It would be difficult for any person to conduct experiments on all core and flake types or to understand fully all the permutations of the features that go into making ~~up~~ ~~a~~ cores and ~~flakes~~ their flakes & blades. But we can broaden our knowledge and resolve certain types by a careful study and analysis of flakes, blades and the debitage resulting from their manufacture. A study of cores and their flakes is basic to a concept of technological studies, and a ~~far too often overlooked~~ much neglected factor of flake, blade and artifact analysis is a consideration of the debitageflakes found at the occupation site and the relating of this waste material to the stages of flaking techniques required to produce the desired size and type of flake, blade or artifact. Admittedly, debitage flakes are not as glamorous as the stone tools or cores, but they can be just as interesting and can furnish information not found on the core and artifacts. The core or artifact usually shows only the last stage of its several stages of manufacture, whereas the waste flakes can give clues to the primary, secondary or intermediate steps of fabrication. The very presence of ~~the common conception type of~~ cores in tool typeology is mute evidence of the importance of flake scar study. They are certainly not a tool (unless they show functional scars) but they are of prime importance in typeology for the express purpose of studying the scars and technological features to resolve the tool types of their flakes and blades. Debitage flakes can be equally important.

In the Americas where we have a great absence of cores, it is not only recommended but almost imperative that we resolve the core technique by analyzing and reconstructing the cores from the flakes and blades if we are to ultimately postulate the type of core with which they are compatiable. ~~This shortage of material~~ Conceivably, a shortage of raw material forced the ancient stoneworker to reduce his core to a minute, unrecognizable or ~~and~~ insignificant size and it is possible that this same lack of stone ~~promoted~~ prompted the modification of these exhausted cores into tools such as wedges, scrapers and cutting implements. Pebble tool industries, no doubt, developed because materials larger than pebbles were not available

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Even though we rightfully regard cores as basic in the study of the toolmaking industry, they represented only the residue of discard debitage to the prehistoric stoneworker. He was not concerned with their weight, beauty or form, and he made no real attempt to keep them uniform other than that required ~~necessary~~ to successfully remove a flake or blade of the desired width, thickness and length. To the stoneworker, the core was the nuceli, the waste product, and he had no thought for their regularity or uniformity ~~he made no effort to keep them regular or uniform~~ - his efforts and aims were on the detaching of flakes and blades. But, Since his ~~needed~~ blade type required certain consistency in flintknapping techniques, he ultimately produced a uniform core type. In other words, the design of the blade, or flake, which was pertinent to different cultures, geographical areas and economies, determined the type and design of the core. This, of course, is what makes core study so important and contemporaneous with the movement and age of man and also points out the need for careful study of the debitage flakes and for core reconstruction thru this debitage, when ~~the flakes themselves are absent~~ ~~[illegible]~~ when none are found at the site.

Because of the nature of the material being worked and the human element of change and error involved, there are many variables and, therefore, steriotypesof flakes and artifacts ca nnot be expected but we can look for consistency. There will be consistent differences reflecting minor & major changes in techniques of flake & blade removal. When flakes are separated into the stages of their taxonomy, each stage will readily demonstrate the rhythms attained by the worker and then there will be a greater consistency of flake types. Categories ~~[illegible]~~, similarities & like attributes will show the development of patterns which will denote the phases & stages of the part they played in the development of artifact types which will greatly assist in the interpretation of their cultural traits. Because of these slight variations and variables, the flakes should not be appraised individually but rather by the manifestations of their traits and techniques.

The flaked tool industries are represented by residue debitage of the various stages of development of the artifact, from the initial break of the raw material to the completed implement. The quantity and size of the flaking residue will normally be proportionate to the distance from the source of raw material. Should the archaeological site be of some distance from the source of raw material, then several stages of manufacturing are apt to be absent. This is due to roughing out, blanking and preforming of the artifact at the quarry. In this case, flakes representing these phases of tool manufacture will occur in the proximity of the material source. These unifacially and bifacially worked preforms found at the quarry are made by using the core technique and, generally, direct percussion. The cores may be derived from large tabular or primary flakes, sections and parts of nodular forms or simply from parts of cobbles derived from alluvium. An occupation site located near a large quarry is most likely to have flakes which will represent all phases of techniques of manufacture. Populations of cores are usually limited to areas abundant in lithic material but when materials had to be transported a great distance to the occupation zone for flake and blade manufacture, the core was normally consumed until there only remained a bare and unrecognizable remnant of the original piece of material. In this case, we must attempt to resolve the core type by relating the flakes. Flakes and blades have certain identifying characteristics which make it possible to reconstruct the core to which they are pertinent and by a study of aboriginal cores and their flakes, one will be able to resolve core types from the flakes alone. The study of cores and their stages of development is usually difficult, for the core was designed to produce flakes and blades and would be consumed in the process. Unless the aboriginal was interrupted and his unfinished work abandoned, it is unlikely that the evolution of the core would remain. Therefore, at best, one must generally base his conclusions on the exhausted or malformed cores and flakes. It is rare, indeed, to find a great population of cores such as Francois Bordes found this year at Corbiac (about 1000) of the upper Perigordian. (personal communication, Nov. 6,1966) On the other hand, most literature shows great populations of flakes and blades with small porpotions of cores(J.Radley and P.Mellers, 1964 proceedings of the Prehistoric Society. A Mesolithic Structure at Deepcar, Yorkshire, England; 23,000 flakes and 17 cores)

By a comparison of their diagnostic attributes, flakes are determined to be similar or the same, and then one may select one or two as being representative of form and technique. Studying flakes and ultimately relating them to various tool types will indicate the cultural technological traits and modes of manufacture and will greatly assist in obtaining a sharper definition of a complex in a cultural area. The debitage flakes from the making of just a single artifact may number several hundred whereas the artifact is often considered individually without placing too much emphasis on the surface flake scars. But even when these surface scars are evaluated, they usually only cover the last stage of fabrication whereas the debitage flakes considered in conjunction with this would give us the true picture. The flake is far more useful in determining the technique than the flake scar for the platform and a part of the original lateral edge of the artifact was removed with the flake. Although the flakes removed from an artifact can be uniform, they may leave scars on the surface that are multi-directional. Uniformally flaked artifacts leave scars that appear to duplicate artifact types but, in reality, there is no facimile. There are duplicates in technological traits but there is no duplicate artifact. Like fingerprints, each is distinct and a mould of one artifact, no matter how similar, will not fit the mould of another. The elements involved in manufacture are not that steriotyped and the human margin of variation is too great. An analysis of flakes will show a greater consistency of form and attributes for it is only necessary to consider one unit rather than the composite units which compose an artifact. It will be much easier for a student to separate flakes into different technological categories than to type artifacts if he considers the surface character of the artifact with the form.

The projectile point forms are probably the most consistent of the flaked artifact types but they, too, vary with the whim and needs of the maker. While their dimensions are variable, their mode of manufacturing is generally constant. An outstanding and well-known example of the variation in form but consistency of technique are the points found at the bison kill site excavated by Dr. Joe Ben Wheat. This site yielded a large population of unbroken and mint condition projectile points and was devoid of the discards and debitage usually found in zones of occupation. The flaking technique of these points was consistent and uniform, with only slight variations, yet they varied in size and form. Unfortunately we do not have enough occurances of these finds for they are a fine example of what actually went to the field and they furnish much knowledge regarding technology and typeology. Because of the unique mode of manufacture of these points and because they are in mint condition, a thorough analysis of this collection should resolve the consistency of flaking techniques and the variation of form and size.

This paper is intended to assist in separating flakes and blades and relating them to cores by interpreting their mode of manufacture, for my experiments carried out over the past years have afforded a basis for some conclusive evidence regarding the mode of tool manufacture. These experiments are intended to shed some light on the aboriginal lithic industries and point out the magnitude of flake study due to the vast quantities of débitage. As more flake assemblages are analyzed in different geographical regions and related to different periods of time, the need for such a study will become apparent. My attempts at replicating flakes and cores have shown that the materials, musucular motor habits of the worker, distinctive traits, human behavior patterns, evolution and phylogony, concious planning, traditional development, outright invention, pride of workmanship, and need for superior tools provides an insight into the lives and economy of the prehistoric people who skillfully fabricated stone tools so necessary for their existance. Working in this very complex industry has increased my respect for the earlier workers' achievements and for prehistoric mans' knowledge of materials and its source, ~~their~~ his unbelievable control of muscular coordination and ~~their~~ ability to vizualize the artifact within an irregular block of stone, ~~and~~ the mechanical and physical problems to be overcome before a useful end product could be made, and consistent and precise mental calculations of angles to project forces of variable intensities. These are just a few of the items to be considered when appraising the past stoneworkers unbelievable accomplishments. This text will attempt to portray the results of these experiments and project the need for additional research on types not yet fully understood. Those not fully understood will be hypothecated on the basis of conclusions drawn from various experiments and possible techniques will be postulated. These experiments have proven that before final judgement or ~~xrxdxx~~ analysis can be made, one must replicate both core, flakes and blades in all aspects and characteristics and unless a replica of the original can be duplicated many times by the same technique one can go far afield from theory alone. There are definite laws of physical and mechanical properties of materials and applied force that remain constant, and if aboriginal results and those that result from experiments are the same we may then conclude that the techniques used will be much the same.

The people who adopted the core and blade traditions most certainly recovered all flakes and blades which conformed to their needs and those found usually are aberrant, malformed or those which broke as they were removed from the core. Such populations of flakes other than trimming, retouch and modification debitage cannot be expected other than an accidental occurance for the flakes were removed from the core for a functional purpose. It is from a reconstruction of these waste flake and blade assemblages that the end product can be evaluated.

An infinite variety of core, flake and blade forms must be considered to seperate the techniques used over a great span of both time and space. It is the writers feeling that by flake studycertain types of flakes will be pertinent to only certain groups of people in certain periods of time and certain geographical areas.

The first and basic step of working isotropic stone either by percussion, indirect percussion or pressure is the ability to control the fracture of the material. One must understand what is happening when force is applied to flintlike material. THE PAST ARTISANS IN NO WAY STRUCK IMPULSIVE BLOWS AND ONLY AFTER CAREFUL PREPARATIONOF SURFACES AND ANGLES WAS THE BLOW DELIVERED WITH CONTROLLED, CALCULATED AND METICULOUS PRECISION. (Before the experimenter starts to remove a flake from a core, he must understand that detachment is not accomplished by indiscriminate random blows but is the result of a preconceived design of the flakes. Any carelessness in detachment will result in a hinge fracture causing the art. to be malformed or useless) ~~The superb examples of aboriginal work reveal not a bag of tricks, but an intensive knowledge of materials that would lend themselves to stone tool making and splendid display of mental and muscular coordination. The analysis of flakes and cores in this text will, hopefully, outline the variables encountered in stoneworking and show how they are overcome and controlled by different techniques. Proper flake analysis should show the development of techniques traditional with each generation and any parallelism in development, as well as other techniques which are highly specialized for particular functions.~~ (see page 11

I recently had an opportunity to study collections at Idaho State University, Washington State University, University of Washington, University of British Columbai, Museum at Victoria, University of New Mexico field school at Vernon, Arizona, University of Ari_ona at NEW MEXICO Grasshopper site, the Denver Museum of Natural History site at Kersey, Colorado, and the information gleaned from these collections has been most rewarding and pointed out to me the great need for debitage analysis. Numerous technological traits and techniques were represented. My method of rapid survey of flake assemblages was: (1) to seperate the flake parts for only the aberrent, ill-formed and broken material was normally abandoned and, therefore, found by the archaeologists; (2) The proximal portions of the flakes were arranged in rows with the platforms facing the sorter for these ends provide the bulk of the information pertaining to technology; (3) Then the mid-sections and distal ends of the flakes were also arranged in a like manner. (4) the proximal ends(those bearing the platform of applied force) were then re-grouped by segregating those with like platform characteristics. This involves many features which will be further explained in this text.

Flake assemblages fall into two classes: those which resulted from flaked artifact manufacture and those which result from making flakes and blades which were to be used freshly struck or to be modified into tool types characteristic to blades and flakes.

It is not the intention of the writer to inject the meaning that there are two major cultural differences in separating flake assemblages derived from making artifacts by the use of the core method or by the modification of flakes or blades, as both techniques can be used by a single group of people. It is only important to be able to recognize these techniques when they make their appearance.

For the purpose of analyzing assemblages, all flakes and blades will be called flakes. Existing literature does, however, use the terms splinters, chips, spalls, blades, lamellar flakes, lamelles, bladlets, prismatic flakes and blades, etc. There are numerous types of flake specilizations. Many now existing in collections haveno terminology, yet they could have considerable diagnostic value in the interpretation of technological traits. At present, the only seperation of flakes seems to be "bladelike forms", yet there are numerous technological techniques used to remove blades from cores. The term "blades" encompasses a vast arrary of flakes with parallel sides with"their length being two times their width". (Francois Bordes, Les Eyzies conference, Nov. 1964) Individual analysis of such assemblages will readily demonstrate that they will fall into technological patterns which are distinctive to that group alone. Future study will, no doubt, indicate certain parallelisms and traditional traits in flaked stone technology.

The flake and blade (specialized flake) industry represents specially formed flakes removed from cores - the flakes being used freshly struck or modified into artifacts. Blademaking techniques are various and involve different types of core preparation, from the simplest to the more refined. Blades can be used without modification or retouched by pressure flaking. Large flakes and blades are sometimes preformed by percussion into knives, projectile points, etc. When smaller flakes are to be modified into a projectile point, the flake is straightened by removing the bulb of applied force on the ventral side of the flake and the distal end of the flake is also trimmed on the ventral side until the longitudinal axis of the flake is straight. This is usually done by the pressure technique. Most pressure flakes are crushed during their removal and, therefore, will pass through the sifting screen at a dig. Cores which result from flake and blade making are sometimes utalized as core tools or can be reduced to usuable flakes. Therefore, discarded, well-defined cores cannot be expected unless there is an abundance of raw material near at hand. An exception to this is the microblade cores of the Arctic. Some well-defined cores are found here for the worker removed microblades until they were so small there was practically no room to seat his tool and, therefore, he discarded his core. So sometimes the very technique can determine whether or not cores were left at a sight.

Experiments in replicating the aboriginal flaked stone artifacts has indicated that they fall into two basic classifications. Artifacts which are themselves cores and artifacts made from flakes and blades removed from cores. Making artifacts from flakes is the more economical industry than the core-type tool for it leaves very little waste. Flakes and blades are removed from a mass of material (core) by applying force on a predetermined definite surface area at definite specific angles with varying degrees of intensity and velocity. The surface which is to receive the applied force will be known as the platform and its design has a direct bearing on the type of flake or blade removed from the core. The raw material sometimes determines which technique will be used to remove flakes or blades. The material must respond under the application of force in such a manner that portions of that material may be detached in any directions. This quality is known to me as isotrophism. Removal of raw material must include control of the width, length and thickness of the flake and the applied force must follow the desired direction of the worker.

The simplest form of a core is a piece of material bearing a flake scar. Such an embryonic stage of core development would probably go unrecognized as a core, but such a core was able to provide substance for a usuable flake. Most cores do have more than on e flake scar.

The core bears the flake scar, or scars, which is usually characterized by a negative bulb of force at its apex. The scar indicates the order of removal of the flake which has taken with it the platform and the bulb of force. Even though a cobble stone is severed by force from a hammer-stone, the portion bearing the bulb of force will be the flake part and the half having the negative bulbar scar will be the core. However, normally the flake will be smaller than the core. The core is more massive than the flake because it must necessarily be heavier to provide sufficient inertia to remove the smaller flake. There is one exception to this rule and this is the absence of a bulb on either part of a severed cobble. This is accomplished by a special technique which results in the splitting of the cone of force. When the cone is split, both halves will have duplicate features. This special technique occurs rarely and is usually associated with pebble, cobble industries and with core rejuvenation.

The use of the core as a source of blades or flakes is an indication of mans' first economy for it provides quantities of usuable flakes either modified or unmodified whereas the artifact made by the core method provided only a single tool and much waste material. Since both artifacts and cores bear flake scars, it is sometimes difficult for the analyst to determine whether ~~the object is~~ a core or a tool. For example: a chopping tool is a core remnant and, under certain conditions, could be mistaken for a core, or vice versa. A case in point ~~are~~ is the so-called cores from the Shoop site. These were identified by John Whitoff as exhaused cores and, in fact, could be cnfused as such but at the Les Eyzies Lithic conference (nov.1964) it was determined by both European and American archaeologists that they were Piece Esquielles. They are in fact a core tool, but not an exhausted core. The normal conception of a core is a mass of material used for making blades and flakes and the residue or remnant is the core. A notched projectile point couldn't look less like a core - yet a core it is.

Exhausted cores, or cores which had the flake removal operation either suspended or discontinued, were sometimes used as functional tools - such as pulping planes or they were sometimes converted into hammerstones. Cores defined as havi g been used as a tool should be appraised very carefully before they are typed. The leading edges should be examined for wear patterns and functional scars for there is a similar surface produced when preparing platforms for a subsequent series of flakes to be removed. Removing the overhang left by the last series of flakes and grinding are technological traits used in certain techniques and can be mistaken for functional scars.

Core forms are endless, yet they play an important part as a diagnostic trait and demonstrate many technological differences. Many are difficult to recognize as cores when they were worked down to a small unfamiliar form. Some sites are distinctive because of the complete absence of cores, yet from the flake discards we know that cores were present at the time of occupation. Generally, this denotes a shortage of material and the worker reducing the core to the last usuable piece of material. In this case, flakes and blades will have to be evaluated and the core reconstructed from diagnostic features which the flakes and blades reveal.

Put on Page 6

Before an analysis of the flake is made, I feel that one should examine the chronology of the first experiments, starting from my early attempts at stoneflaking. Since all mans' acts are by nature inquisitive with a natural and inborn urge or motivation, a relationship between that of early man and my experiments will have certain parallelisms. In order to replicate early mans' stone implements, one cannot but conceive his methods without regressing into time to ask themselves "what did he do and how did he do it". The methods that I have used and the methods he would or did use may not be concurrent but their counterparts may have a certain amount of similarity. Before I made my first eolith, I began by striking a piece of flint-like material with a small cobble rock in order to remove usuable ~~bi~~ flakes. The first results using direct free hand percussion resulted in battering, bruising and ultimately shattering my piece of flint. The core as such was not recognizable. The flakes lacked uniformity or style. However, several pieces in the shattered mess did have sharp cutting edges that could have been used for tools but not recognized as such by an archaeologists. When this repeated striking with a hammerstone was continued over a considerable period of time, I would accidentally remove a good flake. Then by studying the conditions that brought about its removal, such as the correct amount of force, the vector of angle, ~~the blow was struck,~~ the character of the point of impact and the surface of the stone that made the dorsal side of the flake, one could then look for the same conditions to make a replicate flake. These conditions must be firmly resolved in the mind of the stoneworker before he can graduate in the class of a good eolith maker. These first futile attempts in stoneworking did, however, produce flakes and cores even though any refinement was sorely lacking.

Since these first embreonic efforts to remove a flake from a core some forty years ago, Certain inferences may be drawn regarding core types relitive to mechanical laws relating to isotrophic materials. The inherent nature of these materials cause definite patterns in flakes and cores. Upon apraisial these characteristics may be related to various techniques and these techniques correspondent to certain peoples in time and space.

Before one can discuss cores and flakes one must understand what is hapening when force is directed ## against a mass of flintlike material.

Before the experimenter starts to

Page The first conseneration in removing a flake from a core he must is that the flake, understand that detachment is not accomplished by is not removed from a core by indiscriminate random blows but is the result of by a preconceived preconceiving and designing of the flakes. the end results before the flake or blade is The worker must have control of muscular motor removed from the core. The types of flakes desired in order to obtain habits & deliver the pressure or percussion force with a certain form of flake or to complete a certain tool were pre concieved extreme accuracy. by concious planning and the muscular motor habits developed trained to the point of unbelieveable accuracy. With each core or tool there was an effort to achieve perfection in accuracy. The flaked tools of the Neolithic more than demonstrate this goal of perfection. Each flake must be Any carelessness in detachment detached with precission and accuracy as any carelessness will result in a hinge fracture causing the artifact to be malformed or useless.

The making of cores blades or tools may be compared to a game of chess or chekers,one must keep at least one move ahead of the flake to be removed and sometimes several. I~~t would be utter stupidity for one~~ ~~to allow~~ allowing a flake to step owhing fracture ~~and~~ will ruin a core or artifact ~~if~~ ~~it is in any way possible to prevent it~~. In spite of the best of coordination, slight miscalculations, undetected flaws in the material, a crushed platform, the slightest angle change of either the artifact or flaking implement and the improper dampening of the force can cause failure. It is doubtfull if there are any perfect examples of the more complex artifacts, ~~were made~~ Even the ~~skill~~ classic examples of the Danish and ~~the~~ Egyptians show slight ~~imperfections caused by the workers~~ miscalculations of the worker. ~~A human will err~~ ~~and no matter how hard one tries it is~~ The human margin of error makes it almost immpossible to ~~make a~~ fabricate a perfect stone artifact. This statement will probably ~~cause a few eyebrows~~ ~~to be lifted~~ raise a few eybrows but ~~if one will examine the~~ minute examination of speciman~~s closely~~ will reveal minor flake scar distortion, or insignificient step fractures. ~~will be detected.~~

~~I am trying to point out that~~ The making of flint tools ~~are~~ is not the manifestations of a long line of ancestors but the result of ~~with~~ each new generation ~~there pride~~ trying to ~~to make somthing a little bit better~~ improve the product. ~~The basic techniques could be~~ ~~learned in a short time (a few years)~~ With an ~~apt~~ experienced teacher and an interested and apt student ~~with interest and dexterity.~~ the basic techniques can be learned in a short time

No. 1 MATERIAL IDENTIFICATION

The first step in the apraisial of flake assemblages is an evaluation of the material from which the flakes were made. ~~The distance of~~ Postulate the How far is the material from the source. ~~How the material occured~~ What are its diognostic qualities? How does it compare to materials from other well known sources? How many ~~########~~ varieties are represented in the site? The occurance of the material may be indicated by ~~natural~~ the unaltered outside surfaces found on the dorsal side of the primary flakes. The natural surface may denote bruising , abraiding and cratering typical of alluvium. Natural surface can indicate that the material was ~~quaried~~ quarried or natural breaks found in ledges ##,lodes fault zones, bearing the mold markings of a vesicular cavity. Organic replacements will ~~point to~~ indicate the material ~~forming~~ formed in sedimentary deposits. Concretions of flint will indicate the wererabouts of limestone - and dolomite. These are but a few of the ~~many~~ clues ~~that the~~ found on flakes that may indicate ~~the~~ its occurance and aid in locating the source.

Detailed studies of materials that were used in the lithic industries hold much information regarding the movements of man through time and space as each material bears impurities that are characteristic to that material alone. Such a study will ultimatly aid in resolving the ~~movements~~ moving by man of these materials ~~by man~~ from their sources to their final destination and their paths followed even ~~the~~ though cultural tool forms are not in evidence.

SEE MATERIALS PAPER

No. 2 TEXTURE OF MATERIAL

~~N##########################~~

~~The first step in the appraisal of a flake assemblage is an evaluation of the material~~. The texture of ~~the~~ material is a most important consideration when one is determining the quality of the modes of manufacturing. The quality of the artifacts canot exceed the qualities of the materials, regardless of the knappers skill. The LITHIC materials range from the glassy to the granulose, the more granular/varities can result in only inferior types of flakes and ~~resultant~~ artifacts. The techniques must be adapted to the materials. Fine definition of the flake atributes are usualy erased in the course grained rocks. The platforms crush more eisily and the flakes or blades will collapse before they ~~are~~ terminate at the distal end of the core. The flakes havent the resistance to end shock and A greater amount of applied force is nessary to remove them from the core. The use of direct percussion with a hard hammerstone to concentrate the kinitic energy to a confined area is usualy nessary to fracture the course grained materials. The more vitrious the material the greater the control, the sharper the cutting edge. A ~~decreasdd~~ ~~lessend~~ decreased amount of force is required to remove a flake of equal area aompared to the granular material. ~~and the material~~ Vitrious material has elastic qualities not found in the granulose rocks, allowing the fakes to bend without breaking. I do not intend to imply that the course grained materials are not important to the economy of many ethnic groups ~~but~~ for they did play an important part. ~~and~~ Sometimes they were even prefered to some of the more vitrious rocks, because the flakes struck ~~fro~~ from the coarse textured rocks were most usefull for certain funtional needs. Such flakes serve admirably for sawing and carving, forming materials of wood,bone, antler, shell and soft stone. These materials may be severed and shaped with surprising and astonishing speed ~~not~~ with coarse-grained material which is not found when using a tool made of the more vitrious materials.

Simple field tests should be done by actual flaking ~~of~~ questionable materials ~~in question~~ before any final desisions are made regarding the workability of of a particular mineral. ~~Detailed studys of material types and their diognostic atributes may be able to add much information in traceing the lithic materials from their sources to their final destination. The routs may be followed even tho cultural tool forms are not in evidence.~~

###

No.3 MATERIAL ALTERED BY THERMAL TREATMENT

Certa in ## silicious materials will respond to an artificial vitrification by the aplication of heat . The change occures upon the ~~tempature~~ temperature being slowely raised to around 450 ~~to~~ or 500 degrees Farenheight Then slowely cooled. Different materials require different ~~tempatures~~ temperatures to ~~cause this~~ affect the alteration~~, to take place~~, All materials do# not respond to the heating. The alteration of these materials is an exacting practice requiring a thourough knowelege of the material being altered. ~~See~~ (Crabtree and Butler Tebwia, Vol. 7, 1964) In order to determine if the flake has been altered, one must examine the flake very carefully before ~~passing~~ making a final judgement. ~~The flake or core will not indicate a texture change until a flake has been removed after it is heated as the surface remains the same.~~ after heating, the surface of the material remains unchanged and one must remove a test flake from the mass to determine alteration. In order to be positive that the thermal treatment was practiced, a ~~piece~~ Flake of the suspected material ~~or a flake~~ must be found ~~that~~ which bears a flake scar on the ~~exterior surface. or with a flake~~ on the dorsal side that still retains the materials original texture prior to heating, ~~while~~ The ventral side of the flake or flakes removed from the piece of altered material will have the distinctive lusterous character ~~that was caused by the application of carefully controlled heat~~ pertinent to thermal treatment which is not present on the original surface. Should the flake be detached after all the surface of the treated core has been removed, then it will be ~~vitrious~~ lustreous on both dorsal and ventral surfaces. A flake such as this is not ~~sureable~~ reliable ~~for conclusive evidence~~, but only ~~suspeck~~ suspect as there are a few materials that have a natural vitreous lustre. However ~~, but~~ they are limited. Occasionaly abandoned heat treated flakes will be noted which ~~in that have been abandon after being intentionly heated and~~ still retain their original texture, but ~~upon~~ occasionally close examination will reveal small flake scars ~~will occasionaly be noticed~~ on their margins ~~that~~ which show the change of lustre. These small flake scars may be the result of the aboribinals testing the material to see if the heat application was sufficient. A simple field test is accomplished by removing a small flake and then examining the scar to determine a difference in texture. If the material is heated over a long period of time the trace minerals will be subject to oxidation causing yellows to become red and other color changes, depending on what mineral impurities were present in the material being heated. Flakes will be observed which have been overheated, resulting in crazing, potliding, and occasionaly complete disintergration. These are relatively infrequent considering the exacting control nessary to perform this alteration.

No. 4 RELATION OF MATERIAL TO FLAKES

The character of the flake has a direct relationship to the material being used. The very glassy rocks have well-defined attributes and characteristics that greatly assist in flake analysis. Each feature is quite obvious. These features are not readily found in the more granular materials. The knapper must make the technique suit the material and the tools used to remove the flakes must also conform with the materials. Flakes made from a tough, granular, tenacious material naturaly require a greater amount of applied force than the vitreous materials.

and therefore the impact area must be of sufficient size to withstand the additional force nessary to dislodge the flake. therefore The platforms on the proximal ends of the flakes of Tarsecane Material will be larger when simple direct percussion is applied with ~~used with the aid of~~ a hard hammerstone. normally, ~~Normaly~~ upon using the course textured materials, there is not the ~~a lack of~~ careful platform preparation ~~of the platform that~~ which is applied to ~~used on~~ the vitrious rocks. The freeing, or the isolation of, the platform in the granular rocks ~~rodks~~ reduces the amount of material that will recieve the force and increses the chances of its collapse. ~~######~~ No amount of skill can transform a granular-textured material ~~with a granular texture~~ into the refined artifact ~~that will compare to one made from~~ which can be made from a vitreous material. But a ~~Also I might add that the~~ lack of skill can reduce high quality material to an inferion artifact.

5. THE AMOUNT OF APPLIED FORCE

The amount of applied force may be related to the area measured on the ventral side of the flake or the flake scar its self. The amount of force is also contingent to the type of material being fractured. The more granulose the material, the greater the amount of force required to dislodge the flake. The amount of forde must be very carefully controlled and the ~~human~~ mind must direct the muscles, to deliver ~~delivering the~~ the force to respond to predetermined intensities and velocities. ~~The~~ Also, the eye must ~~also~~ diredt the muscular coordination to implant the force at a predetermined point on the material being wor-ked. Because of the ~~varable~~ variable amounts of force required to ~~break away~~ sever or detach portions of materials ~~that are~~ of different ##### dimentions, the ratio of force must be mentally calculated. ~~mind must calculate these changeable amounts of force~~. The last series of repiticious flakes of the same dimension removed from an artifact or core ~~that bears repiticious flakescars~~ will show that the intensity of applied force was delivered in a uniform manner. ~~if the scars are of the same dimentions~~, Such a series of blades or flakes demonstrates the control and concentration of the mind direct-ing the ~~musels~~ muscles to respond uniformily. ~~The~~ Control of the applied force on ideal materials is one of ~~The amounts of force is~~ the basic principal of flint-knapping. ~~if the materials are ideal.~~

6. THE KINDS OF APPLIED FORCE

The kinds of applied force are the key to the developement of independent techniques. The need and desire to make flakes of certain dimensions required the invention of different ~~kinds of~~ ############ methods of apply force whether by pressure or percussion. ~~In order~~ To make a flake of a certain form the force must be transmitted to the material by incorporating several techniques. These techniques are combinations of tool types, velocities, of force, dampening of the force, angles in which the force is applied, and the method in which the material is supported. All have a direct bearing on the detached flake. Certain combinations of methods will make similar flakes. However, variations in techniques will make minor but consistant differences in the resulting flake. These differences will be useful in seperating pertinent cultural traits.

7. METHODS OF APPLYING FORCE

The methods of applying force usually fall into three major types: percussion, indirect percussion, and pressure. Others are the use of a pressure implement aided by percussion, and the Egyptian method of retouch accomplished by pressing the percussor on the edge of the artifact to be retouched, then striking both the percussor and the artifact against a wooden anvil. This drove the retouch flake toward the anvil, removing the flake by bidirectional forces. This is a variation of the bi polar technique.

~~The earliest flakes were derived by the use of the percussion method. There are many methods of applying percussion to produce flakes, the first and simplest was probably done by throwing the piece of flintlike material against another larger piece of rock untill pieces were dislodged or untill it was shattered, then recovering pieces that retained a sharp cutting edge. Flakes produced in this manner will be most irregular in form and showing evidence of much shattering. It is inconceve-~~

~~The~~ Methods of applying force are variable and numerous ~~and variable~~ and the use of these methods results in ~~to~~ a varity of flake forms and their ~~scars~~ scars. Thes e varations are the result of the methods of applying the force. In some cases there will be parallesims ~~that~~ which will appear to duplicate and converge, yet ~~there will be~~ minor and major features will be represented on the flake more than on the flake scar. These features are due to the methods, materials, types of force a nd the implements used to transmit the force. The forces will range from a very sharp impact ~~#####hard#hammerstone~~ to gradually applied pressure.Pressure requires ~~a~~ much greater ~~force~~ energy than percussion, because a blow delivered by percussion is increased by an instantaneous conversion of potential energy to kinitic energy. Aboriginal man ~~un beknown to him~~ instinctively took advantage of this feature and overextended the elastic limits and concentrated stress and strains on ~~the~~ his raw materials ~~on which he was working~~ to the point of fracture. Experiments have shown that each technique ~~requires different applications of force,~~ varies the amount of required force. . A large hammer moving at a decreased velocity ~~####useful###~~ can deliver the same amount of energy ~~moveping at a decreased velocity~~ as a small hammerstone moving at a high velocity. The decreased velocity ~~using the~~ of a large hammerstone will decrease the shock and prevent the shattering of the lithic material ~~being worked on, and at the same time decrease the shock~~. This technique uses the potential energy as a means of rapidly applying pressure~~. rapidly~~. However it has the disadvantage of over-comming the inertia of the object being struck and propeling it with the blow. The use of the large hammerstone at slow velocities is therefore only suitable for the more massive types of flake and blade removal.

~~The use of~~ Potential energy can be used instead of kinetic energy ~~made use of~~ by changeing the percussor from stone to materials which are softer, such as antler, bone, wood, and soft stone. The softer the material of the ~~used as a~~ percussion tool, the greater must be the velocity of the blow ~~must be increased~~. Flakes and flake scars made by the use of kinitic and potential energy bear diognostic features which ~~that~~ will be described pertinent to each under individual techniques.

8. THROWING ON AN ANVIL

The earlier toolmakers ~~The earliest flakes were~~ derived their flakes by the use of percussion. There are many percussion methods and techniques ~~of applying percussion~~ to produce flakes. The simplest, and probably the initial method was ~~first was done~~ by throwing thepiece of flintlike material against another larger ~~piece of~~ rock until pieces were dislodged or the rock ~~untill it was~~ shattered, then recovering the pieces that retained a sharp cutting edge. Flakes produced in this manner will be ~~most~~ irregular in form and will show evidence of much ~~mush~~ shattering. It is inconceveable that any degree of control could be ~~may~~ gained by using this method. This method does not allow selection of the impact surfaces ~~The surface being subject to impact canot be selected~~, the angles on the surface of the core canot be predetermined, the amount of force to propel the core canot be related to the size of the detached flake ~~to be detached~~, and contact cannot be made with the anvil with duplication & regularity. ~~the exact position on the anvil canot be struck with regularity. The~~ If this technique is used, Cores and flakes will ~~##~~ contain strains and weaknesses which ~~that~~ would render the largest portion ~~proportion~~ of the material useless. However, this method has been recently observed among the ~~in recent times ############### being used by the~~ Austrailian Aboriginals. (Norman Tindale, South Austrailian Museum, Vol. 15, No.1, Oct. 1965) This cultural trait may be only characteristic to the Nakako, Ngadadjara as well and Pitjanjjara of the great western desert. Donald F. Thompson writes of his experiences among the Bindibu and of their skillfully removing flakes from blocks of lithic material which ~~with skill that~~ obviously came from long experience, and a knowelege of the stone behavior, ~~of the stone~~. He stated ~~that~~ " We watched the men carefully examine and balance each block and ~~and~~ with a few dextrous blows, convert them into what were obviously sharp, effective cutting tools". (Proceedings of the Prehistoric Society 1964) These are ~~but~~ examples of embreonic and refined techniques being used at the same period of time and not separated by a great deal of geography. According to Tindale, The cores ~~##########~~ resulting from casting the ~~####~~ material ~~as done by Tindale's people will~~ have a battered and bruised surface

~~and bear no flake scars tjat omdocate tjat tjo f;ale was re,pved by usin-~~

and do not bear ~~no~~ the flake scars ~~that~~ which indicate ~~that the flake was removed by usin-~~ detachment by ~~g~~ a preconcieved and planned point of impact. The core residue is distinctive because of ~~their~~ a lack of regular form. On the other hand, Thompsons Binidibu people ~~will~~ habe cores and flakes that show the selection of platforms and flakes removed in a regular manner, plus the evidence of percussion tools.

9. STRIKING ON ANVIL

~~The use of~~ Using the anvil as a purcussor is ~~a reversal~~ just the reverse of the normal procedure of using a stone to strike ~~striking~~ the material to be worked ~~with another stone~~. T his technique involves the ~~the use of both hands. holding~~ the material to be worked is held in both hands and then ~~striking~~ struck ~~is~~ on a large stone which is partially imobilized ~~by partial~~ by burying; or at least is securred in some manner to prevent its movement when struck by the core. ~~It is~~ This technique ~~that~~ uses to the utmost a concentration of kinitic energy ~~to the utmost~~. The energy and force is condenced into the material being worked due to ~~because of~~ the stability and mass of the anvil and the velocity of the object being propelled against the anvil. There is a greater concentration of forces because the core is not projected from the application of the force, as is done when the core is struck by another object. ~~The~~ Force applied ~~produced~~ in this manner causes a distinctive break in the isotrophic material. The fracture made by using this technique produces ~~is one with~~ no bulb of force, The bulb of force is ~~being~~ a part of a cone, usually the cone part being ~~usualy~~ well definded ~~in the material~~ by the radiation of the force, The use of this technique causes the cone to be sheared a nd bisected, A break such as this is distinctive because at the point of impact the ever widening ~~wideing~~ circles of force make waves ~~that~~ which are accentuated and are much closer to gether than when a flake is removed with a hand held hammerstone. One of the ####### experiments ~~in using~~ with this technique was immobalizing ~~to imobilize~~ a large cobble, which ~~that~~ had a natural ridge on the exposed surface ~~and use that~~ ridge. This was used as the area ~~that would~~ to contact another isotrophic cobble ~~of isotrophic material~~ to be cleaved. The cobble of material to be bisected was held in both hands and struck verticaly on the anvil, or the partly buried water worn, tough, granulose cobble. ~~it being a watter worn tough granulose rock~~. The flint like material was cleaved into two equal pieces with each part having a flat surface at the point of truncation ~~where the break occured~~. The pieces are well suited for ###### cores. This technique was probably well understood in Mexico and used to make the thin, flat, regular, uniform in ~~in~~ thickness flakes which ~~that~~ were used to make the graduated radi of obsidian ~~and used~~ for# neck orniments. The surfaces of these orinements bear the same type of force circles or rippeling. The use of this# technique requires considerable skill to deliver a blow of the correct intensity and at the same time mentaly calcullate the proper striking angle ~~to strik the blow~~. The angles may vary according to both the desires of the manipulator, and the proposed implement ~~to be made~~. Becaus e of the concentration of force in such a restricted area, this technique is unsatisfactory for removing blades. There are indications that ~~this~~ a simmilar method was used in making the Levallois flakes, but a platform is prepared on the Levallois & striking is at a different angle ~~but was done in a different manner~~ than when ~~one~~ preparing plat-forms on cores or cleaving material to be used for cores. ~~In order to~~ Removing ~~the~~ one or two flakes from ~~the~~ a Levallois core involves another set of principals. ~~are used, First~~ The platform is specially prepared ~~in such~~ to provide ~~a manner that~~ a ridge ~~is built~~ directly above the flake to be removed. The ~~ridge~~ is is ~~made~~ established by ~~the removal of~~ removing two or more flakes ~~that~~ which will produce a ridge from the dorsal side of the core to the ventral side. ~~The ridge is ## isolated in order~~ To increse the accuracy of the blow the ridge is isolated so ~~as~~ it will contact the anvil ~~at it's apex~~ when the core is struck. ~~on the anvil~~. In order to remove ~~the~~ a flake from ~~the~~ a Levallois core the cone of force must not be ~~is not~~ bisected. But the angle of the cone itsself is calculated and the core struck against the anvil in such a manner that cone will make the negative scar on the core. This technique concentrates the force to such a degree that the Levallois flake will not flex and will be flat if the core is struck against the anvil in the proper manner ,. This experiment ~~involves~~ [requires] considerable practice [to properly prepare the core + platform and] to regulate the intensity and velocity of the force ~~and the proper preparation of the core and the paltform~~ . This type of tool making requires an abundance of material, and is ~~most~~ wastefull [when] ~~to~~ make[ing] only one or two usable flakes.

The use of ~~the~~ [a small] anvil ~~in miniature~~ is usefull [when] ~~to~~ make[ing] ### certain ## types of burin-like implements from flakes and blades. Two experiments in replicating this ~~tool~~ [burin type] form ~~is done by the following methods~~ [are as follows:]. The first is to select the proper blade or flake with an######## existing flat on the lateral margin, or [to] make one by a marginal retouch. The flattened edge will be the platform to be impacted on the edge of the anvil. ###################### The angle ~~in~~ [at] which the edge of the flake is struck will determine the angle of the edge to be used,. The flake can then be struck against the anvil a second time but changing the position of the flake and using the flat surface [scar] made by the previously struck flake ~~scar~~. The removal of the second flake should leave a ~~#######~~ chisel edge. The angle of the chisel edge depends on the angle ~~in~~ [at] which the flake was struck. This type of burin may be made by placeing the flat edge of the flake on the anvil and then striking the flake with a small hammerstone to remove the second flake. However, this method usualy dulls the tip.

[Don — Second method missing]

~~These~~ This burin techniques ~~of produceing burins~~ is fast but lacks control. ~~and the next step~~ Second method is to ~~may~~ remove the burin spalls by the use of a pressure tool, which will be described in detail under pressure techniques.

The use of the anvil to remove flakes and make artifacts is an important ~~step in both~~ method of making both flakes and simple chopper forms. No one can apreciate the difficulty encountered ~~to remove~~ in removing a flake from material such as water worn cobbles ~~that~~ which is rounded and ~~without~~ devoid of flat surfaces, ~~such as water worn cobbles.~~ It is ~~most~~ difficult to remove flakes or cleave a sphereoid cobble with a hammer stone . The anvil stone allows the worker to concentrate the force in a predetermined area and produce a fracture that will either cleave or remove a flake. Once a flake has been removed or an angle created, then a hammerstone can be used efficiently. Evidence of the use of the anvil technique was noted on material collected by Dr. Charles Borden, University of British Columbia. This material was collected on the high terraces above the Fraizier River and exhibited both flakes and cores made with great skill ~~and~~ with the ~~use~~ aid of the anvil. Some of the large primary flakes showed suberb control of ~~the~~ this technique. It is unfortunate that the very useful anvil is difficult to rechognize as a ~~useful~~ tool. ~~as it~~ Perhaps this is because it may be any hard durable stone of assorted shapes and sizes. Only close examination of its surface would distinguish it from another simular stone.

While experimenting in replicating knives with the distinctive ~~backed knives with~~ ~~the~~ cortex backing, I made use of the anvil to remove flakes from one end of a quartzite cobble rock. The original aboriginal backed knife had a backed surgace ~~that~~ which indicated that its origin was from a watter worn cobble of quartzite. My first atempts to remove flakes that resembled the aboriginal tool was by ~~the use of of~~ using a hand held hammerstone. I shattered three hammerstones without breaking or removing a flake from the quartzite cobble. So then I resorted to striking the cobble on an anvil ~~Then~~ By ~~the use of~~ using the anvil, a series of flakes were removed from the cobble ~~that~~ which bore a strong resembelence to the backed knife. Upon examining the core, it replicated the common chopper made on a cobble. It might be interesting to note that unless there is sign of use on the chopper, it could very well be a core. ~~The~~ Backed knives made of ~~this~~ course granular material should possibly be called saws because they are excelent for shapeing and forming objects of antler, bone , wood, and soft stone , yet they are almost worthless for skinning or dressing game. By us ing the same technique~~, but with a~~ on vitrious material the same style of flakes are ~~most sutable~~ suitable for a different function such as skinning and other cutting purposes.