colour index, texture, structure, and sometimes from field relations."

(Hamilton et al 1976, 146-147)

obsidian

Obsidian and pitchstone.

Colour: Shiny black, also brown or grey. Pitchstones have a dull rather than a shiny lustre.

Grain size: None; the rock is glassy. Texture: Glassy, but obsidian may contain numerous phenocrysts.

Structure: May be spotted or flow banded and spherulites (see rhyolite) are common. Being a siliceous glass it breaks with a conchoidal fracture and may be fashioned to a sharp cutting edge. It was used for cutting tools by primitive peoples.

Mineralogy: Essentially a glass. Rare phenocrysts (abundant in pitchstones) of quartz and feldspar.

Field relations: Dykes and flows. Commonly associated with rhyolites to which they are chemically equivalent." (Hamilton et al 1976, 164)

obsidian flake

index

black obsidian tool

'banded' obsidian tool

MOVIE 3.1 obsidian point

index

rhyolite

Colour: Usually light coloured; white, grey, greenish, reddish or brownish. The colour may be even, or in bands of differing shades.

Grain size: Fine to very fine.

Texture: Frequently shows altering layers that differ slightly in granularity or colour. Phenocrysts not uncommon (porphyritic rhyolite). Flow banding is sometimes evident, defined by swirling layers of differing colour or granularity, and by aligned phenocrysts.

Structure: Vesicles or amygdales may be present. (Pumice is a highly vesicular variety of rhyolite.) May contain spherulites which are spherical bodies, often coalescing, comprising radial aggregates of needles, usually of quartz or feldspar. Spherulites are generally less than 0,5 cm in diameter, but they may reach a meter or more across. They form by very rapid growth in quickly cooling magma, and the crystallization of glass. Mineralogy: As for granite, but rapid cooling results in minute crystals. Phenocrysts of quartz, feldspar, hornblende or mica occur.

Field relations: Flows, dykes and plugs. Rhyolite (or granite) magma is highly viscous and so flows only very slowly, so that if it is extruded it forms very short, thick flows or is confined as a plug in the throat of a volcano." (Hamilton et al 1976, 164)

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rhyolite

rhyolite tool

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SECTION 5

metamorphic rocks

1. slate
2. quartzite

METAMORPHIC ROCK

The Earth´s crust as well as being intruded by magma, is from time to time subjected to stresses generated within the crust and mantle which are sufficiently great to cause it to break to form faults, and also to bend forming folds. These forces are often concentrated along relatively narrow, sinuous belts when the folding, usually combined with intrusion and extrusion of magma, gives rise to mountain chains. The rocks within a mountain chain not only sustain considerable pressures but are also heated both generally and by the large scale of intrusion of magma, with the effect that rocks are deformed and recrystallized to varying degrees. Such rocks are called metamorphic rocks. (Hamilton et al 1976, 148)

slate

Colour: Black and shades of blue, green, brown and buff. Texture: fine-grained.

Structure: By definition, slates are characterized by a single, perfect cleavage (slaty cleavage), enabling it to be split into parallel-sided slabs. On the cleavage surfaces sedimentary structures such as bedding and graded bedding can often be seen. Fossils may be preserved but are invariably distorted. Folds are often apparent in the field.

Mineralogy: Too fine-grained to distinguish with the naked eye. Pyrite porphyroblasts often occur, usually as cubes.

Field relations: Slates are produced by low-grade regional metamorphism of pelithic sediments (shales, mudstones) or fine-grained tuffs. They may be associated with other metamorphic sedimentary or volcanic rocks." (Hamilton et al 1976, 150).

slate point

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quartzite

Colour: White, grey, reddish.

Texture: Medium-grained; usually of a granoblastic texture. Structure: Usually massive but primary sedimentary features may be preserved, such as bedding, graded bedding or current bedding.

Mineralogy: Essentially composed of tightly interlocking grains of quartz. A little feldspar or mica may also be evident. White varieties are distinguished from marble by their greater hardness.

Field relations: Quartzites are metamorphosed quartz sandstones and are found in association with other metamorphosed sedimentary rocks such as phyllite, schist and marble." (Hamilton et al 1976, 188)

quartzite flakes

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SECTION 6

miscellaneous

1. amber
2. ochre

amber

Amber is fossilized resin and in some deposits numerous insects and spiders are preserved, complete, inside pieces of amber.

Amber is rare but insects such as this are occasionally seen for sale as jewelry. Lepkjtis is a member of the Diptera which includes the true flies. Insect in amber (Leptis Oligocene). (Hamilton et al 19761976, 292)

insect in amber

amber artifacts

ochre

A native earth consisting of hydrated peroxide of iron with clay in various proportions, used as a pigment. First found in association with Homo erectus at Olduvai gorge and has been found in many cultures throughout the Stone Age period. It has been found in many contexts, particularly in burials where it is interpreted as having a ritual function, used as a pigment in Palaeolithic cave paintings, and in association with hide processing. (see Wreschner 1980)

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study methods

There are various ways of studying and analyzing stone tools

typology

typology

Science of classifying stone tools by form, techniques and technological traits. Must include duplication of the technique by first observing the intentional form, then reconstructing or replicating the tool in the exact order of the aboriginal workman. Shows elements of culture. Typology cannot be based on function." (Crabtree 1982, 57)

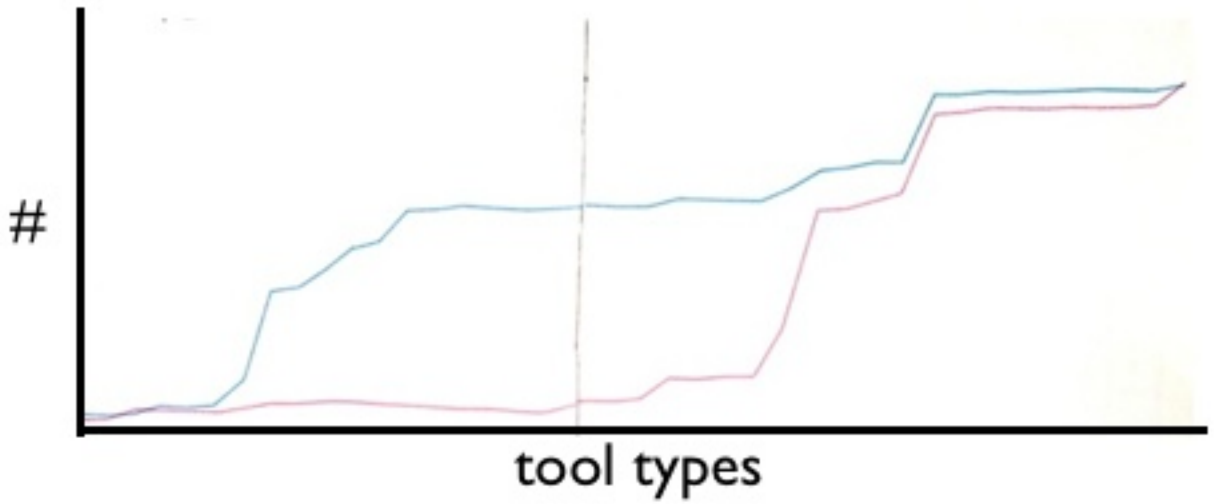
Typology is used to classify i.e. name tools so that archaeologists can easily communicate the kind of tools found in an assemblage. Typology has been used to classify and date cultures in that type fossils have been used to ascribe an assemblage to a culture and time. For example finding a handaxe was used to interpret the culture as Acheulian and date the find to the lower Palaeolithic. This practice was abandoned because ‘type fossils’ were found in different contexts and dated by other means, mainly stratigraphy and more recently by metric dating techniques such as radio carbon. Handaxes for example are found in some assemblages stratigraphically dated to the middle palaeolithic and associated with Neanderthals.

A development was to abandon type fossils but use collections of tools by counting the numbers of different types in an assemblage particular the devolopment of cumulative graphs predominantly used by Francois Bordes. These were used to classify assemblages particularly in the middle palaeolithic in France called Mousterian

And so we have Quina mousterian, Denticulte Mousterian and so on.

Cumulative graphs

Numbers of each tool types in an assemblage

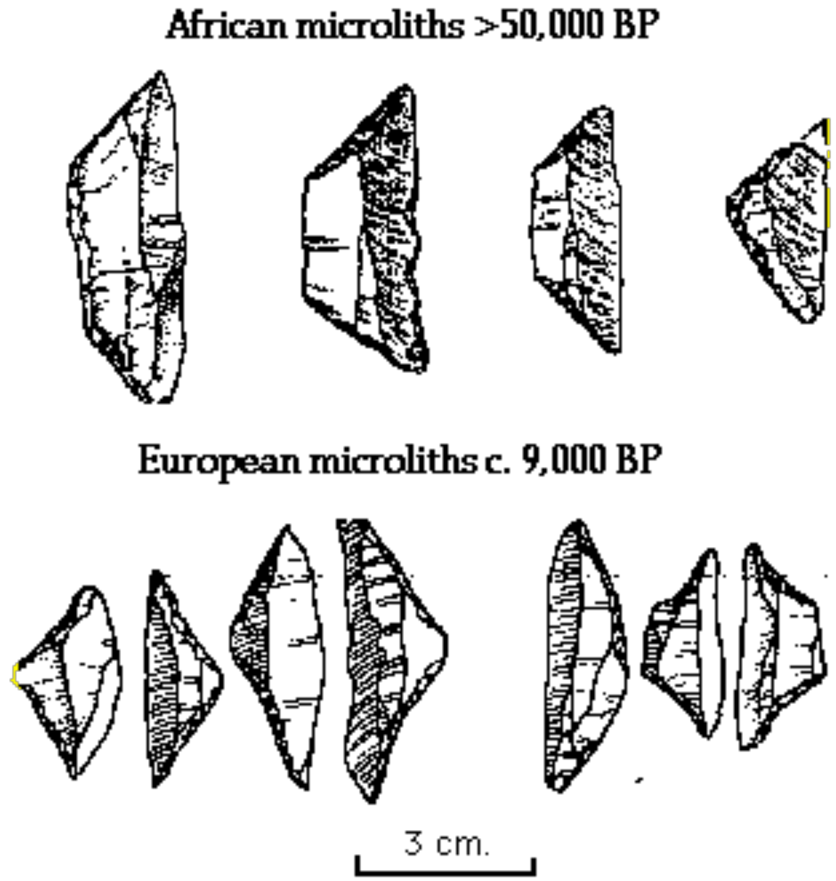


Discoveries of similar tools types in different geographical and time periods have led to the abandonment of this approach to more dynamic studies of all aspects of an assemblage as exemplified by the Chaîne opératoire approach.

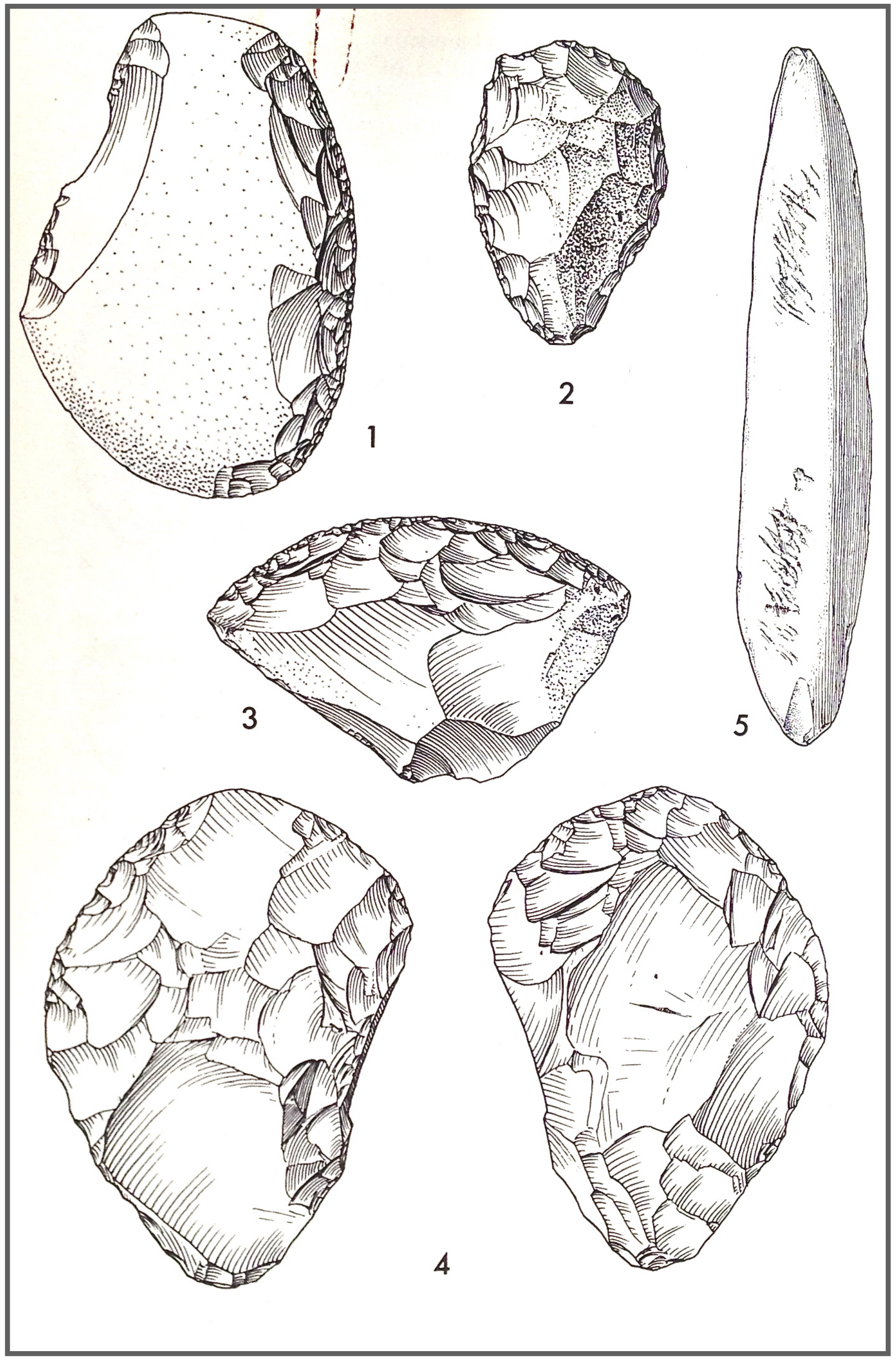
The main use of typology is to classify stone tools in the same way that species are classified in biology or quarks in physics.

Classification provides a common language so that any lithic archaeologists will know what is meant by a "concave end-scraper".

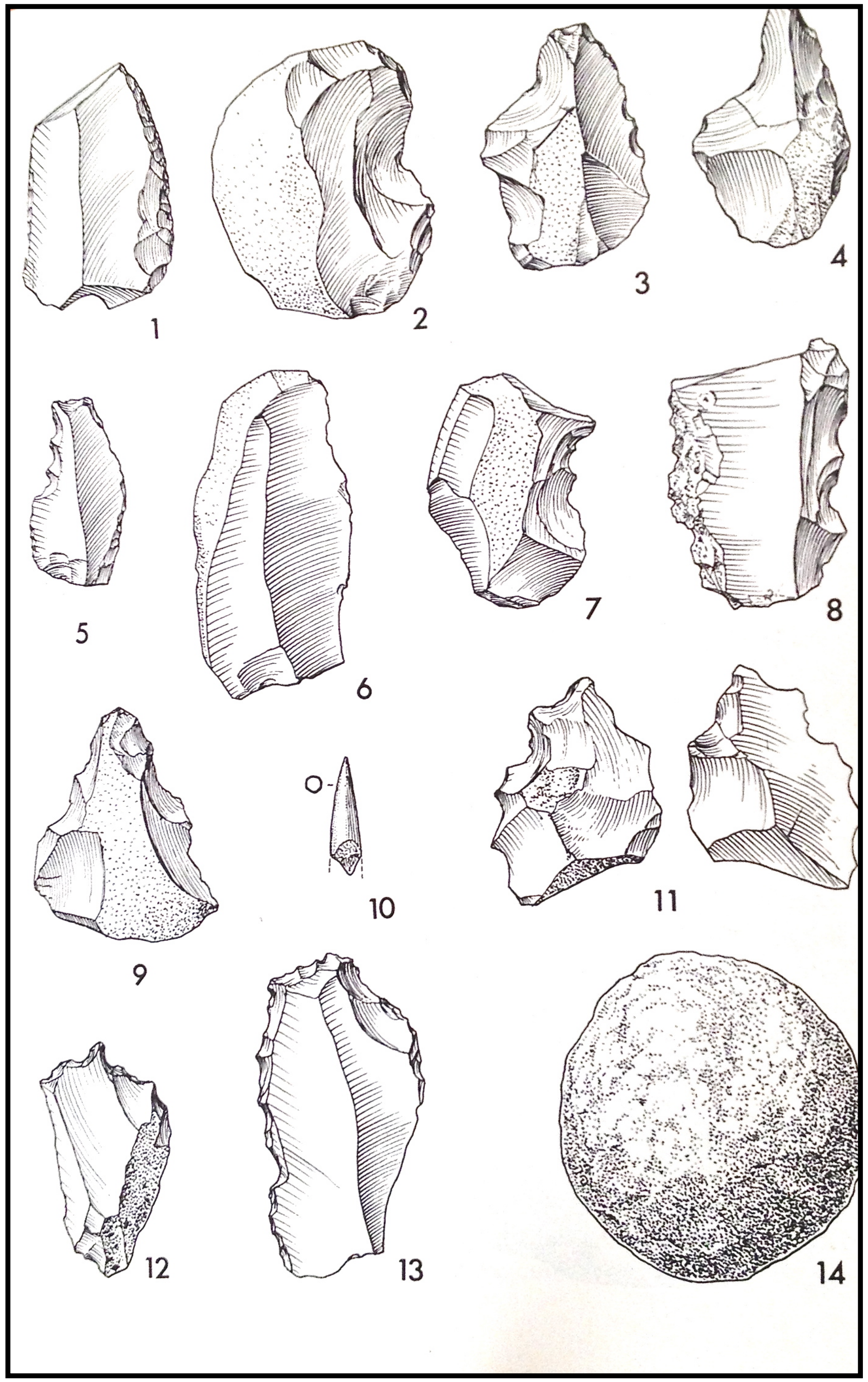
Microliths, often use to date European assemblages to the mesolithic, were also produced at the southern tip of Africa during the Middle Stone Age in a very different environments.



Quina Mousterian



Denticulate Mousterian



use-wear analysis

use-wear analysis

The analysis of stone tools using microscopy in order to interpret the function of the tools. This method involves the examination of the morphology of the tool, edge fractures caused by use (use wear) and the alteration of the stone surface caused by use, known as use wear polish.

This method of analysis involves experimentation by making and using replicas of stone tools in order to record the use-wear from known functions (Fischer et al. 1984). This wear can then be compared with that found on archaeological material.

Pre-1980 use-wear analysis concentrated on edge fractures.

use wear fractures

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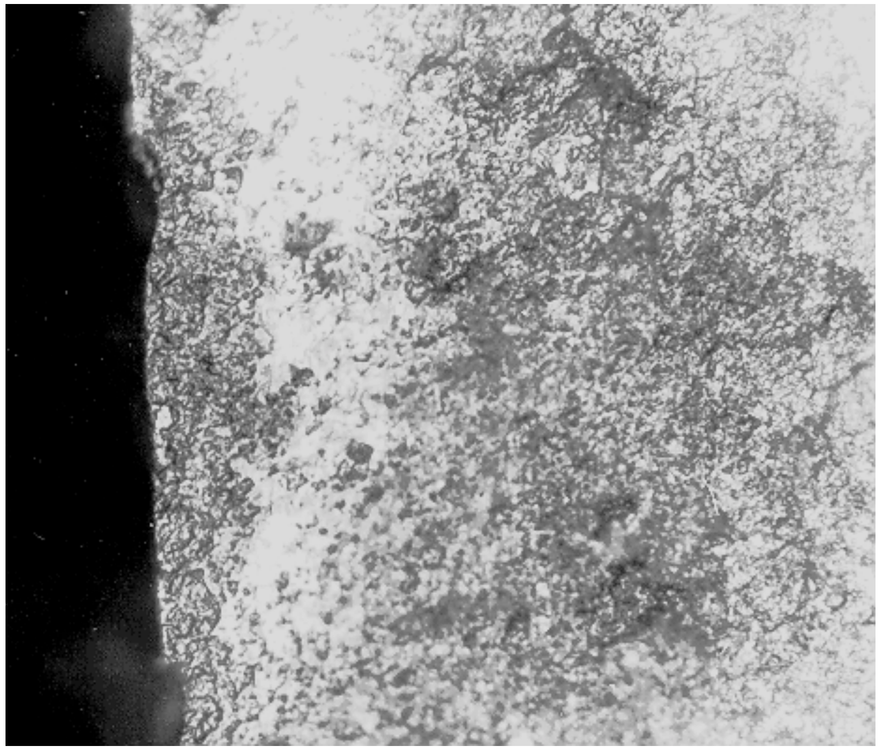
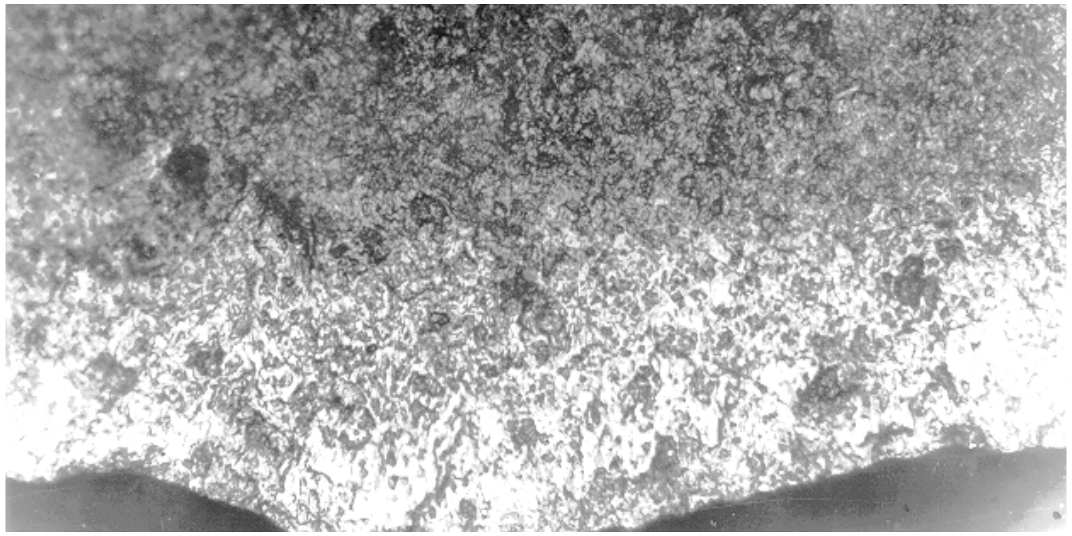
Use-wear analysis in the 1980s concentrated on identifying polishes.

alteration of flint surface caused by contact with bone

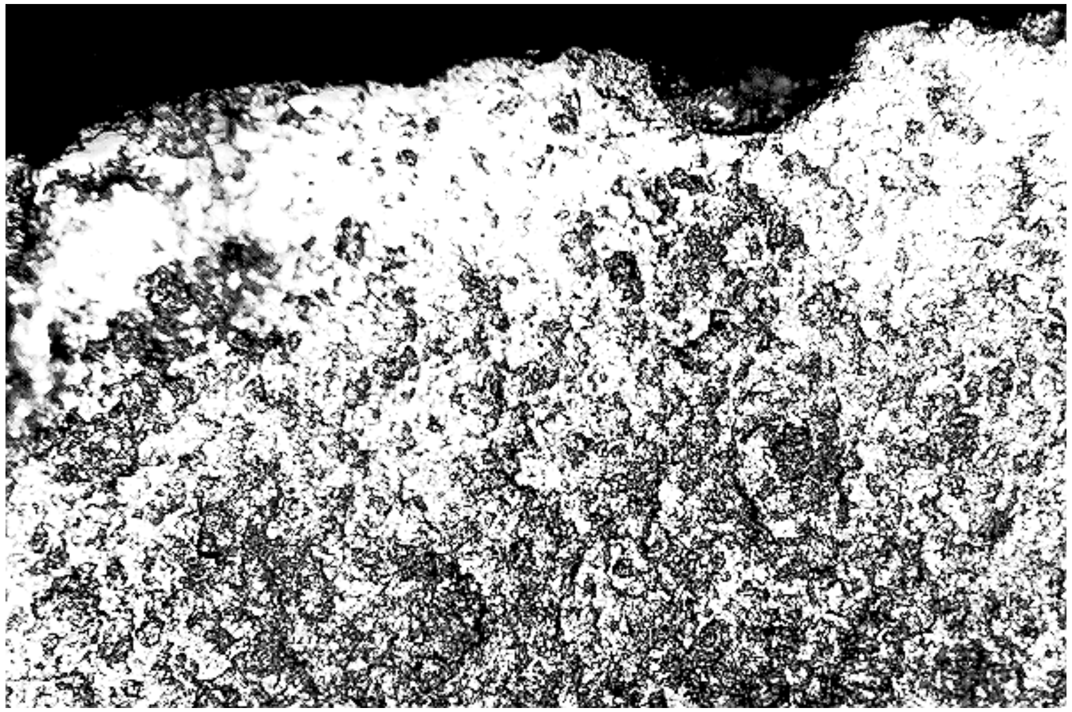


alteration of flint surface caused by contact with fish

alteration of flint surface caused by contact with hide



alteration of flint surface caused by contact with wood



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Since then a new approach which standardises the methodology of analysis has been developed. This method involves the systematic recording of the functionally diagnostic attributes of a tool. These attributes are described using a standard vocabulary and the descriptions can be replicated enabling different analysts to describe the same tools in similar ways. Grace 1989,

Correlations between the variables then allow the analyst to eliminate some of the possible functions of a tool until the most probable function is isolated. In some cases the elimination of possible functions leaves only one that is consistent with all the wear traces on the tool.

This involves looking at a number of variables including information on the morphology of the worked edges, edge fractures and rounding and polish in terms of its distribution and development.

Matching of archeological use wear with experimental use wear is based on experience but recent developments in the use of expert systems (Grace 1993, Dries 1994), has made this process more objective which means that functional reconstructions which include the specific material the tool was used to work can be made with some confidence.

Use wear is not used simply to produce a list of tool functions but to approach such questions of subsistence strategy and spatial arrangements of activity areas on a site. This in turn can be used to examine social behavior. (Keeley 1980, Grace 1989, Juel Jensen 1988)

Interpreting the Function of Stone Tools including Use wear analysis of drill bits available at

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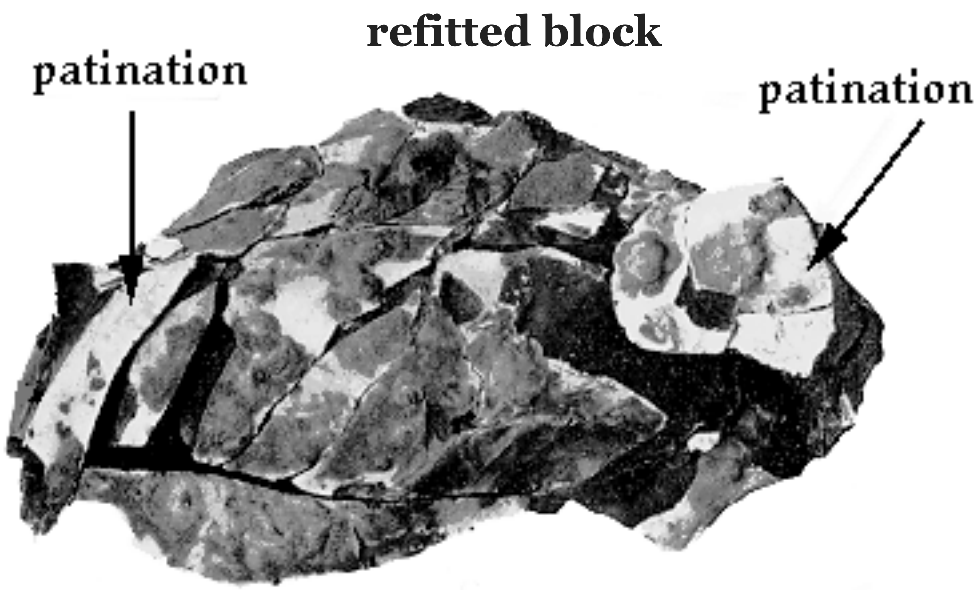
refitting

1. refitting movie



refitting

Refitting is the process of putting debitage back together in order to reconstruct the knapping sequence.

Refitting can also give information about activity areas especially when the tool is found in one part of the site and the refitting debitage is found in another indicating knapping area and activity area.

Sometimes refits can occur from different but obviously related sites showing the movement of material across a landscape (Skar, B. & S. Coulson, 1986).

refitted block

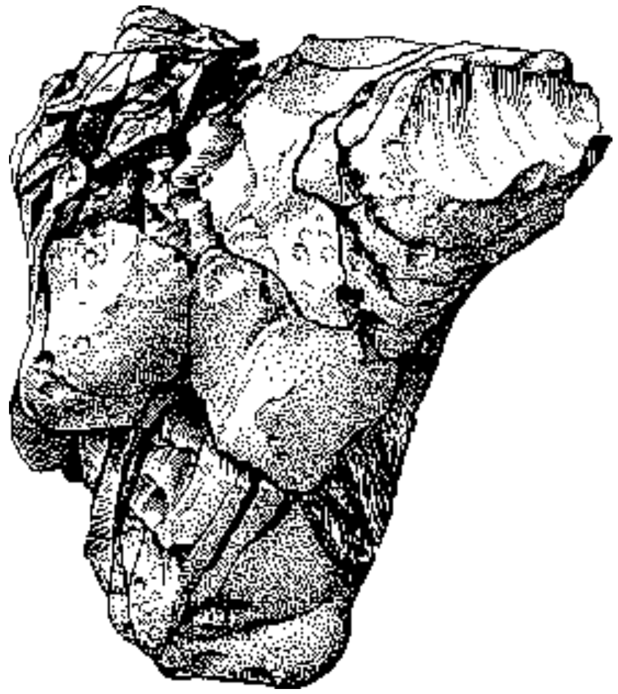
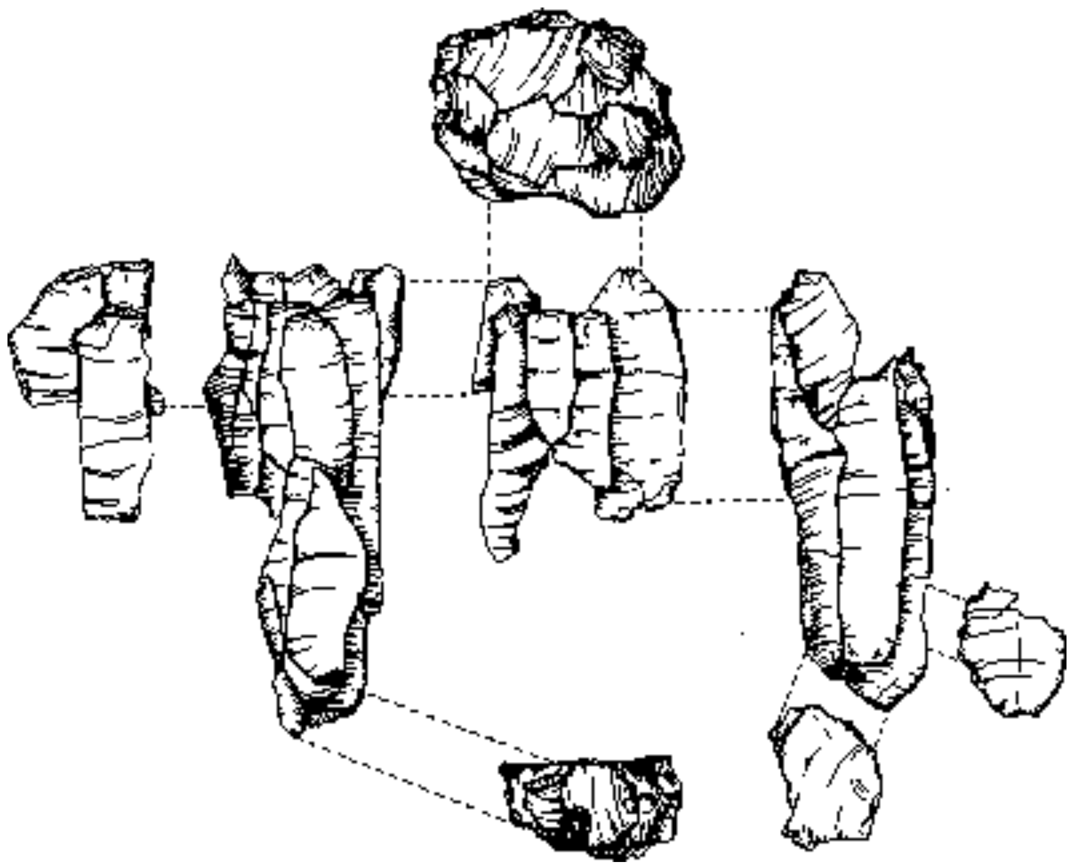


illustration of how refits go back together



Movie 4.1 refitting a blade and a levallois core

Dr Sheila Coulson - University of Oslo

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SECTION 4

chaîne opératoire

1.

chaîne opératoire

Chaîne opératoire, translated as operational sequence, has been described as, "the different stages of tool production from the acquisition of raw material to the final abandonment of the desired and/or used objects. By reconstructing the operational sequence we reveal the choices made by ... humans." (Bar-Yosef et al 1992). Excepting that the individuals in a group have a number of raw materials and techniques available to them; "identification of the most frequently recurring of these choices enables the archaeologist to characterize the technical traditions of the social group." (ibid). Culture is expressed in these choices which are made throughout the operational sequence.

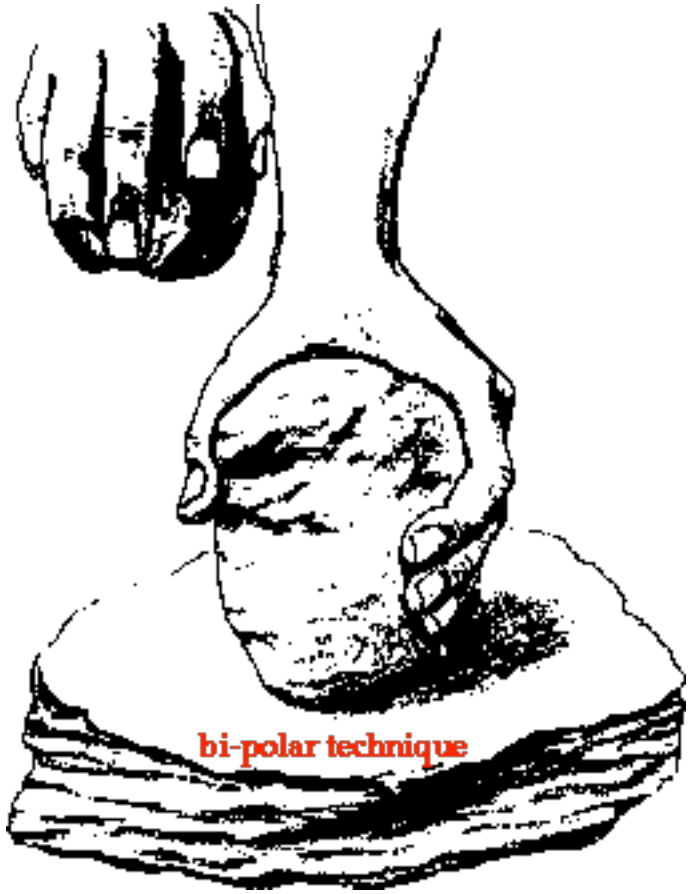
This approach contrasts with the typological approach which concentrates on the end product alone as opposed to the whole process of lithic exploitation. Typology automatically produces a limited sample as only a very small percentage of pieces are retouched. The role of 'human choice' has become more important in understanding stone age sites, and one way of studying 'human choice' is through the chaîne opératoire approach. The operational sequence is from raw material procurement to primary reduction techniques (the reduction of nodules to cores), secondary reduction (the removal of blanks from cores and the manufacture of tools with retouch), the use of tools and the discard of the artifacts.

There are choices in the means of raw material exploitation. The material can be processed at source or transported as nodules, pre-formed cores or as finished products.

Technology is divided into Primary and Secondary reduction techniques and Typology.

Primary reduction techniques are concerned mainly with the reduction of nodules to cores, the kind of cores produced and the technology involved.

For example the use of anvil technique to produce bi-polar cores



Secondary reduction techniques include such aspects as blade and/or flake technology, use of hard or soft hammer, micro-burin technique, pressure flaking and the differences in retouch; both of placement (direct, inverse etc.) and type (abrupt, invasive etc.).

For example pressure flaking

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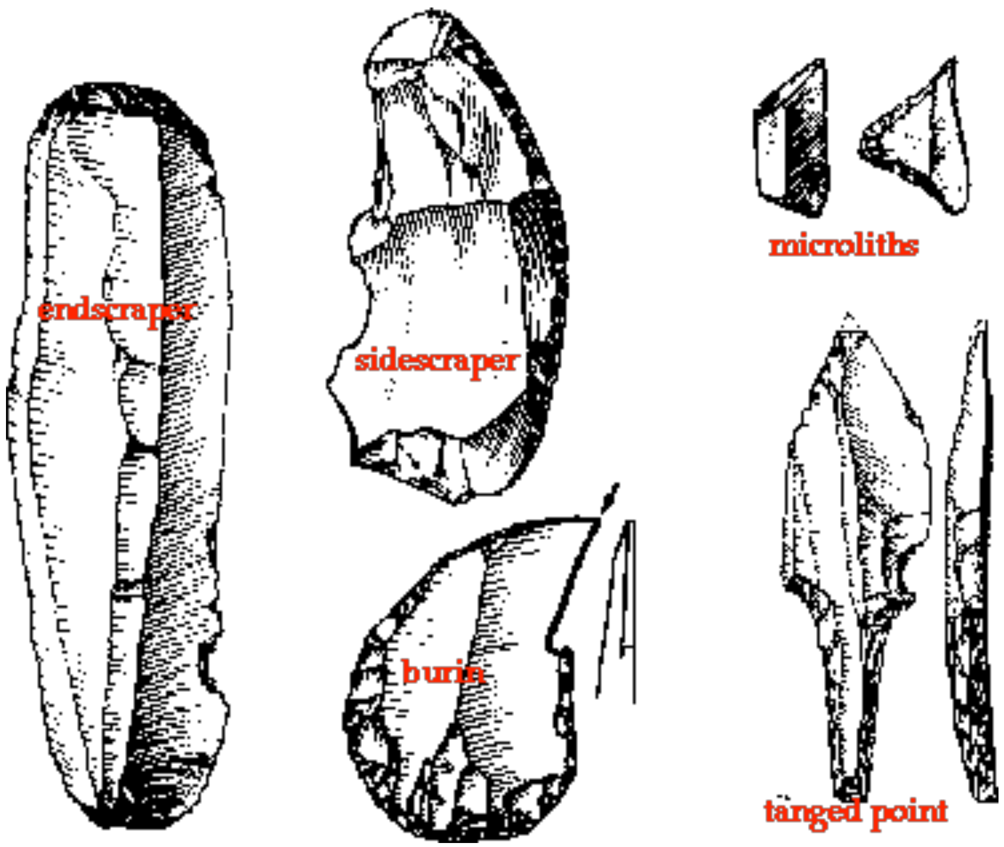
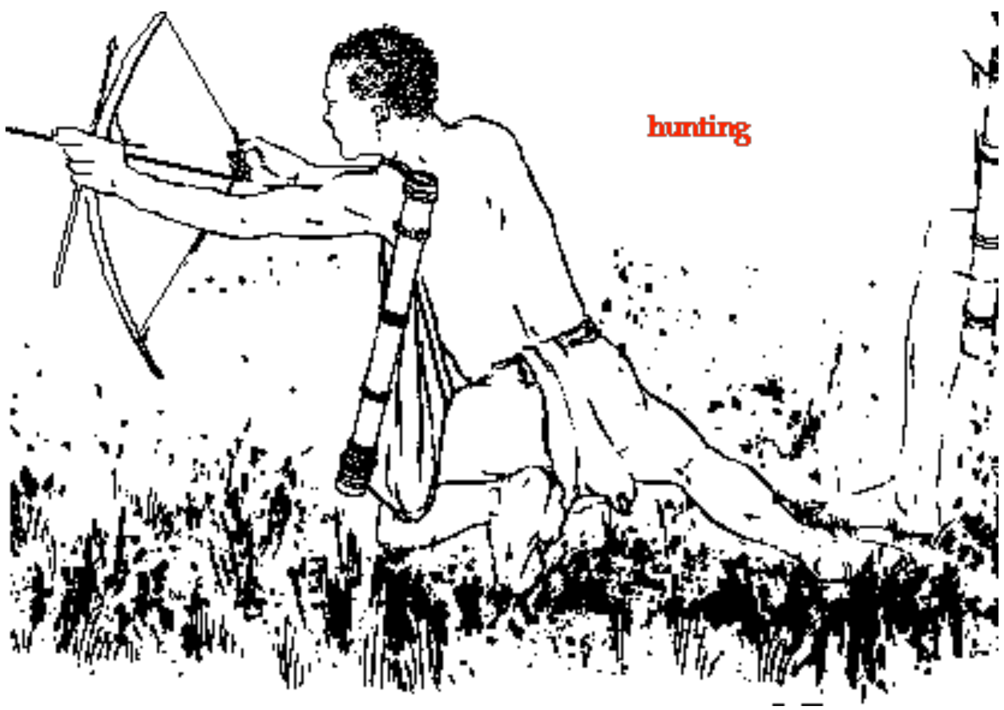
Typology: The morphological classification of retouched pieces.



Function includes the specific use of tools, both of motion and worked materials (scraping bone, whittling wood etc.);

the identification of activities (hunting, hide processing etc.)



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and the interpretation of site type (hunting camp, home base etc.).

The final stage is the discard of the material seen in knapping concentrations and clearance of areas with accompanying 'dump' areas.

Curation of tools would be included at this stage in that the removal of material from the site, for use elsewhere, constitutes a form of discard.

However the sequence includes feed-back loops in that, for example, the 'intended' use of tools will effect the choice of technology and raw material. For example if the intent is to make tanged points this will influence the choice of technology i.e. blade technology to produce suitable blanks.

If blade technology was 'chosen' then flint, as opposed to quartzite, may be procured. Also function need not be limited to utilitarian use. If it is intended to make a flint copy of a bronze dagger for a status or ritual function, this may influence the choice of raw material procurement to be trade in order to obtain large pieces of good quality flint with which to make such a dagger.

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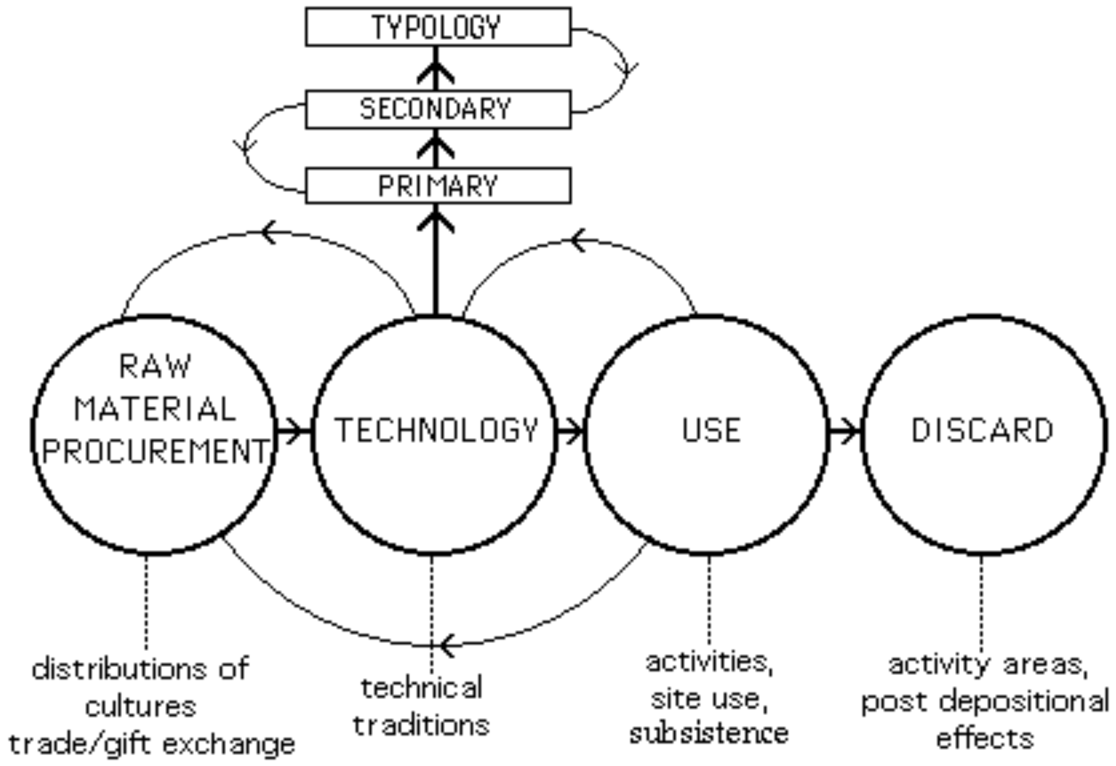
Thus the intended function of the tool can influence technology and the method of raw material procurement.

Intentionality also influences the various stages of technology. If a particular type is chosen e.g.. a truncation burin then burin technique will be used in the secondary reduction and blade technology in the primary reduction.



These choices made along the operational sequence may reflect different social structures and subsistence strategies employed during different periods. The different strategies are chosen from a number of possibilities as the preferred means of exploiting similar environmental resources.

It is the choice of strategy which characterizes the culture rather than simply the types of stone tools.

The chaîne opératoire approach to lithic analysis has mainly consisted of technological analysis of specific knapping procedures.The function of the tools has largely been ignored. Omitting function from the chaîne opératoire is to disregard the essential element, as knapping is carried out to produce tools. In use-wear analysis tools are used pieces whether retouched or not.

The chaîne opératoire approach is not a method but rather a framework within which different techniques (typological and technological analysis, re-fitting, use-wear analysis, spatial analysis etc.) can be used, depending on the particular research topic being examined.

Different theoretical positions can be applied and interpretations tested using this approach. Studying sites as dynamic processes rather than as static units provides a better foundation for understanding change in social groups.

Chaîne opératoire has mainly been used for the detailed reconstruction of reduction sequences by refitting. The emphasis has been on technological issues that are interpreted as reflecting the cognitive abilities of various cultures. (see Karlin and Julien 1994)

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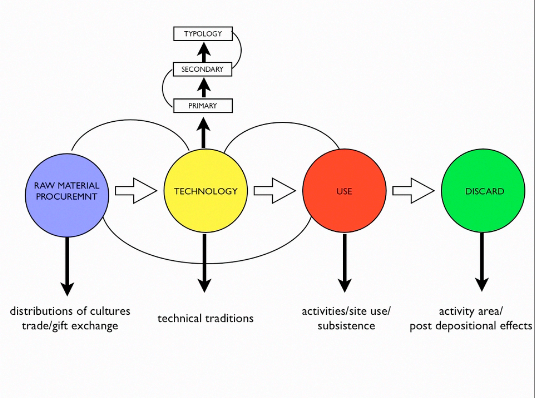
MOVIE 4.2 chaîne opératoire



See Chaîne Opératoire by Roger Grace avaiable at

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expert systems

1.

expert systems

"an expert system is a computer program which uses non-numerical domain-specific knowledge to solve problems with a competence comparable with that of human experts" ((Doran 1988).

The first major advantage of using an expert system for lithic analysis is the act of writing it. "The process of developing an expert system has an indirect benefit also since the knowledge of human experts must be put into an explicit form for entering in the computer. Because the knowledge is then explicitly known instead of being implicit in the expert's mind, it can be examined for correctness, consistency and completeness. The knowledge may then have to be adjusted or re-examined which improves the quality of the knowledge." (Giarratano and Riley 1989, 5).

The expert system approach is essentially looking for patterns in complex dynamic phenomena that have proved to be beyond standard quantification techniques. For example 'ship decoration' cannot be quantified. The outcome of the expert system is a probability statement concerning the tool type or function that is most consistent with the observations. The interpretations are made according to the balance of indications given by the expert system rules and based on the observation of all features.

Expert systems are not intended to replace human experts. For example, the recognition of retouch on stone tools as opposed to edge damage (from spontaneous retouch, trampling, post depositional movement, etc.), is dependent on the analyst's experience and in particular on experimentation, involving not only observation of experimental and archaeological tools , but also an appreciation of the mechanics of making and using stone tools.

Expert systems ensure that interpretations are consistent and comply with the tenets of scientific method. For example, one definition of scientific schemes describes such expert systems, "... scientific schemes are explicit i.e., the rules and the way they are to be applied are spelled out with sufficient clarity and in enough detail that they can be used by anyone. ... such a set of rules can be encoded in a computer program... " (Casti 1993,29).

The expertise gained over many years of research is made available to less experienced practitioners. One of the features of expert systems is that, "The expert system may act as an intelligent tutor by letting the student run sample programs and explaining the system's reasoning." (Giarratano and Riley 1989,5). As an expert system models the behavior of an expert (hence the name), the incorporation of such expert systems into teaching programs enables students to understand the reasoning processes of the expert rather than simply learning the outcome of the reasoning. As the rules that operate the expert system are derived from a number of sources the expertise of many researchers is incorporated into the program. The LITHAN and FAST programs are currently being used as part of a teaching program for lithic analysis.

The use of expert systems has a number of advantages over other techniques.

Increased consistency and standardisation. The development of an expert system means that the observational techniques have to be systematised and the rules provide a base from which results can be assessed.

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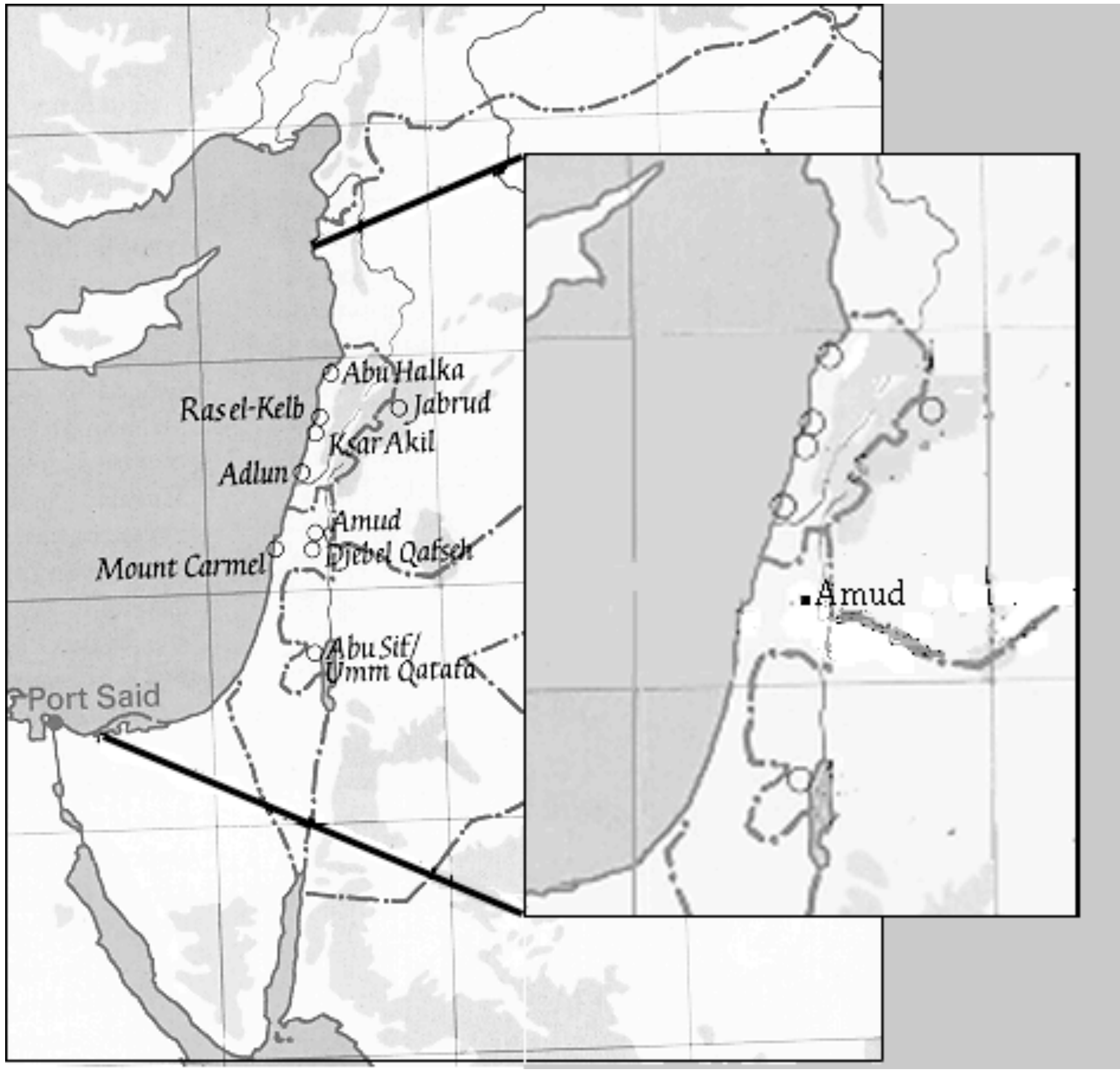
Different analysts using the same program will obtain the same results. This has been repeatedly confirmed during instruction in use-wear analysis when several students have independently analysed the same experimental tools and all interpreted the correct function of the tool using FAST. Often students enter different observations, due to inexperience, but the flexibility of the program (in particular the 'fuzzy logic' aspects) allows for this so that some variations in observations can be accommodated.

Analysts working on different material can use the same program. As demonstrated in a recent study of lithic material from Tehuacán and Oaxaca in Mexico which involved using local material in replication experiments (Hardy 1993)

The rules and procedures for expert systems can be continually being updated in order to improve and refine the analytical procedures. For example, since the FAST program has been in use in Norway (Ballin & Jensen 1995) a large number of experiments have been carried out on fish. The information gained from these experiments has been incorporated into the rules of the FAST expert system making the identification of fish processing more accurate. Subsequently these new rules have helped in identifying fish processing during current research on Neanderthal associated material from Amud cave, Israel.

Location of Amud



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The site of Amud

The use of rule based expert systems is a practical approach to lithic studies that bridges the gap between processual and post processual archaeology. The key here is rules; not laws which are inviolate, but rules that can be changed and indeed are always changing in a reflexive relationship allowing the expert system to accommodate new information.

The rules of the expert system are subjective, but they are explicit in that they are written down and incorporated into the computer program. The observations are defined and the rules are explicit therefore anyone can produce the same results, so that though the system is subjective it is consistent when different subjectivities (i.e. different individuals) use it. The acceptance of the assumptions on which the program is based leads to consistency, and direct comparability between results produced by different people; this fulfills the basic requirements of objective data within the consensus reality of mutual users of the program. Therefore expert systems can extract objective-like data, but the complexity of the dynamic process is retained and the data is produced in the form of probabilities that can be compared as if they are objective data within a defined consensus reality.

Expert systems are so called because they are designed to model the behaviour of a human expert. So they are modeling human behaviour, in fact an individuals behaviour. By extension expert systems can be used to model the more complex behaviour of societies. A series of programs that input the results of each individual program into another program further up the hierarchy is being developed. Not only must the interpretations be consistent with use-wear analysis and lithic programs, but non-lithic material such as the faunal assemblage, environmental evidence and spatial information from the site and any chronological evidence.

Alternative interpretations can be modeled with expert systems so rather than postulating a theory and then testing it, a number of alternatives can be tested and matched against the data simultaneously.

"an expert system is a computer program which uses non-numerical domain-specific knowledge to solve problems with a competence comparable with that of human experts" (Doran 1988).

"The process of developing an expert system has an indirect benefit also since the knowledge of human experts must be put into an explicit form for entering in the computer. Because the knowledge is then explicitly known instead of being implicit in the expert's mind, it can be examined for correctness, consistency and completeness. The knowledge may then have to be adjusted or re-examined which improves the quality of the knowledge." (Giarratano and Riley 1989, 5).

For technical descriptions of the Lithan (lithic analysis) and FAST (Functional Analysis of Stone Tools) expert systems see

Interpreting the Function of Stone Tools by Roger Grace at

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experimental archaeology

experimental archaeology

There are three main areas where experimentation has been used in relation to lithic analysis

1: Knapping experiments

2: Functional experiments

3: Taphonomic studies

knapping experiments

Knapping experiments are divided into two categories. First is the replication of knapping techniques in order to understand the process of the technology involved in producing particular types of tools e.g. replication of the process of producing microliths which led to the discovery that 'micro-burins' where not tools but bi-products of microlith manufacture.

Numerous experiments have been going on since the study of stone tools began replicating such tools as handaxes, or techniques such as the Levallois technique .

The second major aspect of replication experiments is the study of the resulting debris (debitage). This is achieved through recording the spatial distribution of the resulting debitage. These spatial distributions can then be matched against archaeological distributions and inferences made concerning knapping sequences and even in some cases the position of the knapper (e.g. sitting down, or standing up according to the pattern and distance of the distribution of the debitage).

Movie 4.3 experimental archaeology

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functional experiments

Replicas of tools are used in various ways with two main aims. One is to test a particular hypothesis concerning tool use and the other is to provide reference material for use-wear analysis. Experimental tools are often made and used in conjunction with blind tests.

Examples:

Chopping down trees with a stone axe

A ground stone axe was replicated and then used for chopping down trees.

In this experiment three trees of the size illustrated were chopped down in about 20 minutes, demonstrating the efficiency of such ground stone axes.

Use-wear analysis of the axe demonstrated that there was no edge damage to the axe whatsoever. Also no microscopic 'polish' was evident, but this was not unexpected because the axe was already 'polished' from the process of manufacture and therefore could not be 'polished' any further by use. polish formation.

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The absence of any fractures on the edge of the axe would indicate that the advantage of ground stone axes over flake axes is that the edge will not fracture so easily and thus provide a longer lasting tool which would require less 'maintenance'

The general impression from this experiment was that the axe was very efficient and would have enabled relatively rapid forest clearance.

As illustrated the experimenter seemed pleased with the results.

There was a residue that formed on the edge of the axe. This residue was visible to the naked eye. The distribution of this residue was 'away from the edge', as found with some use-wear 'polishes'

Such residue however, is very unlikely to be preserved on archaeological tools, except on sites where wood is preserved, usually on waterlogged sites. The residue was easily removed by biological cleaning.

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Ethnographic use of stone axes.

Skinning and butchering a deer with stone tools

A deer was skinned and butchered using a variety of flint tools ranging from well made flint knives to simple flakes. This experiment was to test the efficiency of various tools for a single task and also to provide reference materials for use-wear analysis.

Initial incisions

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The skin is removed

The carcass is ready for butchering

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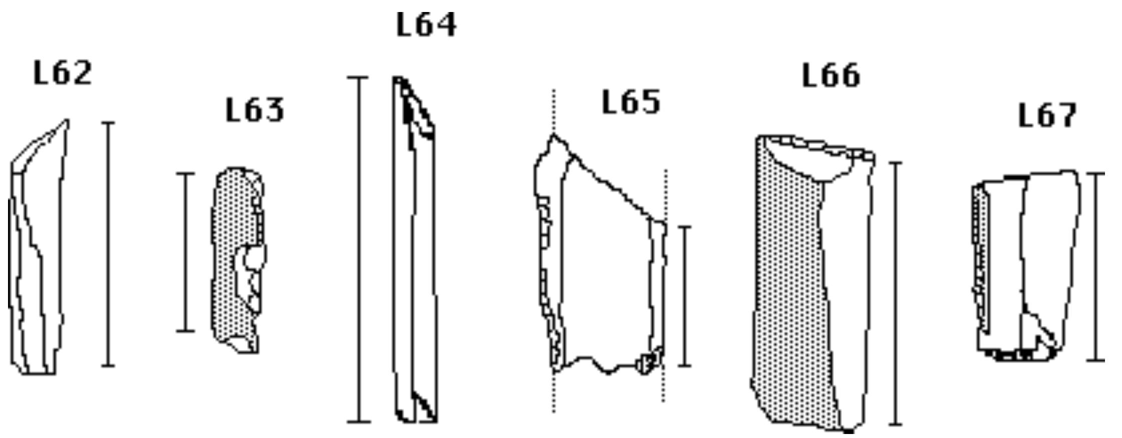
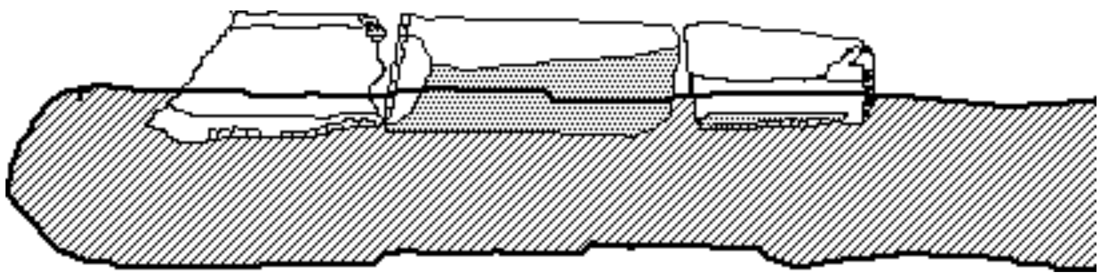
Post use wear analysis replication experiment

The evidence from the use-wear analysis of the Mesolithic site of Thatcham, England (Healey et al. 1992), produced a number of tools used for cutting an unidentified 'soft material'.



There were also indications that some of these tools were hafted.



It was suggested that there 'cutting soft' tools represented a concentration on the exploitation of vegetable resources. The reeds of the nearby swamp were not the material involved because reeds are silica rich and produce a significant polish quite quickly and this was not the case with these 'cutting soft' tools.

It is particularly difficult to identify the precise worked material when the material falls into the 'soft' category. This is because soft materials produce less stress and abrasion on the tools edge and so produce less use wear, making precise identifications extremely difficult, especially if these tools have not been used for long periods of time (see Bamforth et al. 1990). One way of obtaining greater precision is to carry out post analysis replication. Replicas were made of the tools and used on a variety of soft materials to see if the use wear produced by a particular soft material, (such as meat or vegetable material) can be matched against the use wear on the archaeological tools. Such a programme of experimental replication was carried out in the based on the environmental resources that would have been available at the site (Hardy 1993).

There was no direct evidence, in the form of plant remains, of the presence of tubers or root vegetables on the site (pers. comm. Rob Scaife), but such things as wild carrots and parsnips would have been available and probably utilised by the inhabitants of the site.

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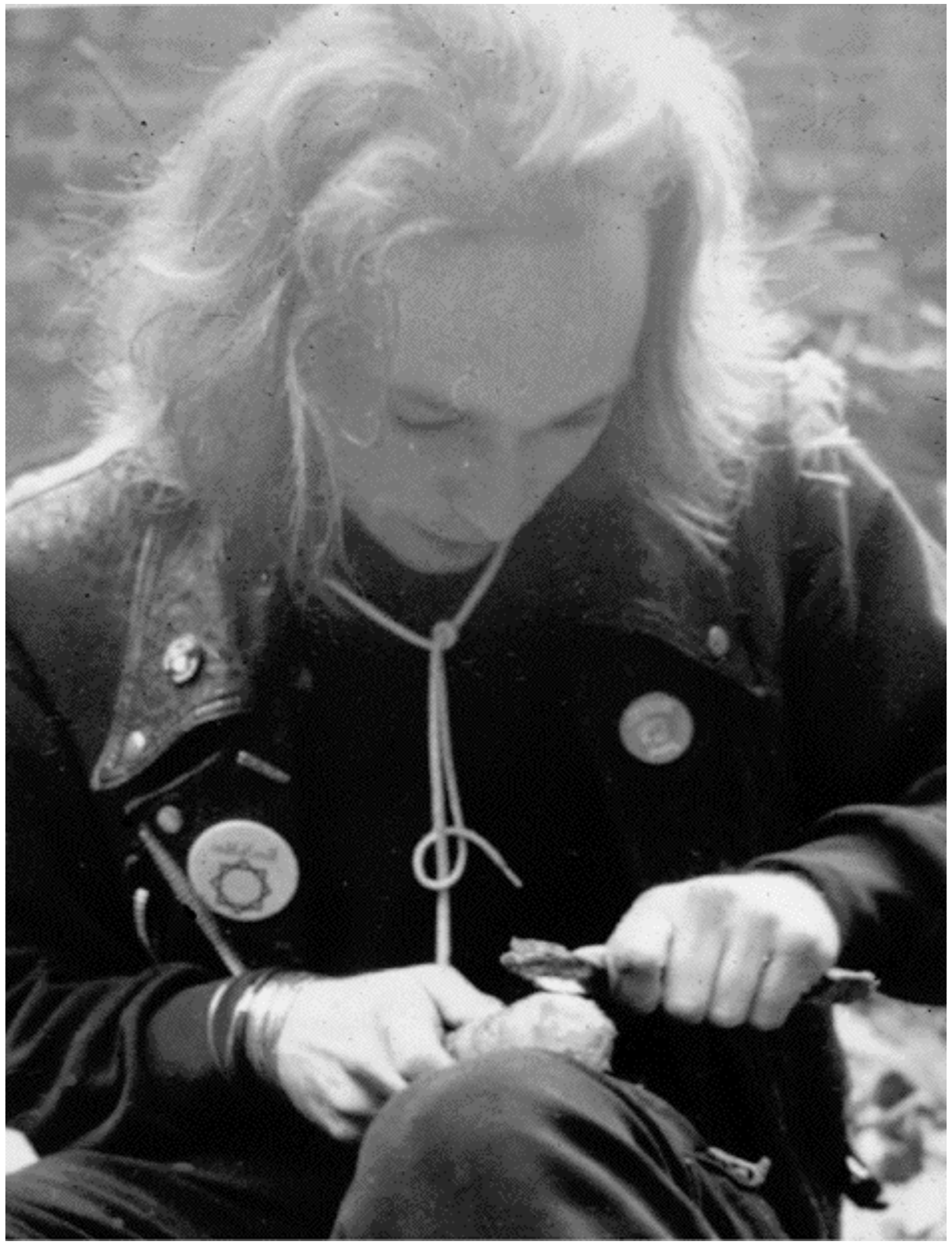
The processing of such tuberous plants could have left the kind of use wear traces that is found on these 'cutting soft' tools.

Thatcham replicas being used on wood

Replicas of the tools from Thatcham were made and used on a variety of materials to see which material produced similar use-wear to that found on the archaeological tools.

Thatcham replicas being used on parsnips



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It was found that tools used on vegatable materials, such as parsnips and carrots, produced use-wear that matched that on the tools from Thatcham.

The emphasis on food gathering supports the idea of Mesolithic subsistence as being primarily a gathering strategy rather than hunting, "... a significant and possibly, in certain cases, a major proportion of flakes, blades, bladelets and microliths may have been associated with vegetal and other food-gathering and processing..." (Clarke 1978, 8). This statement by Clarke would appear to be substantiated by the evidence from the use wear analysis of the stone tools from Thatcham. Use wear analysis can be used to estimate the relative importance of gathering as opposed to hunting, even when there are no, or few, surviving plant remains as is the case with Thatcham. A major difference in the evidence from the stone tools is that it is directly related to the activities of humans. The presence of pollen or plant remains on a site, or from the site catchment area, demonstrates that these plants were available but not that they were definitely exploited. The reconstruction of subsistence strategies from the environmental evidence alone ignores this important point that the presence of a food resource does not necessarily mean that it was actually eaten. To quote Clarke again "...the ecological paradigm has been an important factor in redressing the biased conclusions that emerged from earlier studies restricted to artifact data. However, there has been a disconcerting tendency for essays in this new field to repeat the worst sins of the artifact typologist in a new dimension, merely substituting the differential minutiae of bone and seed measurements and statistics for those of typology and substituting doubtful generalizations based on eccentric faunal and floral samples" (Clarke 1978, 17).

Use wear analysis can gives direct evidence, rather than the assumptions based on environmental evidence, of the importance of vegetable resources in the Mesolithic. The evidence of the prerequisite technology for the processing of vegetable resources (such as composite knives) gives a scenario of a more gradual rather than abrupt transition from a predominantly hunting economy in the mesolithic to agriculture in the Neolithic.

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taphonomic studies

Taphonomic studies have been carried out by creating sites. Stone tool replicas and debitage are buried along with bone fragments to simulate a site. The position of each lithic and bone fragment is carefully recorded. These simulated sites are often created so that they are trampled on and undergo various post depositional effects. One example was a square metre which was created to simulate a portion of the site of Klithi in northern Greece. The simulated site was positioned along the path leading to the site so that it was regularly walked upon by diggers going to and from the site. It was also 'trampled' by the regular passing of goat herds along the valley.

After a period of time the simulated site was excavated and the position of the artifacts recorded. Comparisons can then be made between the original position of the artifacts and where they may have moved to giving information about taphonomic changes that may take place on a site. also see Barton, R. and Bergman, C. 1982.

Other taphonomic studies have involve placing stone tools in rivers to investigate how they might be transported by fluvial action. A note of caution on such experiments. A number of used flakes that were place in a small stream in order to investigate post depositional effects on flint surfaces in connection with use-wear studies. disappeared after only a few months. Either having been washed away or buried in the silt of the stream bed. To alleviate this problem some experimenters have painted the lithics a bight colour in order to facilitate the recover of the lithics. of course this not feasible with experiments concerned with use-wear analysis where the intent is to carry out microscopic analysis on the recovered lithics.

Experiments involving the burial of flints have been carried out to investigate the potential survival of organic residues on stone tools.

In the paper by Cattaneo et al 1993, experiments were carried out by putting blood on lithics and burying them. Of 10 scrapers and 10 flakes only 1 scraper tested positive for albumin content after a year and some tested negative after burial for only one month. The investigators suggest that very specific conditions are required for residues to survive on stone tools,"... a combination of behavioural and taphonomic factors will be necessary for preservation. We suggest that amongst these may be: intensive blood letting, meat-cutting or bone/skin scraping at the use-sites; artifacts with numerous flake scars to catch and preserve fragmentary residues; good preservation of residues before the tool was lost or discarded, for instance under handle, in leather bags, or within bone where the knife or arrowhead has jammed; a suitable soil matrix; and reasonable protection from the elements." (Cattaneo et al 1993, 41).

Further experiments have been carried out with even less optimistic results. The authors concluded that, "...it is apparent that immunologically meaningful residues did not survive on stone tools tested from archaeological sites or from simulated archaeological contexts. Even under conditions of unusual dryness blood showed degradation in less than a year." (Eisele et al 1995,44). Following their conclusions they state that, "The claims of Loy and co-workers (Loy et al. 1990, Loy and Hardy 1992) to have detected human immunoglobin in 20,000-year-

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old and 90,000-year-old samples by use of gold conjugated Protein A are extremely unlikely in view of the fact that Cattaneo et al 1993 and the present study have found immuneglobulin does not survive even a few months." (Eisele et al 1995,45).

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ethnography

1. knapping in Australia
2. spear fishing in Australia
3. making and using stone tools in New Guinea gallery
4. using a bow drill in Erzurum, Eastern Turkey
5. threshing sledge in eastern Turkey

ethnography

Information has been gathered from ethnographic studies concerning both techniques of stone tool manufacture and the way in which they are used.

knapping in Australia

One way of studying lithics is through ethnoarchaeology

spear fishing in Australia

the function of tools can be studied by ethnographic observation.

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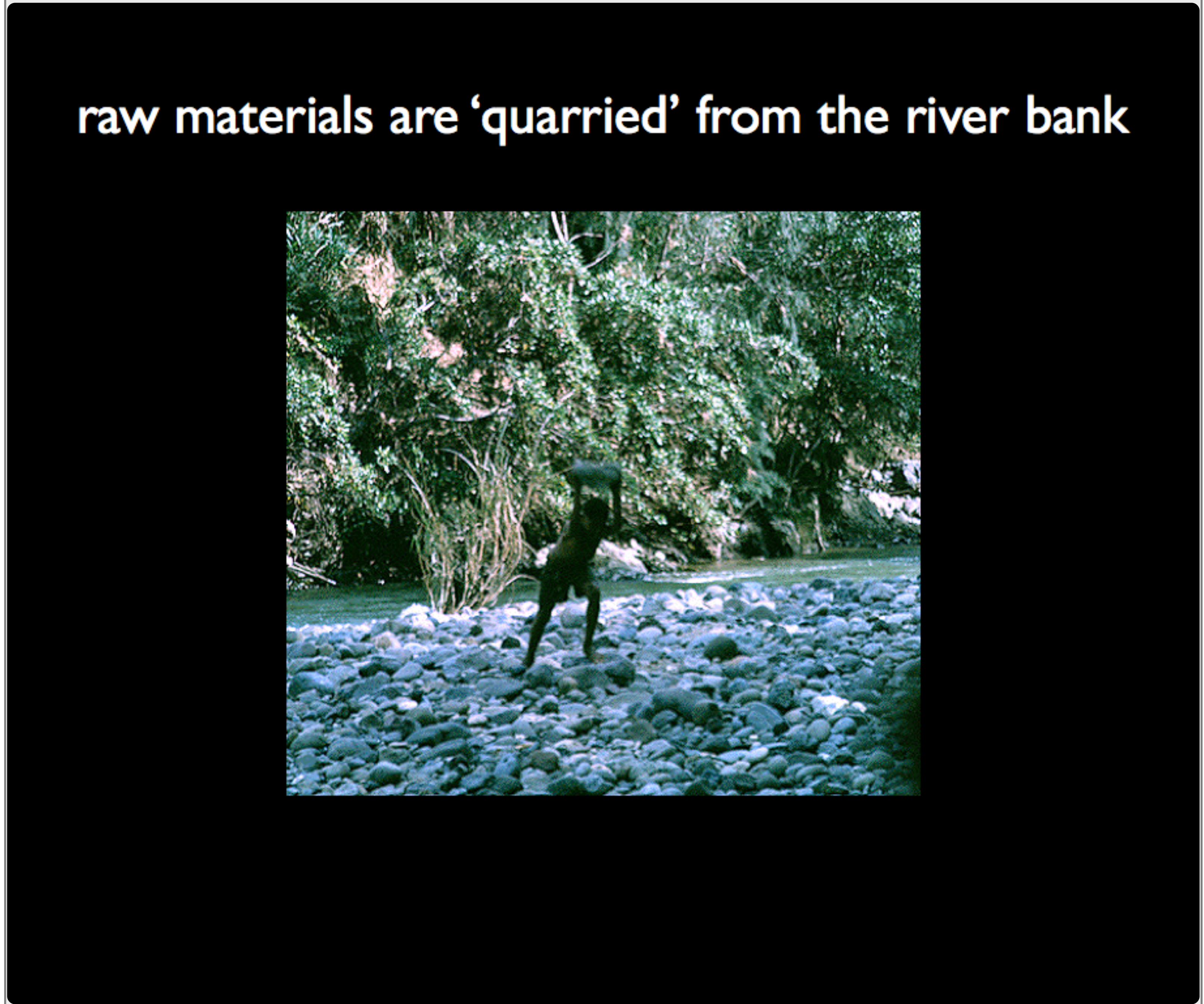
GALLERY 4.1 making and using stone tools in New Guinea



Using a bow drill in Erzurum, Eastern Turkey

Simple bow drills are still used in Eastern Turkey to drill soft 'Erzurum stone' in order to make beads.

Here the bead worker is trying to drill a piece of obsidian

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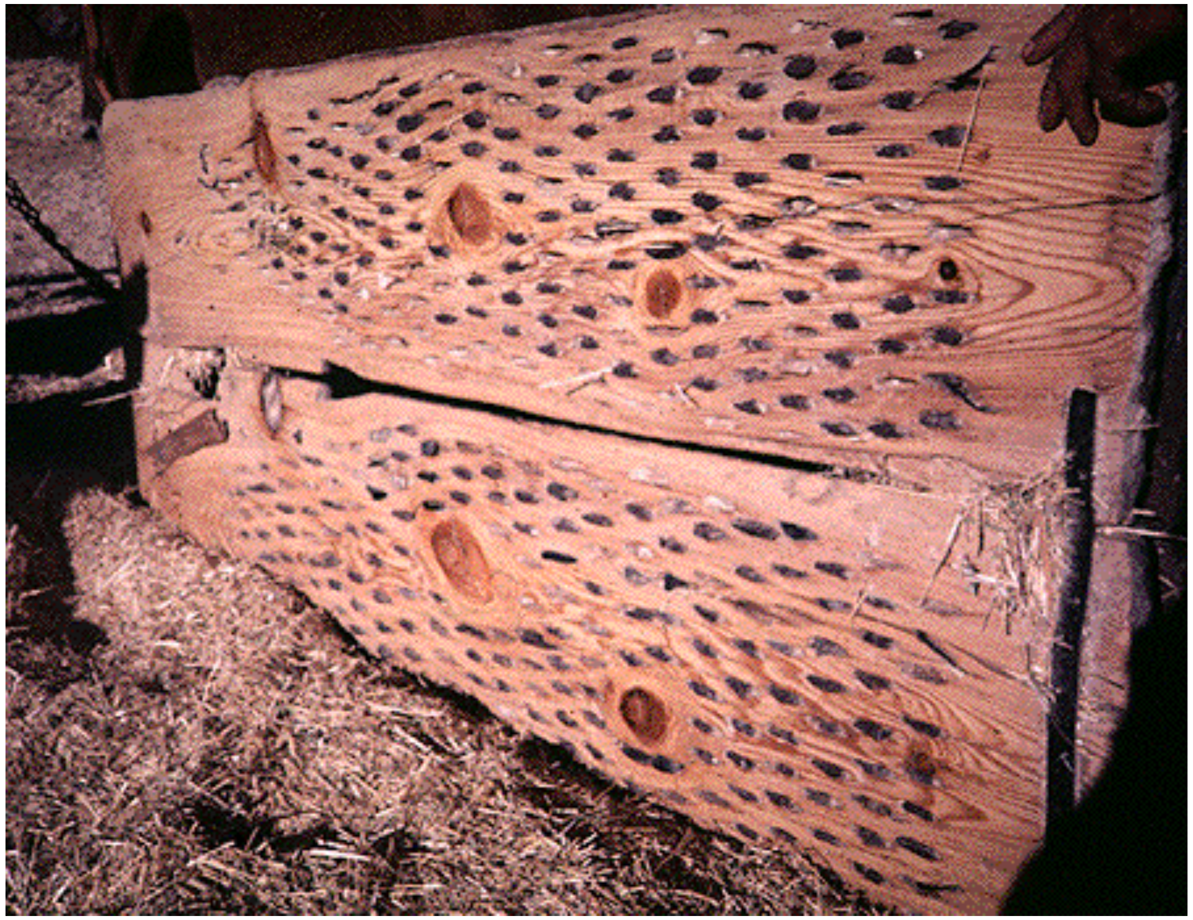
Threshing sledge in eastern Turkey

'Threshing sledges' made up of wooden boards inset with flints and pieces of obsidian.

These threshing sledges are dragged over the cereal grain (or other crop) to loosen the edible grain from the inedible chaff that surrounds it

The stone pices were removed in order to establish the kind of use wear traces that this activity would produce.



These pieces were then compared with archaeological materials in order to establish whether such sledges were used in prehistory with the implications of the use of agriculture

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end scraper interactive graphic

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transverse point

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barbed and tanged point

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how crested blades are made movie

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plain butt

prepared butt

dihedral butt

prepared faceted butt

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indirect percussion

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frost fracture

patination

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fire-cracked rocks

ballast

edge damage

patination interactive graphic

nodules

flint

obsidian

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silica

flint

chert

quartz

rock crystal

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obsidian point movie

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abbevilian handaxe

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triangular handaxe

cordiform handaxe 1

cordiform handaxe 1

INTERACTIVE GRAPHICS

nosed end scraper

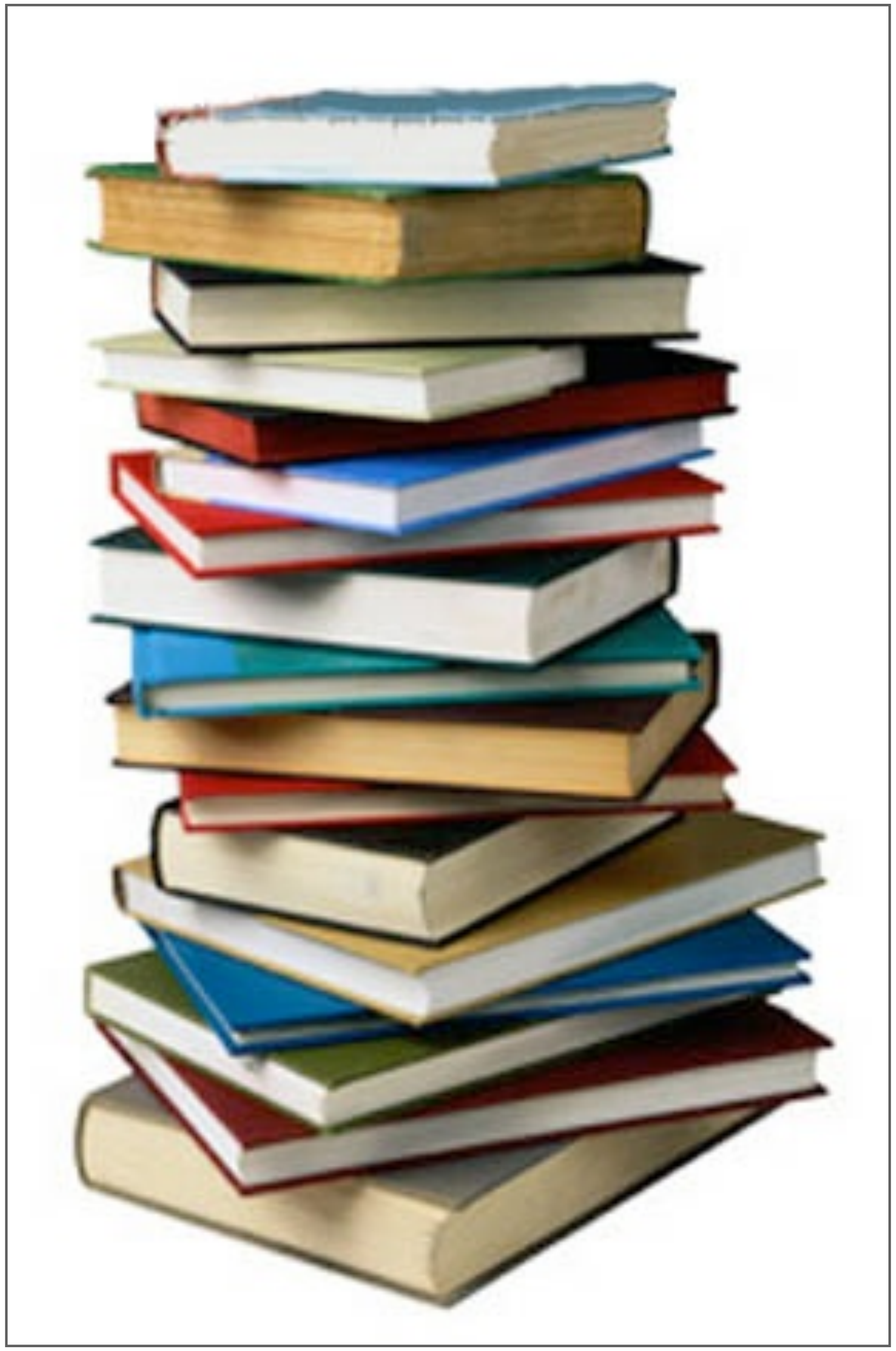
convex endscraper

convex side scraper

tanged point

patinated nodule

bibliography



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