Grinding: The flaked or pecked flake or core is later grounded on a stone slab to get the required shape and size with the production of a working edge.

Polishing: The axes so prepared are now having a more or less smooth and regular surface. These are now rubbed on hard granite stone with sand and water thrown in from time to time. The result of this action creates on axe which, unless told, can be mistaken as a metal axe. It is so shining.

Usually all axes are biconvex in cross-section. These are, however, some which are plano-convex in cross section. These are believed to be used for chiseling. These are called 'Adzes'. Some Adzes have an elongated body and a slightly narrowed anterior end. These are called 'Shoe-last celts', on the assumption that these were probably hafted as a shoe to the primitive ploughs.

Finally another type that emerges with this technique is called a 'Ring Stone'. There are flat round stones in the centre of which a hole is made using a spindle with hard quartz as the tip. The extremely varied size and shape of these ring stones make it very difficult to comment on their probable function. The general view is that the massive ones were probably used as mace head for pounding crops, while the small ones were probably used as net sinkers in nets used for fishing.

2.6 SUMMARY

In the journey of human evolution if we will see and analyse the past then we can say our ancestors have spent 90% of their life in Stone Age. This lesson basically dealt with the how prehistoric man survived with these simple stone tools. This unit also dealt with cognition of prehistoric mind.

Suggested Reading

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Sample Questions

1) Discuss the tool types and techniques of Lower, Middle and Upper Palaeolithic Culture.
2) Discuss the tool types and techniques of Mesolithic and Neolithic Culture.
3) What is Blade tool?

UNIT 3 TOOL TECHNOLOGIES

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3.9 Summary

Suggested Reading

Sample Questions

Learning Objectives

Once you have studied this unit, you should be able to:

- understand what is raw material;
- learn tool tradition; and
- discuss various stone tool making techniques.

3.1 INTRODUCTION

Although prehistorians and archaeologists are sure that the early man initially used some kind of natural tools made of perishable materials, the emergence of a stone tool technology during the course of hominid evolution marks a radical behavioural departure from the rest of the animal world and constitutes the first definitive evidence in the prehistoric record of a simple lithic cultural tradition (i.e., one based upon learning). Although other animals (such as the Egyptian vulture, the California sea otter, and C. Darwin's Galapagos finch) may use simple unmodified tools, or even manufacture and use simple tools (as in the termiting and nut-cracking behaviour of wild chimpanzees), a fundamental aspect of human

adaptation is a strong reliance upon technology for survival and adaptation. Archaeological evidence shows a geometric increase in the sophistication and complexity of hominid stone technology over time since its earliest beginnings at 3–2Ma.

Stone is the principal raw material found in nature. It is very hard and at the same time is suitable to produce effective working edges when fractured into pieces. A wide range of tasks can be executed with a piece of well fractured stone those include animal butchery (hide slitting, disarticulation, meat cutting, bone breaking), woodworking (chopping, scraping, sawing), hide scraping, plant cutting, and bone and antler working. Although other perishable materials, such as wood and bamboo including other raw materials susceptible to decay like bone, horn, and shell, were probably used early in the evolution of hominid technology. Tools made of stone are relatively indestructible and so provide the longest and most detailed record of prehistoric tool manufacture. Therefore stone tools supplemented biological loss like loss of sharp canines and claws as a means of adaptation to the environment during the course of human evolution, and the study of their manufacture and potential uses reveals important information about the evolution of human culture that was substantiated with the two free hands with opposable thumbs, erect posture together with a high brain capacity.

3.1.1 The Earliest Tools

The earliest archaeological sites bearing definite flaked-stone artifacts (Oldowan or Omo industry) include those found in Member from the Omo Valley (Ethiopia), dated to ca. 2.4Ma, the archaeological sites from the Gona region of Hadar (Ethiopia) at 2.5–2.6Ma, the sites at Lokalalei (Kenya) at 2.34Ma and possibly Senga-5 (Zaire), between 2.3 and 2Ma. Other sites believed to be at least 1.5 Myr include those in Member E at Omo; Koobi Fora (Kenya) in and above the KBS Tuff at Olduvai Gorge (Tanzania) Beds I and II; and Peninj, west of Lake Natron (Tanzania). The stone artifacts from the South African caves of Swartkrans and Sterkfontein (Member 5) may be put in the same time range as well.

3.2 RAW MATERIALS

It was quite obvious that early man after the loss of the power of canine and claw, was certainly having a kind of habit to pick some natural objects of perishable and non-perishable materials to defend him and in search of his food. It is true that tools from perishable raw materials do not survive in archaeological ruins but one can substantiate the use of such objects rather a tool from ethnographic sources. Therefore when raw materials of prehistoric tools are concerned, it classified into ‘perishable’ and ‘non-perishable’ objects.

3.2.1 Perishable Materials

Perishable materials comprise materials like wood, bamboo and different parts of animal bones.

3.2.2 Non-perishable Materials

The typical rock from which artifacts are produced are relatively fine grained hard igneous rocks suitable to fracture easily in any direction (i.e., they are *isotropic*).

Commonly used rock types are flint or chert, quartzite, quartz, agate, chalcedony, jasper and various other igneous rocks, including obsidian (volcanic glass). Some materials namely flint or chert, can be more easily worked after heat treatment (a controlled heating that alters crystal structure), a practice that may have begun in Late Paleolithic times.

The different types of raw materials vary widely in their overall spatial distributions and in time in terms of size, shape, quantity, and quality. They may be found in *primary* geological context, that is, at their site of origin or formation, such as a lava flow, quartz vein, quartzite layer, or flint nodule seam, or they may be in *secondary* (redeposited) context, such as cobbles in river gravels or rocks forming the pavement of desert surfaces.

Both the cultural rules regarding artifact design and the intended use of a tool influence the tool types those are found in the prehistoric record. Cultural norms and functional requirements in addition to size, shape, quality, and flaking characteristics of the stone material also can strongly affect the kind of artifact. More sophisticated, delicately flaked artifacts can generally be made in fine-grained materials like high-quality flint and chert than are usually made in coarse-grained rocks. The relative abundance or scarcity of stone suitable for flaking affects the qualities, quantities and sizes of artifacts. For this reason the artifacts made in rock available locally often tend to be larger and found in greater numbers than artifacts made from stone transported over greater distances.

In general, there is increasing selectivity in use of stone materials over time in the Palaeolithic age. Later Stone Age people were found to concentrate more on finer-grained, high quality rock sources, often quite localized in distribution and transported from some distance. Stone tools are broadly categorised into Core tool and Flake tool. Subsequently different tool-making tools are associated with them.

3.3 FRACTURE MECHANICS OF STONE

One type of fracture observed in stone-tool manufacture is often called *conchoidal fracture.* This means conch shell like ripples or swirls that is generally evident in the artifacts manufactured in finer-grained materials. In stone-tool manufacture, a sufficiently enough force is applied to the stone in a controlled fashion. The stone usually fractures in alignment with its crystalline structure; thus, non-crystalline or finer-grained materials, especially isotropic materials with no preferential cleavage planes, such as obsidian or flint, tend to produce a smoother and more predictable fracture.

The stone is deliberately fractured (or *flaked*) either through a sharp, percussive blow (direct or indirect flaking) or through the application of a compressive force (pressure flaking). The parent piece of rock is called the *core,* and the spills so removed are named the flakes.

Fracture in core is done by a hammer placed at an acute angle (less than 90°) to the core. For this reason, in manufacturing tools from rounded pieces of rock, such as stream cobbles, which have got pronounced overhangs or are with flattened edges tend to be easier to flake than more spherical pieces. When a hammer strikes the core obliquely and with sufficient force near one of these edges, a flake is detached, that results in an associated scar called a ‘flake scar; on the core (Fig. 3.1).

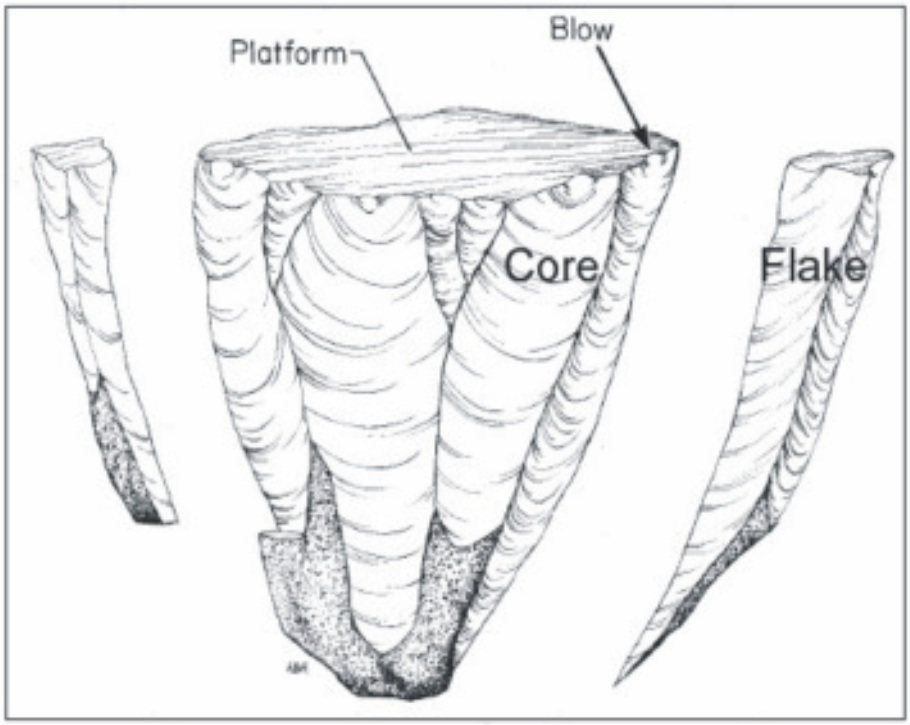


Fig. 3.1: Core and Flake (modified from Whittaker, 1994)

There are several characteristics features of the flake. The surface which was detached from the inside of the core is called the ventral, or *release,* surface. This surface includes a striking platform *(butt)* at the top of the flake with a definite point of percussion, where the hammer had struck, a bulb of percussion, a bulbar scar *(éraillure),* ripples or waves, and fissures. The outer surface of the flake is known as dorsal surface. On this surface several features are found. Sometimes a cortex, which is a weathered surface of the core and/or scars of flakes removed previously from the core (Fig. 3.2).

Although some natural processes (e.g., high-energy fluviatile or glacial forces) can produce percussion flaking on pieces of stone, they do not exhibit the controlled, patterned removal of flakes characteristic of even the earliest stone industries. Early hominids clearly had a sound intuitive sense of geometry when flaking rock and expertly exploited acute angles on cores.

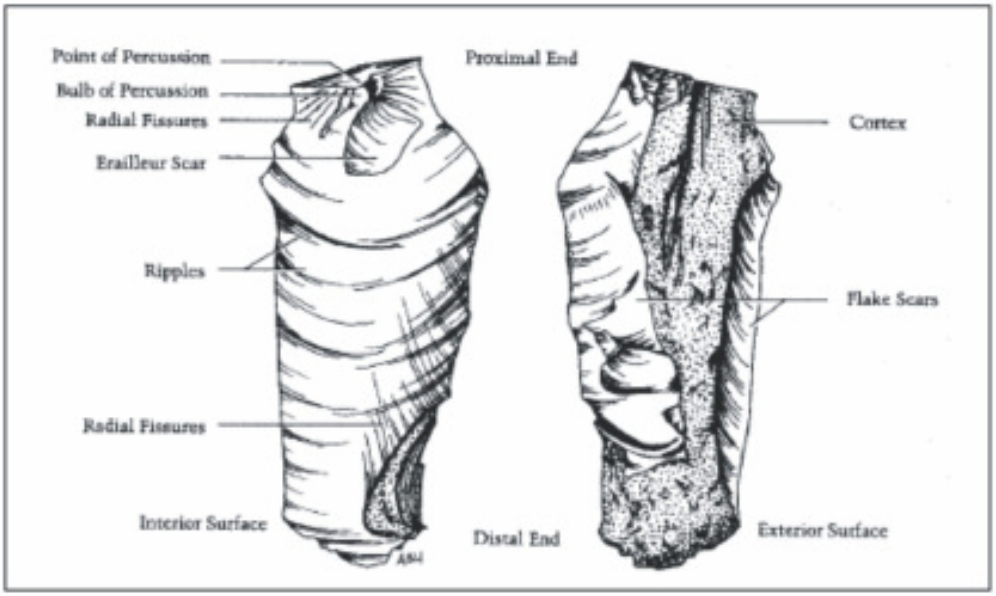


Fig.3.2: Flake Landmarks (Modified from Whittaker, 1994)

3.4 SOME TERMINOLOGICAL UNDERSTANDING

The mechanics of flake formation in stone tool making and use are basically the same and any differences that occur can be attributed to scale. As much as possible archaeologists and anthropologists use nonspecific language to describe the phenomenon of flaking, and here following Cotterell and Kamminga, (1987) some such terms are described, most of which is indicated in the following diagram (Fig. 3.3).

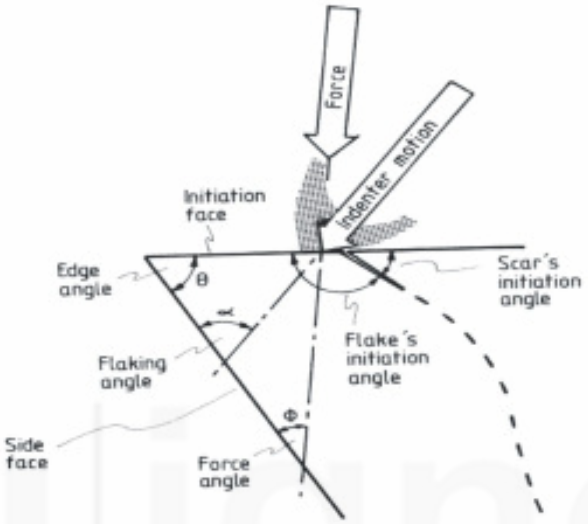
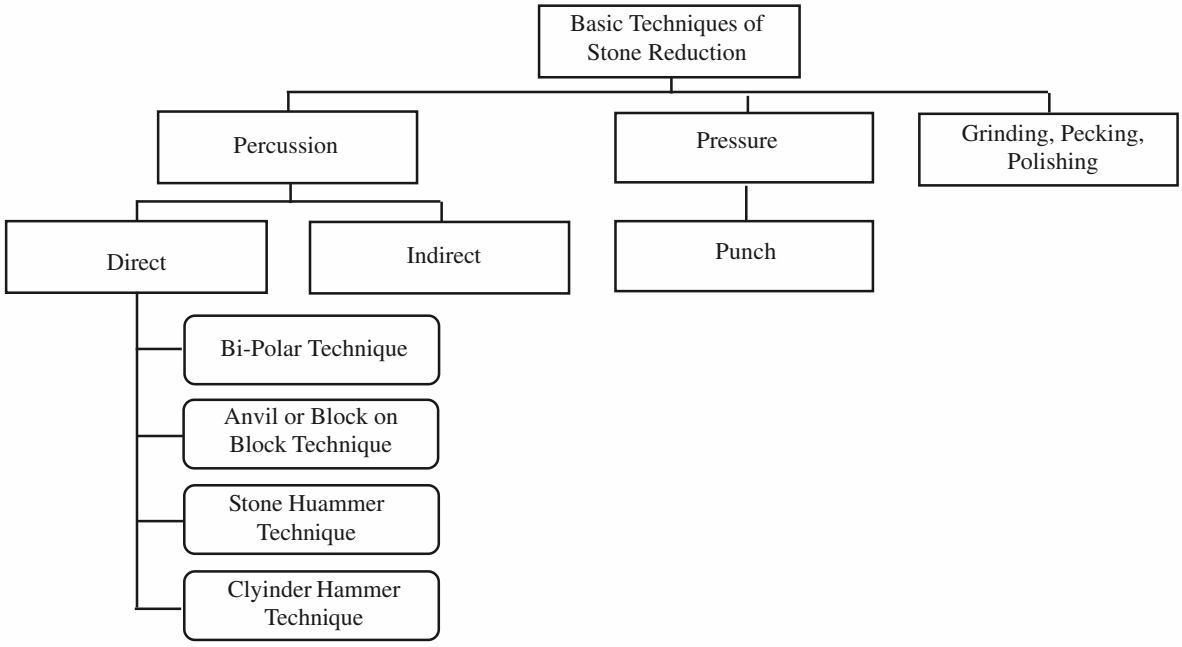


Fig.3.3: Flake Terminology (modified from Cotterell and Kamminga, 1987)

A 'flake' is a kind of fragment detached from a nucleus. A nucleus or 'core' is a piece of rock from which a flake is detached, and the selected core, which is considered as a 'future tool' after it is picked up and finally it is systematically transformed into a 'tool'. It is important that before the selection of a core, the tool maker was certainly having a kind of positive notion in his mind regarding shape, size and future use of the tool.

3.5 BASIC STONE TOOL MAKING TECHNIQUES

The Basic stone tool making techniques can be divided in the following way-



All the above techniques are described below.

3.5.1 Percussion Technique

The simplest and most obvious way to remove a flake is by directly striking the stone with another object preferably a stone as a hammer. The earliest crude stone tools were primarily the result of direct percussion; there were great refinement in indirect percussion. The tool maker has been referred as a 'knapper' who used two types of hammer: a hard hammer or a stone hammer selected mostly from a river pebble. and a soft hammer. The latter is a hammer of antler, wood, bone, or other material, softer and more resilient than stone, hardened pieces of long bones or antlers. Stone hammers continued in use since the Lower Palaeolithic times. During Acheulean culture stone hammer was used but cylindrical hammer as well as soft hammer was used for final shaping. Stone hammer results in removal of large flakes and with the help of cylindrical hammer smaller, shallow, round and fish scale like flakes are removed. Beside these one of the earliest form of percussion method used by prehistoric people was Anvil technique or Block-on-block technique and Bipolar technique. These were prevalent in Lower Palaeolithic times.

3.5.1.1 Anvil Technique or Block-on-block Technique

A core is struck against a stationary anvil to produce flakes. This percussion technique is sometimes used in flaking very large cores. The features on flakes and cores are similar to hard-hammer percussion (Fig.3.4).

Fig.3.4: Anvil or Block-on-block technique (Modified from Whittaker, 1994)

3.5.1.2 Bipolar Technique

Simply involves Setting a core on an anvil and hitting the core from above with a hammer stone, just like cracking a nut. This technique was often used for very small or intractable, hard-to-flake raw materials. In such a case, 'positive bulb of percussion' appears on both the ends of the tool. (Fig.3.5).

Fig. 3.5: Bipolar technique

3.5.1.3 Stone Hammer Technique

Usually refers to the use of a stone hammer used in making handaxes during Abbevillean culture. In this technique large flakes were struck off and therefore profile lines of the handaxes of that time are wavy (Fig. 3.6).

Fig. 3.6: Hard hammer percussion with a stone hammer. The knapper uses a precision grip on the pebble hammer stone because not much force is needed. The blow strikes the top of the core, and the flake comes off the underlying surface (Modified from Whittaker, 2004)

3.5.1.4 Cylinder Hammer Technique (Fig.3.7)

On the other hand, often means the use of a hammer of antler, wood, bone, or other material softer and more resilient than stone. Such tools are often called batons or billets. Soft hammers are less effective than hard for removing large flakes from normal cores; so the use of a soft hammer often implies to bifaces produced during the Acheulian culture of Lower Palaeolithic times. In case of the entire handaxe industry of the Abbevillo-Acheulian culture, best piece of handaxes were made with this technique, and 'ovate' from Europe was the representative tool of this time. In Africa and India, 'cleaver' is a branded tool of this culture. Small flakes were carefully removed with the said hammer from the edge towards the centre of the tool and this was the advantage of the cylindrical hammer, the blows of which could be given in a controlled way. In case of handaxe industry of Lower Palaeolithic time, a handaxe is also known as a 'biface' or a 'coup-de-poing'. In other cases, bifacial tool has been mentioned as similar to handaxe, the blows fall on the edges, rather than on the flat platform surfaces of normal cores. The edges of bifaces (handaxe like tools) in production are generally strengthened by intentionally dulling them, because a thin, sharp edge will crush under the blow rather than transmitting the force to a clean flake fracture. The flakes produced in making bifaces have somewhat different traits from the normal hard hammer core flake and are often referred to as biface thinning flakes. Hammers of all degrees of hardness can be used somewhat interchangeably, and the difference in the kinds of flakes produced depends in part on how the hammer is used and what form of artifact is being worked. Quite often, a large flake struck with a hard hammer is thinned and shaped with a soft hammer to make a finished bifacial tool, or a previously prepared form (perform) that can be finished by pressure flaking as described below.

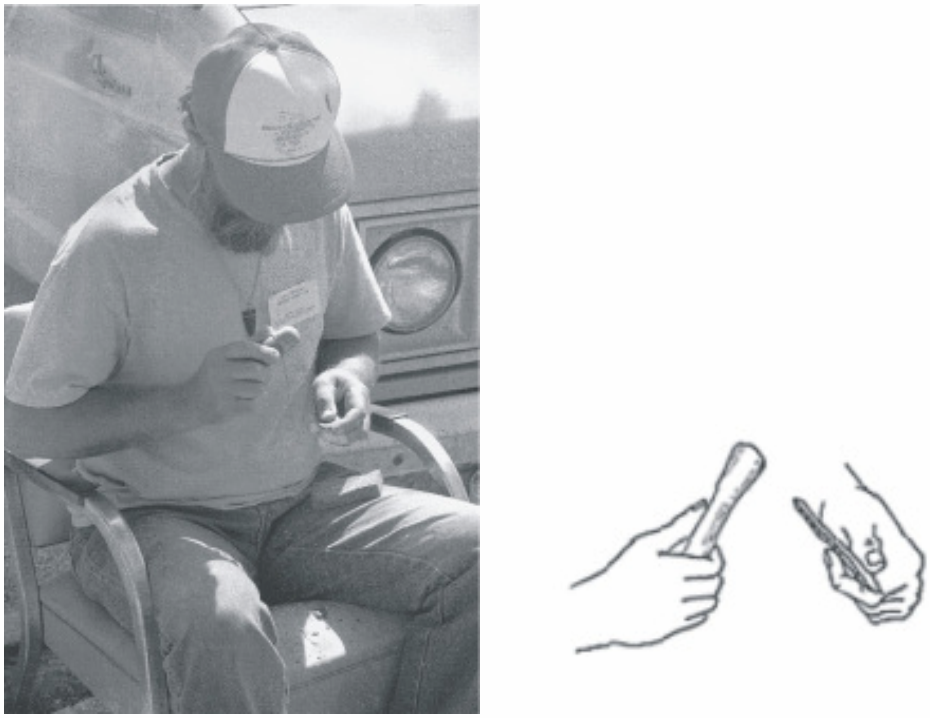


Fig.3.7: Soft hammer Percussion using wood or antler (Modified from Whittaker, 1994, 2004)

3.5.1.5 Indirect Percussion or Punch Technique

Means that the blow is transmitted to the stone through an intermediate punch, usually made of antler called a 'puncher'. This is a relatively uncommon technique, though there are several modern knappers who use different styles of indirect percussion to thin bifaces. However, because the punch can be small, and can be placed very precisely, indirect percussion has some advantages over direct percussion techniques and is also used for making blades (long, straight flakes) or for notching projectile points. The disadvantage is that tools must be held with both hands, making it more difficult to stabilize the piece that is being worked, and many modern Knappers find it slow and clumsy. Those modern knappers who are expert at indirect percussion, however, consider it every bit as good as more common techniques (Fig.3.8).

Fig.3.8: Indirect percussion with a large Antler punch (Modified from Whittaker, 2004)

3.6 PRESSURE FLAKING

The final category of knapping techniques is pressure flaking. In pressure flaking, the force is applied by pressing instead of striking. This allows great precision, but generally limits the amount of force. Pressure flaking is most often used for the final work on refined tools like various leaf points, arrow-heads and for notching and other details that cannot be done by percussion.

In pressure flaking, the point is held on a pad of some sort in the hand or occasionally on a bench or table like object, while the other hand presses the tool against the edge of the stone, directing the force both inward, to make the flake run across the face being worked, and downward, which begins the fracture. Pressure flaking can be made more powerful by adding the pressure of the legs, or the leverage of a longer tool, called an Ishi stick by many knappers, which is held under the arm. The name honuors Ishi, last survivor of a group of Yahi Indians from California. His flint knapping skills and tools were recorded by a number of early anthropologists and are admired by modern knappers. It is also possible to remove very long flakes (called blades by archaeologists) from a core by pressing with a chest crutch or other tool that allows the body weight to be brought to bear (Fig. 3.9, 3.10 and 3.11).

Fig.3.9: Pressure flaking on a bench.

Fig.3.10: Pressure flaking into hand pad with an Ishi's stick. punch (Modified from Whittaker, 2004)

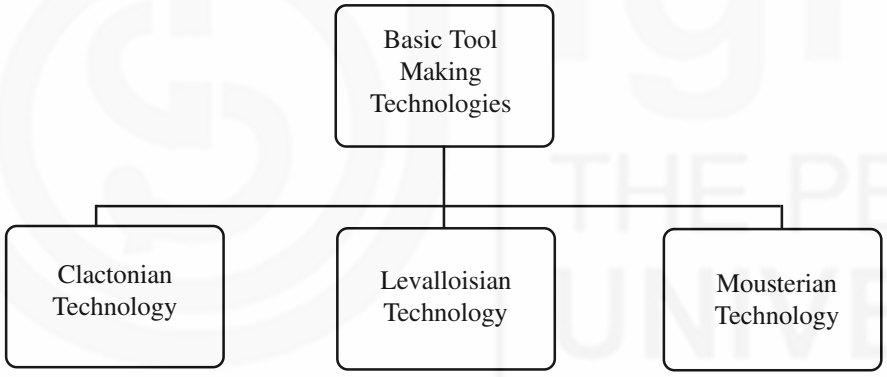
Fig.3.11: Making obsidian Pressure Blade with a Chest crutch punch (Modified from Whittaker, 2004)

3.7 GRINDING AND POLISHING

It involves grinding and shaping a rock by rubbing it against another rock. Prior to the said operation, the selected core for this purpose is processed by percussion technique in giving a desired shape to the future tool. Partly flaked and ground – edged tools bear the testimony of this application. Celts that include axes, adzes, chisels and others were manufactured by this technique. Polishing is a stage that is applied to give the tool a smooth and shining texture. This part of action is done by rubbing the tool to furry animal skin. These techniques are applied on hard grained material and often were useful for re-sharpening a Celt when its working edge get damaged. This technique is often associated with Neolithic farming communities in Southeast Asia, Europe, and North Africa, but it can be found also among aboriginal hunter-gatherer communities of Australia.

3.8 BASIC FLAKE TOOL MAKING TECHNIQUES

Flake tool tradition made its appearance at the end of the Lower Palaeolithic and flourished since then through Middle Palaeolithic times. A number of flaking technologies were used to make blanks and to shape a core into a finished tool. Here a chart is given which shows some basic flake-tool making techniques.



However beside these a number of other techniques like crested blade technology and Kombewa technology were also present at that time. Brief description of these basic technologies are given below:

3.8.1 Clactonian Technique

It originally involves use of anvil technique to produce large flake tools. From the name of the type site Clacton-on-sea, this technology is known as Clactonian method. The flakes produced by this technique present large natural striking platform with very pronounced interior angle (greater than 105 degrees), which is produced due to the intersection of the axis going through the natural striking platform with the axis going though the main flake surface, and a diffuse bulb of percussion. The lack of any surface preparation makes these flakes highly variable in structure and thickness.

3.8. 2 Levalloisian Technique

This is a prepared-core technology named after a place called Levallois-Perret, a suburb of Paris where flakes and cores of this kind were first recovered and

defined. Levallois technology is most characteristic of Middle Paleolithic industries but begins to appear before 200Ka, in some cases in association with Early Paleolithic industries.

Levallois cores were artificially prepared for striking out better flakes to make a better kind of tool. Centrally directed removals were generally used to create a square, ovoid, or other regularly shaped block of stone, which was more or less flat on the upper surface and markedly convex on the lower surface (planoconvex). The sides of the block were also convex (lateral convexities). A striking platform, at right angle to the flat upper surface was prepared at one end of the core. The Levallois flake was then removed from the upper surface by bringing the striking platform down sharply at an angle on an anvil. The large flake that often resulted was extremely thin in size, conformed closely to the outline of the prepared core, and retained the pattern of centrally directed removals on its upper surface, as well as the facets of the striking platform. Although not all of these features characterise every Levallois flake or core, the distinctive thinness of Levallois flakes, together with their regular shape, are suggestive of the use of the technology in a particular assemblage. Definitive determination of Levallois technology, however, can be made only by reconstructing the entire knapping process through refitting. It is worth mentioning that the angle produced by the intersection of the axis passing through the prepared striking platform with the axis that passes through the main flake surface is always a right angle.

3.8.3 Mousterian Technique

The Mousterian or disc core technology is characterised by centripetal flaking around the entire core margin on one or both surfaces. Although it is not different to Levallois in both the technique and form of removed flakes, it lacks clear support that the exterior morphology of the core was specially prepared to achieve a flake of a particular form. Two characteristic products of this technology are the pseudo Levallois point and the disc core itself. The later is generally circular in form with centripetal flake scars and typically has a flaking surface that is quite high or even pointed at the mid point.

> Neanderthals were primitive humans and are the Mousterian tool-makers. Massive skeleton and teeth, flat foreheads and heavy brow ridges were the characteristic features of Neanderthals. The Mousterian tool habit gets its name from artifacts discovered at a ancient rock shelter named Le Moustier in south western France.

3.8.4 Retouching and Blunting

The term retouching involves removal of flakes from a piece of stone. Sometimes the term *primary retouch* refers to the initial, roughing-out stages of stone reduction, while *secondary retouch* designates the more refined reduction of stone material, as in the case of bifacial thinning or the shaping of flake tools. Some archaeologists restrict the term to refer to the formation of flake tools. Where as blunting is a form of retouching which is done in such a way that a sharp edge of a flake turns into a blunt edge. Most developed form of retouching and blunting were actually developed during the greater part of Stone Age especially during Upper Paleolithic and Mesolithic to make various type of points and microliths.

3.9 SUMMARY

The study of stone technology does not entail simply observing the techniques or procedures of artifact manufacture; ideally, it considers a complex series of prehistoric actions that surround the creation of a set of tools at an archaeological site. It is useful to view stone technology as a system that encompasses the procurement of raw materials, the manufacture of tools from those materials, the transport of tools and raw materials, use of the tool, the re-sharpening and reshaping of the tools, artifact discard or loss, and the final incorporation of the stone tools within the archaeological record. Within each major component of this system, there are some basic questions that can yield important information about prehistoric behaviour.

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Sample Questions

1) What were the basic technologies used during Lower and Middle Paleolithic?

2) What do you mean by the term 'flake'? Describe different feature of a flake with suitable diagram.

3) Discuss briefly the direct percussion method with suitable diagram.

4) Mention name of at least three sites from which earliest stone tools are discovered. What types of raw materials were used to make stone tools?

5) What do you mean by the term lithic technology? Why study of lithic technology is important in prehistory?

6) What type of rock fracture was used to make stone tools? Define the following terms with diagram: Indenter, Edge angle, Flaking angle, and Force angle.

7) What is bi-polar technique? What do you mean by the terms retouching and blunting?

Write short notes on the following with suitable diagrams.

i) Levallois Technique

ii) Soft hammer percussion Technique

iii) Pressure flaking Technique