Analysis of Lithic Artifacts from Sabana Grande, Nicaragua

by

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ABSTRACT

The site of Sabana Grande, Nicaragua was tested in 1975 by Richard Magnus as part of the Proyecto Arqueologico de la Meseta Central sponsored by the Banco Central de Nicaragua. Two contiguous test pits placed in a single mound yielded 10,816 pieces of chipped stone and eleven groundstone artifacts. No significant differences in artifact content by provenience were discovered, and the assemblage is considered a single unit. The assemblage is analyzed with a view to identifying patterns in tool manufacturing behavior and tool use. A behavioral model of tool manufacture is outlined based on an initial intuitive classification of artifacts into core, blank, preform, and tool categories. The model is then tested and verified by a statistical (principal components) analysis of complete debitage flakes, and expanded by analysis of flake tools and resharpening flakes. Categories of tools based on similar patterns of use are established by means of microscopic examination of use wear. Tool manufacturing and use are then integrated in a systemic model which provides a view of prehistoric behavior dealing with chipped stone. Stylistic regularities for certain technological and use categories are described as an aid to future comparative research in Central America.

ACKNOWLEDGEMENTS

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INTRODUCTION

Recent excavations by Richard Magnus at the site of Sabana Grande, Nicaragua, yielded a sizeable quantity of stone artifacts, as well as ceramic and architectural remains. Sabana Grande is located approximately 23 km east of Lake Nicaragua, 2.5 km north of the town of Juigalpa, and 1.5 km north of the Mayales River (Fig. 1). The site consists of 15 low mounds. One of these mounds was selected for testing, and two 2 x 2 m contiguous test pits were excavated. The lithic artifacts recovered from these test pits are the focus of the present study.

Geographically, the region in which Sabana Grande is located is in the western foothills of the Cordillera Chontalena, "...essentially a rolling plateau with a few high peaks and ridge crests..." (Denevan 1961:256). The soils are volcanic and still fertile due to the seasonal precipitation pattern (West and Augelli 1966:50). Possible sources of micro-crystalline cherts may derive from uplifted coastal material formed from deep-sea oozes (Ken Hon, personal communication 1976). In addition, petrified wood (Sapper 1899:24), quartz (Sapper 1899:24, Belt 1911:72) and flint (Bransford 1885:76) may have been available farther inland.

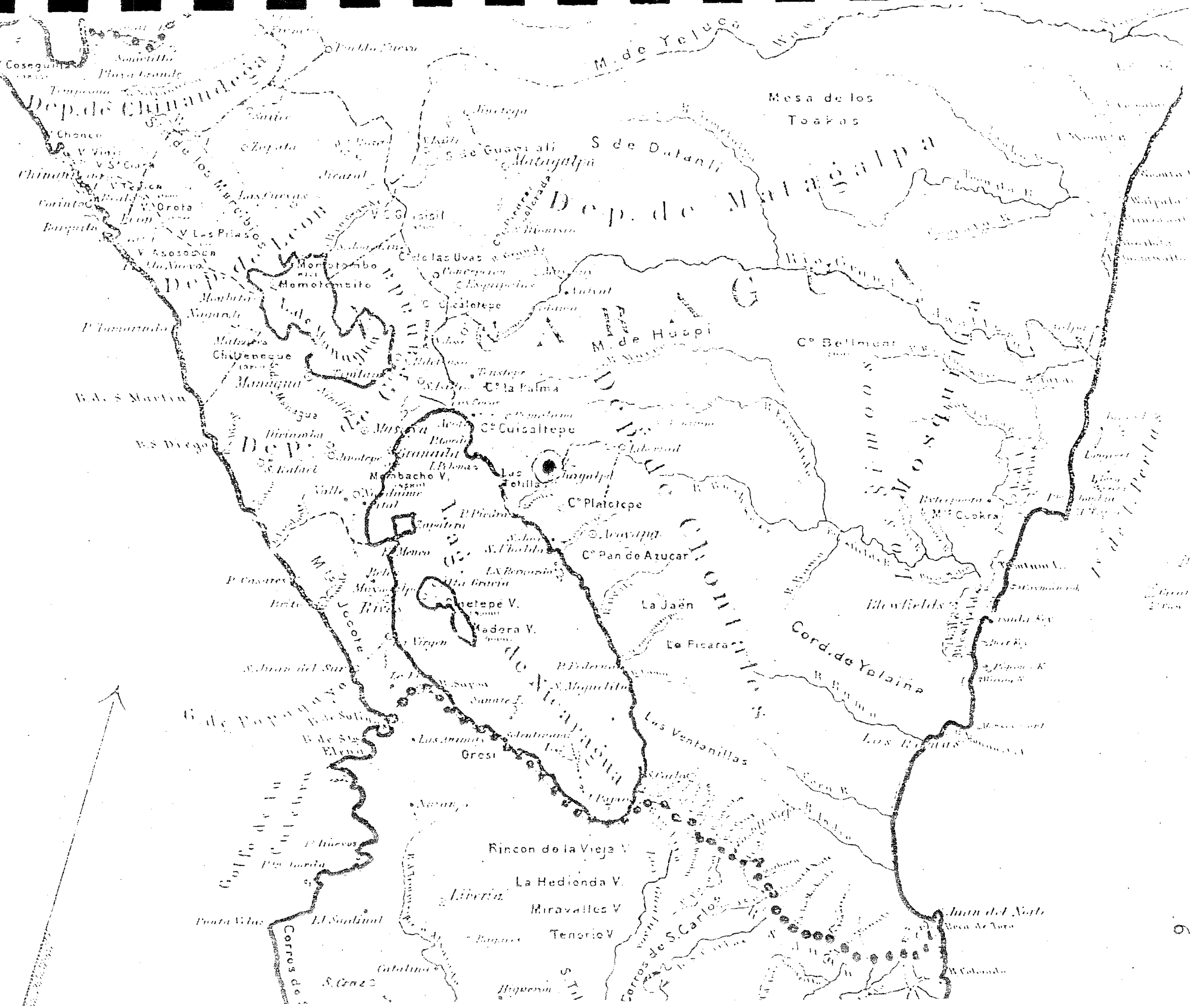


Figure 1. Location of Sabana Grande

Previous Research

Research into the prehistory of Nicaragua, and southern Central America in general, has been relatively sparse. Strong noted that "...as Lothrop pointed out in 1926, we have to thank Hartman for the only published scientific excavation work in either the Pacific or the Highland region. Unfortunately, in 1946, this strange state of affairs is still true" (1948:121). Since 1948, investigations have been conducted in the greater Nicoya archaeological subarea by Baudez, Coe, Norweb, and Willey (Coe 1962:170) and a chronological framework for the area has been established (Table 1). The site of Sabana Grande, based on a single radiocarbon date of A.D. 730±85 (I-9098) taken at 90 cm below the mound surface (R. Magnus, personal communication 1976), appears to be within the transition from Early to Middle Polychrome.

Attention paid to chipped stone artifacts especially has been exceedingly limited. There is practically no information at all on chipped stone artifacts or chipping techniques used in this area (Strong 1948:129, 139). This is probably due to biased recovery techniques of archaeologists rather than actual lack of chipped stone remains (P. Sheets, personal communication 1976). Indeed, there are references in the literature to archaeological specimens (e.g. Peralta 1893, Bransford 1885) as well as ethnographic examples (e.g. Bransford 1885, Stone 1966). Unfortunately, they are rarely given systematic consideration. As Strong mentioned, the work of C. V. Hartman (1901, 1907) is a partial exception in which chipped and ground stone celts are thoroughly described and illustrated.

In view of the sparse information available, the analysis of the Sabana Grande lithics should be particularly useful as a foundation for future research.

The Present Study

The present study of the Sabana Grande lithic material deals with several aspects of the assemblage. The chipped stone tools and debitage are examined for patterning and variation in flaking techniques and tool manufacturing procedures, and tool use. Stylistic regularities in tool form are identified. Groundstone artifacts are briefly described with regard to function. This information is then combined to give a composite picture of the role of stone in terms of various activities occurring prehistorically at the mound.

The material derives from a single mound, non-randomly chosen and, at least according to surface indications, non-representative of the site as a whole. The results of the analysis are therefore applicable only to that particular mound. The emphasis of the analysis is therefore on variation within the assemblage rather than intra- or inter-site spatial characteristics and variability.

The approach used in the analysis of the Sabana Grande chipped stone is based on a model designed to elucidate the patterns of behavior involved in both tool manufacture and use. The conceptual focus of a behavioral model is on the decisions and resulting actions of the prehistoric flintknappers (see Sheets 1975, Collins 1975). The model is defined and refined by observing the results of the flintknappers' actions: the debitage and tool collection recovered from the excavations. Recurring patterns in the artifact collection may be traced back to recurring habits of the flint-knappers, thereby allowing identification of regularities in tool manufacturing and use behavior. The analysis of the Sabana Grande chipped stone is concerned with two major aspects: manufacturing technology and tool use, to be considered in that order.

Patterns in the tool manufacturing process are identified by two complementary methods. The core-to-tool reduction sequence is established by intuitive evaluation of the artifacts according to the degree of reduction to which they have been subjected. Statistical analysis of a sample of the complete debitage flakes provides both an objective verification of the intuitive model and additional information for refining and expanding the behavioral model.

Analysis of tool use is approached using the working edge of the tool as the primary unit of analysis. Attributes of the utilized edges of the tool are used to delimit the range of tool uses evident in the assemblage.

Finally, a comprehensive model is presented which integrates the behavioral patterns of both tool manufacture and use.

<u>Sampling Strategy</u>

The quantity of artifacts is so large that, given limited time, it was deemed necessary to take a sample for the purposes of analysis. The assemblage was divided into several categories (Table 2). All cores and tools in various stages of reduction were grouped together, all complete flakes were separated out, and all fragmentary flakes formed a residual category.

In order to maintain a statistically valid sample size for the first category, 100% were included in the analysis. For the flakes,

MAJOR PERIODS	DATES
Late Polychrome	
	1200 A.D.
Middle Polychrome	
	800 A.D.
Early Polychrome	
	400 A.D.
Zoned Bichrome	
	B.C./A.D.

Table 1.
Chronological framework for southwestern Nicaragua.
(from Norweb 1964:553)

Cores, blanks, preforms, and tools	analyzed	136
	not analyzed	108
Complete unmodified flakes	analyzed	499
	not analyzed	1,209
Resharpening flakes	analyzed	52
Flake tools	analyzed	172
Flake fragments	not analyzed	8,640
	TOTAL	10,816

Table 2.
Artifact categories and quantities.

five of a total of fifteen 10 cm excavation levels were chosen at equally spaced intervals of 20 cm throughout the test pits. They were chosen in this manner rather than randomly, so that comparisons could be made between sub-floor, floor, and above-floor deposits. All complete flakes were analyzed from each of the levels selected in this manner. Fragmentary flakes were not analyzed in this study due to the excessive time requirements and the necessarily incomplete information to be derived from them.

In sum then the components of the lithic assemblage which are analyzed are: the complete and reconstructable cores, blanks, preforms, and tools from all levels of the excavations, and all complete flakes from five (out of fifteen) levels evenly spaced throughout the depth of the excavations.

FLAKING TECHNOLOGY

A general model of flaking behavior is presented in Figure 2. This model contains the possible decisions (represented by arrows) which may occur in the process of manufacturing a tool. Beginning with the unmodified raw material and ending with use and discard, a given piece of stone may or may not undergo a series of modifications (represented by rectangles). This modification is a subtractive process and each step involves the production of flakes and a core (represented by slanted rectangles). The dimensions and characteristics of the flakes and cores vary depending on the stage of modification which produced them. At the beginning stages of reduction, cores are generally characterized by large size, possible irregular shape, and fewer but larger flake removals. Initial core reduction flakes are usually large and may have cortex on the dorsal surface of the flake. Cores which are near the final stages of manufacture are often smaller, exhibit shaping, and may exhibit regular patterns of retouch flaking. Final trimming flakes are also correspondingly smaller.

The characteristics of both the cores and the flakes vary depending on the specific type(s) of modification to which they have been subjected. The core may be used to produce flakes which are then used as blanks to manufacture tools, or the core itself may be either unifacially or bifacially flaked to become a preform. In either case, further reduction results in a technologically finished tool. At any stage, either the flake or the core or both may re-enter the modification process as an independent unit, or may be

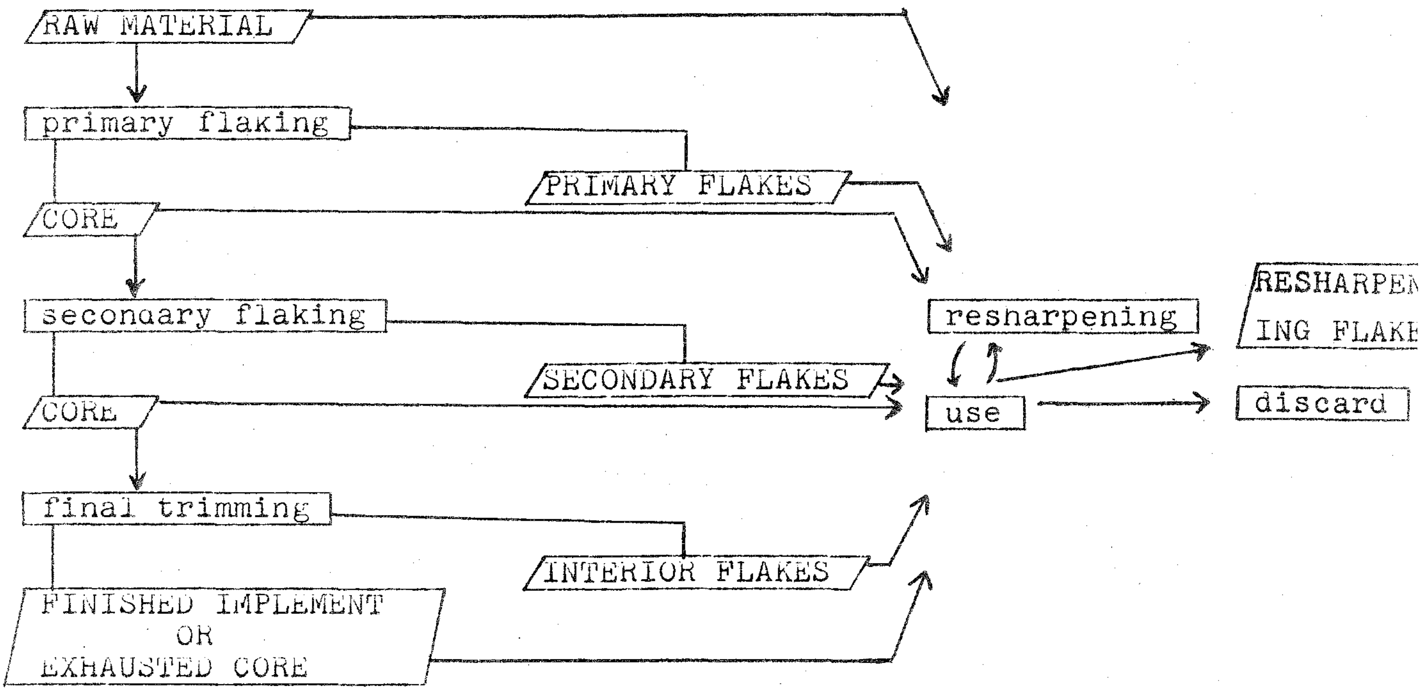


Figure 2.

Proposed general model of tool manufacturing behavior.

discarded as waste. The problem becomes one of isolating the particular steps or decisions in the model which characterize tool-manufacturing behavior at Sabana Grande.

Although the procedure used during the manufacture of the tool may not be evident on the tool itself, it is possible to reconstruct the process by analyzing the complete collection of debitage, cores, and tools. Inevitable mistakes on the part of the flintknapper insure that evidence of the complete process will probably remain in the archaeological record. The flintknapper often partially completes a tool and then errs, making completion of the tool impossible. These "mistakes" are often discarded and represent an intermediate stage in the process of tool manufacture. In conjunction with debitage, these errors allow for a fairly complete reconstruction of the stone-flaking technology of the inhabitants of the site of Sabana Grande.

Artifact Analysis

Method. Analysis of the lithic artifacts for the purpose of determining the flaking procedures of Sabana Grande was divided into two components, one consisting of the sample of whole flakes, the other of cores and tools in various stages of reduction.

Initially, all the cores and tools were arranged on a large laboratory table and grouped according to obvious similarities in degree of reduction and form. These groups were arranged in a sequence starting with large, unreduced cores exhibiting a minimal number of flake removals, proceeding to blanks which showed further reduction, preforms with preliminary shaping, and finished tools which were shaped and given final retouch treatment. Finally each group was divided into subgroups based on formal characteristics which correspond to the reduction sequence from the unreduced core to each finished tool type (Fig. 3). The increasing number of subgroups in each successive stage of reduction corresponds to the increasing differentiation between the finished tool groups. It must be emphasized, however, that the reduction sequence represents a manufacturing continuum, and not a series of abrupt jumps from one stage to the next, as indicated by the model. The groupings indicate that the specimens within the group are generally more similar to each other than to the members of the other groups, but the range of variation in form and degree of reduction within some groups is such that the assignment of marginal specimens is somewhat arbitrary. For example, the smallest of the "large biface blanks" may be only slightly larger than the largest of the "small biface blanks", but for most of the specimens, there is a considerable difference between those attributes which characterize the groups.

The criteria which are used to distinguish the technological groups as shown in Fig. 3 are the following: degree of reduction, amount and regularity of shaping, and fineness and regularity of flaking. The position of each artifact in the core-to-tool manufacturing continuum is decided by intuitive evaluation based on these attributes. In many cases, as noted previously, the specimens represent errors on the part of the flintknapper and are broken, possibly by end shock (Crabtree 1972:60). Other sources of error are poor placement of flake removals, leaving scars which terminate in hinge or step fractures, or merely represent the selection of a material too coarse or with too many inclusions to be successfully completed.

Reduction Sequence. As shown in Fig. 3, the procedure for reducing cores to blanks, preforms, and tools consists of a variety of alternative routes, each of which results in a particular tool.

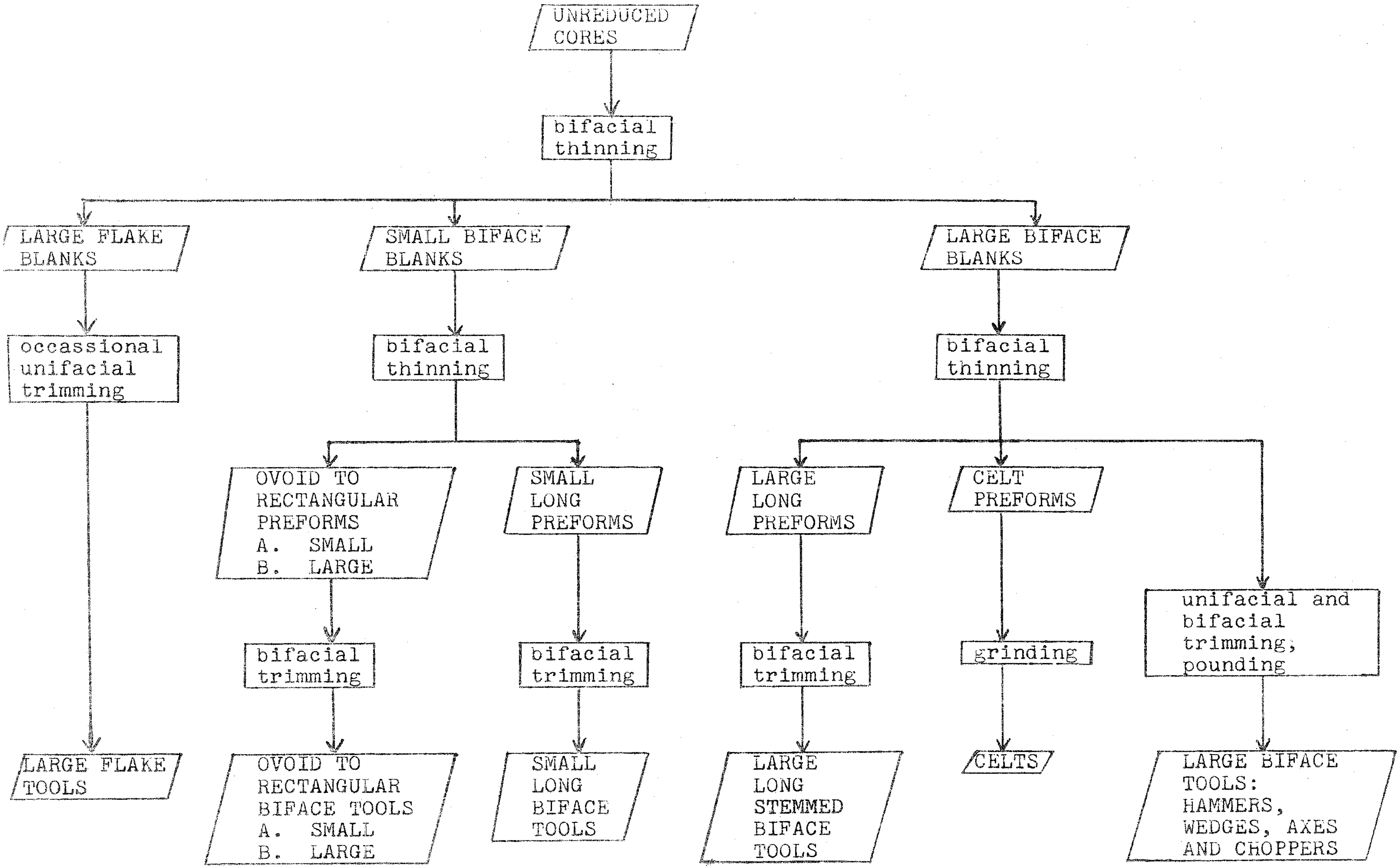


Figure 3.
Core reduction sequence.

Some of the routes are more complex than others, that is, the sequence of reduction involves a greater number of decisions which the flintknapper must make, depending on the tool to be manufactured.

Once the raw material (Plate 1) has been acquired, one of several alternative types of blank are manufactured: either a large biface blank, a small biface blank, or a large flake blank. Whether large flake blanks were produced at the expense of a small or large biface blank is unknown. Both the large and small biface blanks have flakes removed from opposite edges on both sides of the core. These blanks are generally slightly longer than they are wide, and are ovoid in shape (see Appendix I for attribute states and dimensions of all groups). They are quite conducive to further reduction into a variety of forms.

With a large biface blank (Plate 2) in hand, the flintknapper usually chooses one of three alternative routes. The first of these is to manufacture a large tool (hammer, axe or chopper, or wedge) (Plate 3). These large tools are produced with only slightly more thinning and final trimming, either bifacial or unifacial, around the edges. The hammers are generally round to slightly ovoid in outline, the wedges are usually sub-triangular; the choppers or axes are ovoid to sub-triangular. Although these tools were used for a variety of tasks, they are grouped into one technological category because the technique used to manufacture them is comparable in that they are all made from large biface blanks with minimal effort spent on thinning and shaping.

A second alternative product of a large biface blank is the celt. These are manufactured by bifacially reducing the blank to the desired form for a celt, that is, ovoid to sub-triangular in outline and subtriangular to bi-convex in cross-section. All of the celt preforms (Plate 4) recovered were made of basalt, although only one of the large biface blanks recovered was made of this material. It is possible that celt preforms were manufactured separately from large biface blanks. In support of this is the fact that two of the four basalt celt preforms in the collection have remnants of cortex on them. This cortex is very smooth, suggesting that the preforms were flaked so that cortex remained where the ground surface of the celt would be. The time saved in grinding the surface may represent a significant increase in celt manufacturing efficiency (Plate 5).

The third common choice was to manufacture a long, narrow preform by a two-stage process. The first stage involves the removal of a large flake or flute from one or possibly both ends of the biface blank with the intention of removing the bulk along the longitudinal axis of the biface blank (Fig. 4). The second stage consists of extensive bifacial thinning from the lateral edges of the thinned blank to produce a preform (Plate 6) suitable for final bifacial trimming and shaping into a large stemmed biface with sharp, low-angled edges (Plate 7).

Thus, from large biface blanks, several possible routes could be taken: one leading to large thick hammers, choppers or axes, and wedges; one resulting in large, thin stemmed bifaces, and one possibly producing celts.

Similarly, there seems to have been two choices which were commonly selected once small biface blanks (Plate 8) had been manufactured. One of these is comparable to the method of manufacturing large stemmed bifaces from large biface blanks. There was, however,

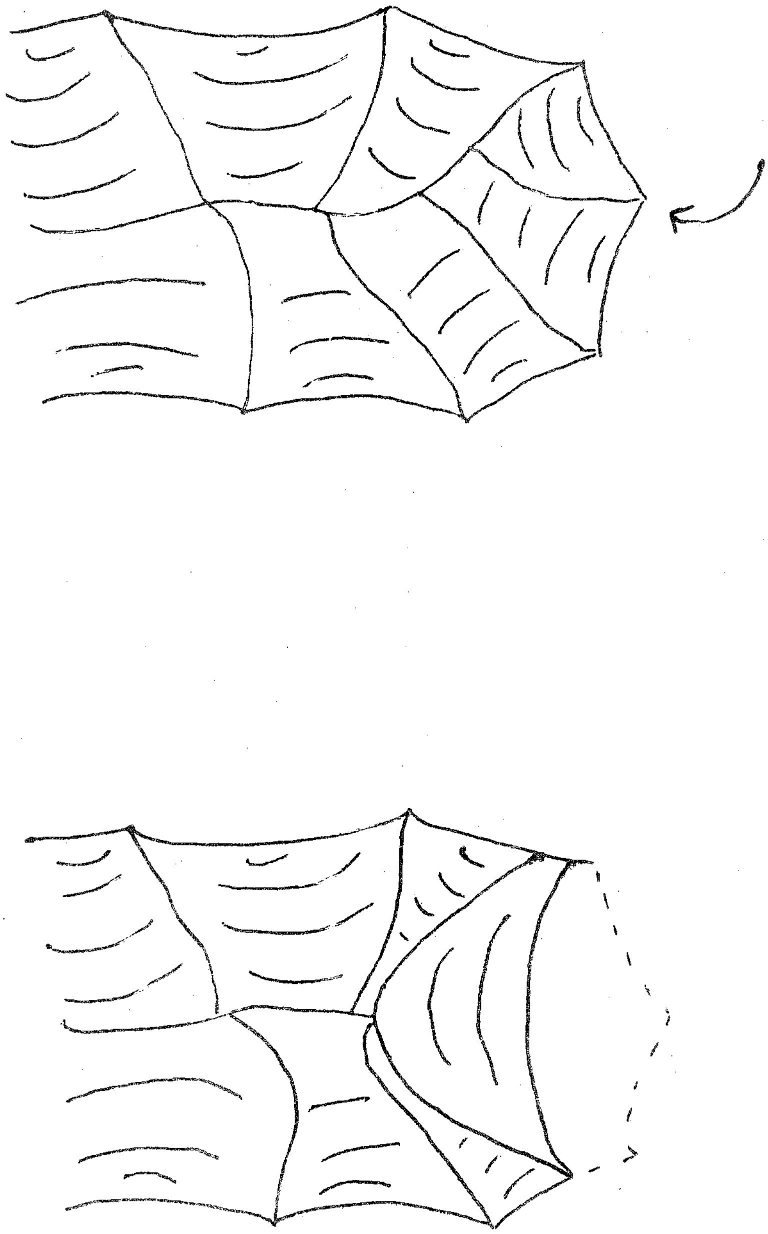


Figure 4.
Large biface blank "fluting" technique.

no systematic attempt to remove a longitudinal flute. Extensive thinning produced preforms (Plate 9) which were then flaked to form small long bifaces (Plate 10).

The alternative choice to small knives involves the manufacture of thinned preforms which are ovoid to rectangular in outline (Plate 11). Bifacial thinning and trimming resulted in a large or small ovoid to rectangular biface as the finished tool (Plate 12).

The final category of blanks, large flake blanks (Plate 13), generally were not extensively modified before becoming tools. Most of them were used without any further reduction. Some exhibit slight retouch along the working edge, but in no case was the flake blank modified beyond recognition as such.

Refinement of the general model proposed initially shows that the tool manufacturing pattern at Sabana Grande is rather straightforward. Of a large number of possible methods of tool manufacture, only a limited variety were used. These methods of reduction may be identified in the core, blank, preform, and tool sequence represented in the recovered artifacts. Analysis of flakes, however, enables one to substantiate and refine the model further and provides evidence of additional activities not revealed in the core-to-tool sequence alone.

Flake Analysis

The procedure used to define the different flake types is statistical, thereby eliminating much of the guesswork and, hopefully, error involved in subjectively assigning flakes to technological categories. The use of multivariate statistics, specifically principal components factor analysis, is based on the fact that each flake has an infinite number of dimensions and characteristics which may be measured in a correspondingly unlimited number of ways (see Ware and Chandler 1976). These measurements, limited in practice to an arbitrary number by the analyst, partially describe the flake. Depending on the problem at hand, the archaeologist selects particular measurements which are believed to be relevant. The attributes, chosen more or less intuitively, are often assumed to be independent and represent unrelated aspects of behavior. This assumption is for the most part unwarranted and untested and is the primary reason for using a principal components fact analysis.

Principal components analysis, based on a correlation matrix of attributes, accomplishes three things: 1) the original data set is reduced, 2) the relationships between the attributes are identified, and 3) the redundancy in the original attribute set is eliminated by producing unrelated factors.

These factors can be considered variables, and consist of those attributes which measure the same dimension of variability in the flake. Thus, the factors can be viewed as new "attributes" which are entirely independent, and the flakes can be sorted with the assurance that the variables which characterize the flake are not correlated. A score is produced for each flake on each factor. These scores are exact mathematical transformations of the combination of measurements which constitute the factor, and may be used to group similar flakes.

Attributes. A total of sixteen attributes (Table 3) were chosen in order to explore and define dimensions of technological variability in the flake assemblage by means of a principal components analysis (SPSS, Subprogram PA1, Nie et.al. 1975:479).

ATTRIBUTE		DEFINITION OR STATE
No.	Name	
1	Material color	1 = white, 2 = yellow, 3 = red or pink, 4 = brown, 5 = black.
2	Material consistency	1 = fine grained homogeneous to 5 = coarse grained with imperfections and inclusions.
3	Flake length	In mm; greatest length perpendicular to platform.
4	Flake width	In mm: greatest width parallel to platform.
5	Flake thickness	In mm: greatest thickness perpendicular to length and width.
6	Ventral angle	In degrees: angle measured between the platform and the point of inflection at the distal end of the bulb.
7	Lateral edge angle	In degrees; the sum of differences from 90° of the angle between the platform and each lateral edge of the flake.
8	Platform length	In mm; distance on platform between lateral edges
9	Platform width	In mm; distance on platform between dorsal and ventral flake surfaces.
10	Platform preparation: grinding	0 = none, 1 = light, 2 = moderate, 3 = extensive.
11	Platform preparation: crushing	0 = none, 1 = light, 2 = moderate, 3 = extensive.
12	Platform preparation: faceting	0 = none, 1 = light, 2 = moderate, 3 = extensive.
13	Percent cortex	Estimated percent of area on platform and dorsal surface covered by cortex.
14	Number of dorsal flake scars	Number of negative scars on dorsal flake surface.
15	"Index of parallelicity"	Integer representing the rate of flake expansion or contraction. Equals difference of widths at 1/3 and 2/3 of flake length divided by 1/3 length of flake.
16	Width ratio	Integer representing rate of flake expansion. Equals greatest flake width divided by distance of that width from flake platform.

Table 3.
Technological attributes.

The first two attributes deal with the raw material itself. Material type was not considered because the majority (93%) of the artifacts are of chert. Rather, material color and consistency were coded as attributes, each on a scale of 1 to 5. Although there is large color variation in any one piece of stone, the predominant color was noted as either white (1), yellow (2), red or pink (3), brown (4), or black (5). The internal consistency of the stone also showed great variation, from very fine-grained homogeneous rock (1) to coarse-grained stone with numerous inclusions and imperfections (5). These two attributes were included in order to determine if there is any correlation between them and any others, i.e. if they affected flaking procedures.

The next three attributes (3 through 5), maximum flake length, width, and thickness, are all measurements of size. The length of the flake was measured perpendicular to the platform, the width was measured parallel to the platform, and thickness was measured perpendicular to length and width.

Attribute 6, the ventral angle of the flake, was measured to the nearest 5 degrees with a contact goniometer using the platform of the flake as the base-line. This attribute is used as a measure of the degree of reduction based on the assumption that the angle will be less if the flake derives from a less-reduced core, and will be greater if the flake came from a nearly-finished tool (Fig. 5). As the majority of the finished tools in the assemblage are bifacially flaked, this is deemed to be a useful attribute.

Attributes 7, 15, and 16 are all intended as measures of flake shape. Attribute 7, the angle of the lateral edges, is calculated in the following manner (Fig. 6): the angle of the platform with each of the lateral edges is measured and the positive or negative deviation from a 90 degree angle is noted. The figures calculated for each lateral edge are then added to obtain a measure of the "parallelicity" of the edges. If the measure is less than zero, the flake is contracting from the platform down; if it is equal to zero, the flake is parallel-sided; and if it is greater than zero, it is a flake with expanding sides.

Attribute 15, the "index of parallelicity" (Ware and Chandler 1976) is calculated by measuring the width of the flake at two points equidistant from the platform, distal end, and each other. The difference between these widths is then divided by the length of the segment between them (Fig. 7). If the result is less than zero, the flake is contracting; if it is equal to zero, the sides of the flake are parallel; and if it is greater than zero, the sides are expanding.

The last shape attribute, Attribute 16, is calculated by measuring the greatest width of the flake and dividing by the distance of that line from the platform of the flake. The larger the score, the more rapidly expanding the flake is (Fig. 8). An imaginary number ($\frac{a}{0}$) indicates a contracting flake, but zero was substituted in the coding procedure. The results of this measure yield an inverse correlation with the other two shape measures due to the nature of the calculation.

Other attributes which are recorded and included in the factor analysis are platform length (#8), measured between the lateral edges of the flake; platform width (#9), measured between the dorsal and ventral surfaces of the flake; the degree of three types of platform

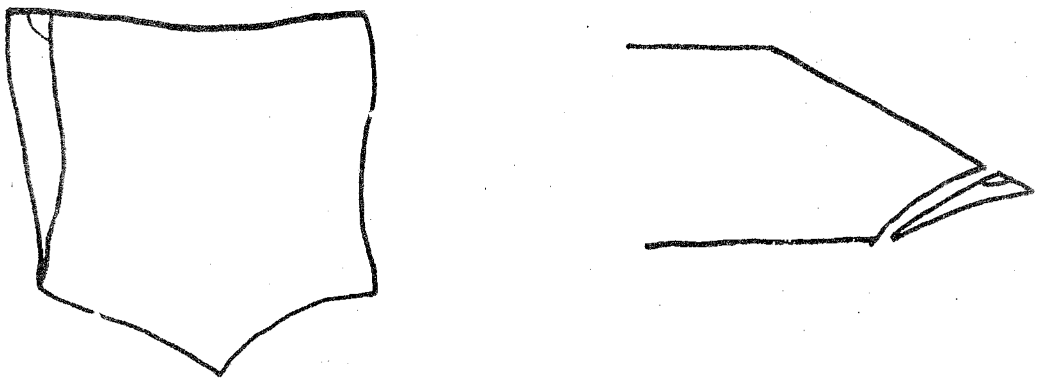
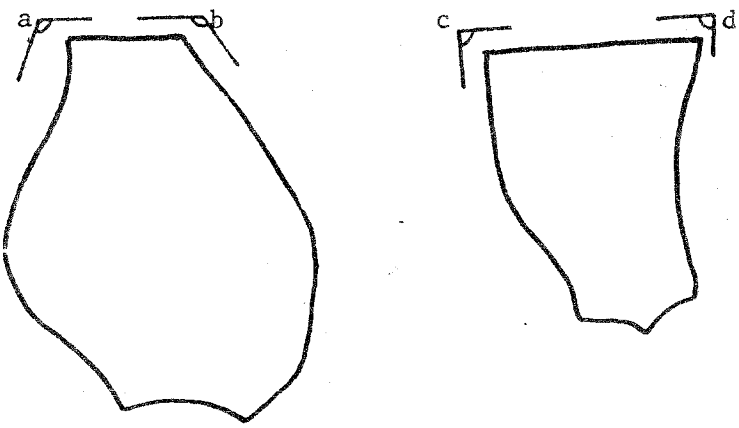
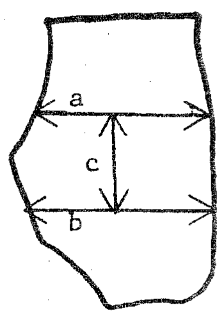


Figure 5. Ventral flake angle.



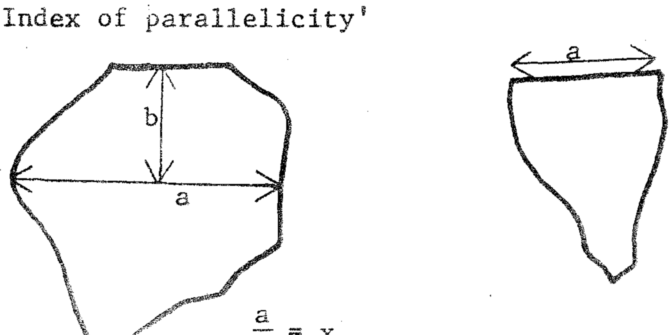
$(a-90)+(b-90) > 0$ $(c-90)+(d-90) < 0$

Figure 6. Lateral flake angle



$\frac{a-b}{c}=x$

Figure 7. 'Index of parallelicity'



$\frac{a}{b} = x$ $\frac{a}{0} = x\ (=0)$

Figure 8. Width ratio.

preparation (0 = none, 1 = light, 2 = moderate, 3 = heavy): grinding (#10), crushing (#11), and faceting (#12). The percent of cortex on the platform and dorsal surface is estimated (#13), and the number of negative flake scars on the dorsal surface of the flake is counted (#14).

Although not all of the attributes are measured on an interval scale, they are treated as such. This violates an assumption of parametric statistical tests; however, the robusticity of the test used is such that conclusions are probably still valid and acceptable (see Benfer 1972).

Statistical Test and Results. The statistical procedure outlined above was performed on 499 complete flakes, the total number of complete flakes from the five levels chosen for the sample. The seven factors which were produced initially were clarified when the number was limited to four (Table 4). The first three of these factors are relatively easy to interpret; the fourth consists of a combination of attributes which are only slightly correlated and therefore, relative to the first three factors, may be considered insignificant.

The first factor may be interpreted as a size factor. The five attributes which received the highest scores on this factor all measure some aspect of the size dimension of the flake: platform width, platform length, flake thickness, flake width, and flake length. In addition, the ventral angle score is relatively high on this factor, indicating that large flake size is correlated with a more or less perpendicular angle between the platform and the flake removed. The flakes which receive a high score on this factor, then,

	ATTRIBUTE	FACTOR I	FACTOR II	FACTOR III	FACTOR IV
1	Material color	.02170	.08906	-.04769	-.46714
2	Material consistency	.03957	.30166	.26618	.49441
3	Flake length	.50910	.65060	.06708	.00923
4	Flake width	.68698	.47849	-.11323	.07844
5	Flake thickness	.78159	.30695	.04366	.08150
6	Ventral angle	.48637	-.11764	-.23463	-.09814
7	Lateral edge angle	.40683	-.10646	-.65390	-.09227
8	Platform length	.86513	-.02283	.27415	.09320
9	Platform width	.89959	-.08969	.08309	.09787
10	Platform preparation: grinding	-.03337	.27709	-.12791	.08437
11	Platform preparation: crushing	-.08946	.14273	.12360	-.46630
12	Platform preparation: faceting	-.03202	.13451	-.07926	.44137
13	Percent cortex	.07109	.00046	-.04176	.53807
14	Dorsal flake scars	.02007	.83532	-.07129	-.23417
15	Index of parallelicity	.09129	-.10230	.69488	-.09346
16	Width ratio	.15665	-.20764	.61611	-.08069

Table 4.
Factors produced by principal components analysis.

are large flakes deriving from cores with relatively large angles between the facets or potential platforms. These are logically large cores which are in the initial stages of reduction.

The second factor may be considered a "degree of reduction" factor. The major component of this factor is the number of flake scars on the dorsal surface of the flake, the next major components are flake length and flake width. The high correlation between these three attributes, independent of any correlation contained in the first factor, is logical as well: the further reduction has progressed, the smaller the flakes and the fewer the number of scars which appear on the dorsal surface.

The third factor is labelled a shape factor, and is composed of the three measures intended to convey shape. The "index of parallelicity" and the flake width ratio score positively on the factor; the third measure of lateral edge angle scores highly in a negative direction solely as a function of the measurement. For this factor, the higher the score calculated for a flake, the more parallel are the lateral edges of the flake.

The fourth factor produced by the principal components analysis consists of a variety of attributes (percent cortex, material consistency, and platform faceting) which are for the most part independent of all other attributes, and even though they are the top contributors, do not load highly on the factor. For this reason, the fourth factor is not considered in the process of defining flake types; it can be viewed as a residual mathematical factor rather than a meaningful technological factor.

Each flake which was entered into the analysis received a score on each factor. The method used to group the flakes into different types in this analysis did not involve the use of further statistics. Rather, the scores on each factor were divided into positive and negative scores and the different combinations of positive and negative for the three factors considered were used to define the flake types (Table 5).

Eight different groups were thus created, each characterized by differences in size, degree of reduction, and shape dimensions. Group 1, which loads positively on all three factors, consists of flakes which are large, have many dorsal flake scars, and are either contracting or expanding flakes. The second group, Group 2, differs from the first only in shape; they are more nearly parallel-sided than those in Group 1. These first two groups will be labelled FLAKE TYPE A and are "primary reduction flakes" (Plate 14).

Groups 3 and 4, or FLAKE TYPE B, (Plate 15) are defined by positive scores on Factor I and negative scores on Factor II. These flakes are also large, generally not quite as large as those belonging to Flake Type A, but do not exhibit many flake scars on the dorsal surface. Group 3 consists of contracting or expanding flakes; Group 4 flakes are considered parallel-sided. This flake type is interpreted as "large thinning flakes".

FLAKE TYPE C (Plate 16) is composed of Groups 5 and 6, in which the specimens are smaller than either of the two groups previously described. Small size is indicated by the negative scores on the first size factor. The scores on the second factor are positive and indicate greater reduction than for the previous flake type. As before, the positive scores on the third factor indicate contracting or expanding flakes, the negative scores indicate parallel-sided flakes. This type of flake is defined as "small thinning flakes" and represent the result of more advanced stages of reduction such as preform manufacture.

The last two groups, Group 7 and Group 8, comprise FLAKE TYPE D (Plate 17). The scores for this flake type are negative for the first two factors, and either negative or positive on the third factor. The lower number of flake scars, indicated by a negative score on the second factor, is explained by the fact that the flakes are small enough that only a few scars can "fit" onto the dorsal surface, even though the number of flakes being removed is greater. This category is labelled "final trimming flakes".

In summary, the grouping of flakes on the basis of the scores they received on each factor has created four different groups of flakes: primary reduction flakes, large thinning flakes, small thinning flakes and final trimming flakes (see Appendix II for dimensions and attribute states). The sequence of reduction represented by these four categories corresponds to the reduction sequence derived from the cores. This correspondence is illustrated in an expanded version of the original model which includes the production of these flake types (Fig. 9). The primary reduction flakes (Type A) are produced during initial core reduction and formation of small and large biface blanks. Large thinning flakes (Type B) are produced by blank reduction and preform manufacture. As reduction progress through the preform stage, the thinning flakes decrease in size (Type C). During the last stages of tool manufacture, final trimming flakes (Type D) are produced. As with the core-to-tool sequence, the flake type characteristics represent the continuum in

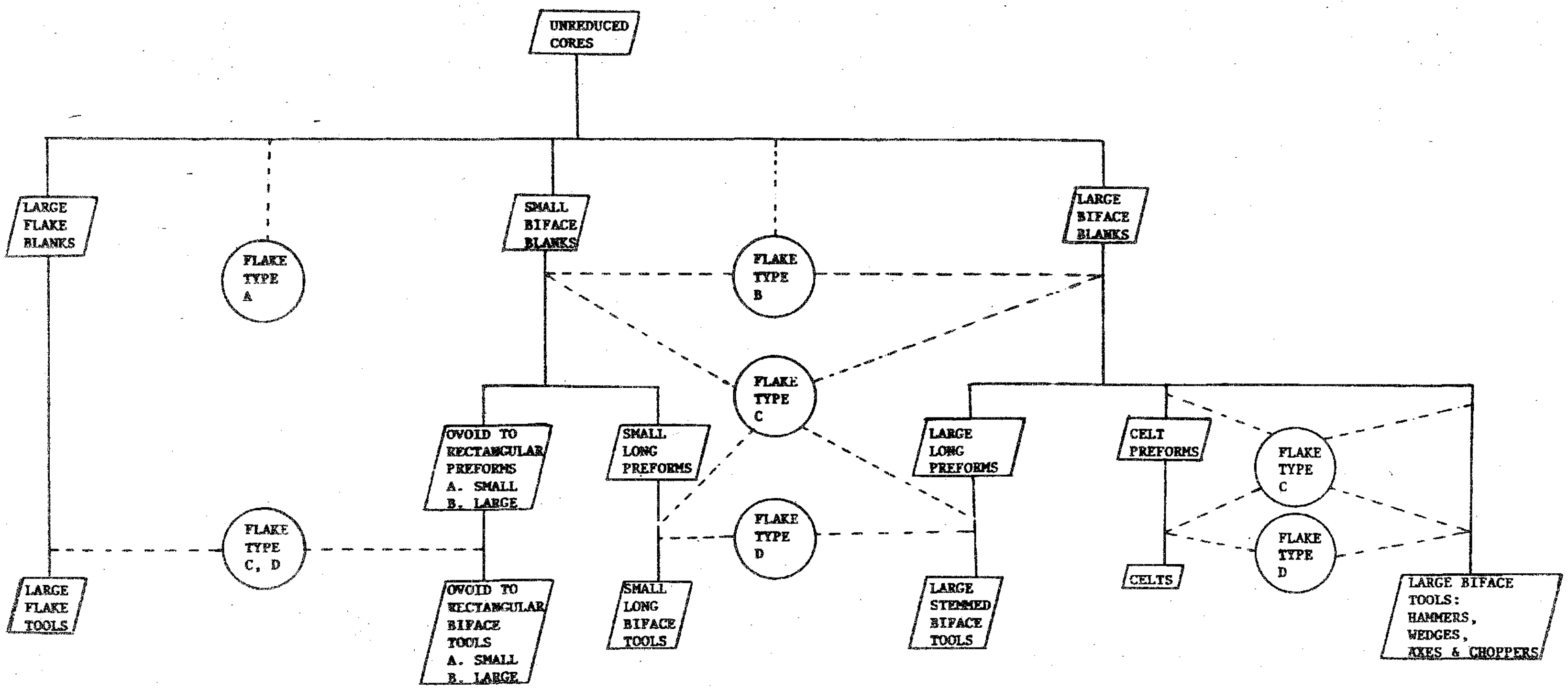


Figure 9. Expanded model including technological flake groups.

the reduction process; the characteristics of each flake type grade into those of the next.

Provenience. Table 6 indicates the total number of whole flakes per level from both test pits. The markedly lower quantities of flakes recovered from Level 8 (80-90 cm) is explained by the presence of a floor paving. The decreased volume of fill results in a decrease in the number of artifacts. In addition, there is a notable difference in the quantity of chipped stone debitage recovered from the levels above and below the floor. Levels 2 and 5 (20-30 cm and 50-60 cm respectively) contain a total of 350 flakes (73% of sample), whereas Levels 11 and 14 (110-120 cm and 140-150 cm respectively) contain only 90 flakes (18% of sample). Although no cultural or natural stratigraphy was observed (R. Magnus, personal communication 1976) it is likely that the fill below the floor represents the remains of some earlier house mound refuse used as a base for the later structure. The fill above the floor may derive from the occupation of the structure and trash deposition. As no specific information is available, it is assumed that quantitative differences do not distort the qualitative content of the assemblage.

Ignoring raw frequencies, the content of the samples from above and below the floor level differ only slightly. The proportions of the various flake types both above and below the floor level are approximately the same. This is substantiated by a Chi-square test, resulting in no significant differences at the 99% level of confidence ($X^2 = 16.43$, d.f. = 12).

Inspection of activities both below and above the 90 cm floor level as represented in the core-to-tool sequence shows that the higher percentage of rough blanks compared to preforms and tools

FLAKE TYPE	GROUP	FACTORS I	II	III	DEFINITION
A	1	+	+	+	primary reduction flake, parallel
	2	+	+	–	primary reduction flake, non-parallel
B	3	+	–	+	larger thinning flake, parallel
	4	+	–	–	larger thinning flake, non-parallel
C	5	–	+	+	smaller thinning flake, parallel
	6	–	+	–	smaller thinning flake, non-parallel
D	7	–	–	+	final trimming flake, parallel
	8	–	–	–	final trimming flake, non-parallel

Table 5.
Definition of flake types.

SAMPLE LEVEL	FLAKE TYPE A	B	C	D	TOTAL
20-30 cm depth	25	16	39	56	136
50-60 cm depth	44	39	57	74	214
80-90 cm depth	15	14	11	19	59
110-120 cm depth	19	20	15	22	76
140-150 cm depth	5	4	2	3	14
TOTAL	108	93	124	174	499

Table 6.
Quantity of flake types per sample level.

corresponds roughly to the higher percentages of flake types resulting from the production of the blanks, namely, the primary reduction flakes (Type A) and large thinning flakes (Type B). Conversely, the lower percentages of preforms and tools corresponds to lower percentages of small thinning flakes (Type C) and final trimming flakes (Type D) (Fig. 10).

As the relative proportions of the assemblage components are not significantly different above and below the floor level, it is informative to consider the assemblage in its totality. The proportions of the different flake types, keeping in mind that they are technological types and are produced during different stages of tool manufacture, give clues as to the relative importance of the different activities performed at Sabana Grande. As can be seen in Table 6, there is a positive correlation between flake type and quantity: that is, the smaller the flake and the closer the tool comes to being finished, the larger the number of flakes produced. The increase in quantity of small trimming flakes does not necessarily indicate that final trimming was especially important at Sabana Grande. Rather, the increase is probably a result of the fact that final trimming requires the removal of more flakes precisely because they are smaller than initial core reduction flakes. The tool itself is also smaller than the initial core, however, per unit edge, the number of flake removals is higher during final trimming than during primary core reduction.

As noted previously, the components of the flake collection and core-to-tool manufacturing sequence correspond reasonably well as far as relative frequency is concerned, thus showing that there is no great discrepancy between the manufacturing procedure as shown in

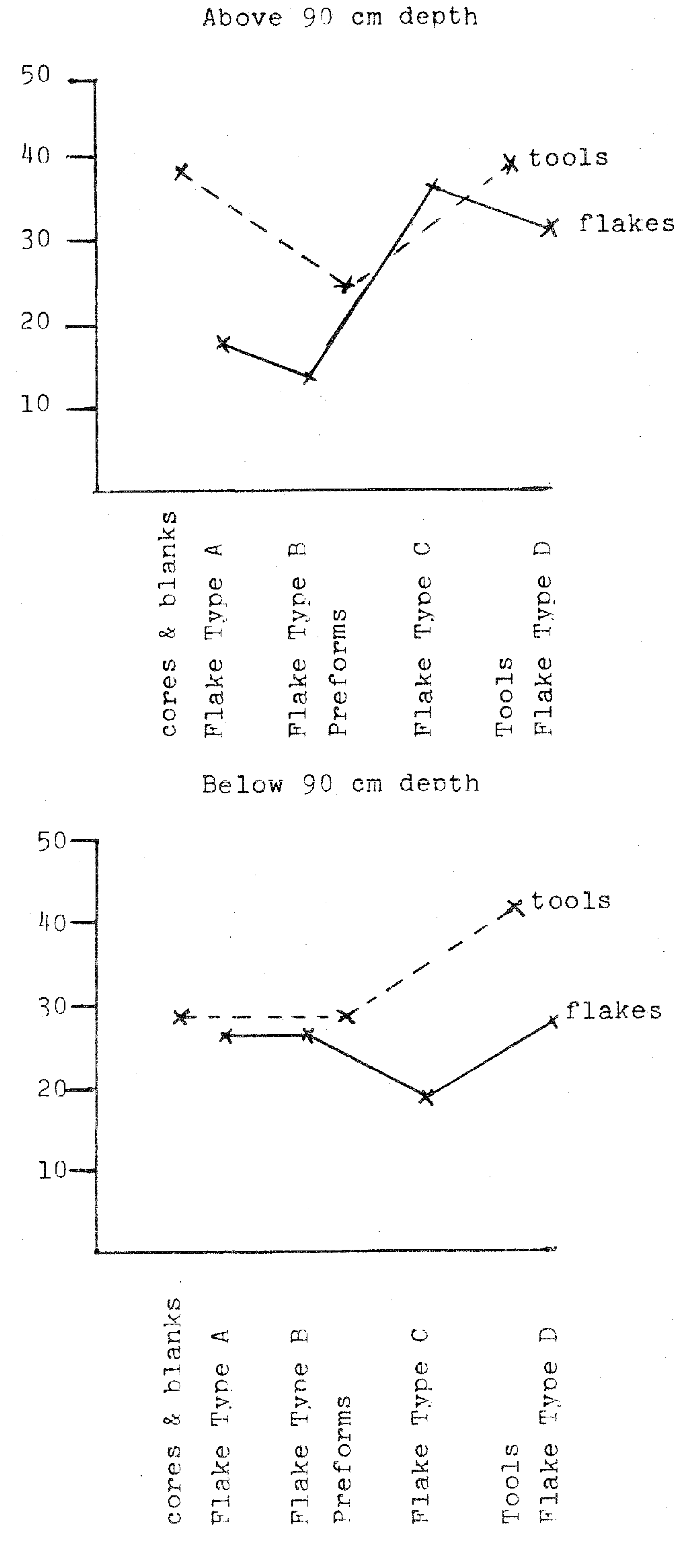


Figure 10.
Correlation between technological core and flake types.

the cores, blanks, preforms, and tools and in the debitage. This serves to verify the model presented in Figure 9, based originally on the core-to-tool sequence only.

Specialized Flakes

Thus far, except for the category of large flake blanks, only whole flakes without evidence of further use or modification have been considered. There are two other major categories of flakes: flake tools and resharpening flakes, which provide information for further understanding the activities of Sabana Grande inhabitants.

Flake Tools. The first category to be considered, flake tools, consists of flakes of all types which exhibit evidence of modification and/or use. A total of 102 flake tools and flake fragments from all levels of the excavation were identified with the aid of a ten power hand lens. Of these, 53 were sufficiently complete to analyze for technological attributes. (Use will be dealt with in the separate functional analysis.) These attributes include maximum flake length, width, and thickness (when complete measurements could be taken), the angle between the platform and the ventral surface, the number of flake scars on the dorsal surface, the type of platform preparation, if any, the presence of cortex, and other artifact-specific observations. The characteristics of these flake tools are summarized in Appendix III. It is assumed that the fragmentary pieces are similar to the complete specimens recovered. The average dimensions of the flakes indicate that most of them probably belong to Flake Types A and B of the statistically defined technological flake categories, that is, they are primary reduction flakes and large thinning flakes. This is supported by the occurrence of cortex on 12% of the analyzed flake tools. The presence of cortex on the platforms of 4% of the flake tools indicates that some reduction had already taken place, but that the cores were not reduced to the point that no cortex at all remained. Most of these flake tools, then, probably derive from the stage of blank and preform manufacture.

Of the 102 flake tools and fragments, 53% (54) were utilized without further modification. The remaining 47% (48) were retouched before use, most of them (96%) bifacially. Although often more than one edge was utilized, in only one case was one edge retouched unifacially, and another bifacially.

Resharpening Flakes. Additional information is provided by the analysis of yet another flake type: resharpening flakes. These are not included initially in the tool manufacturing model because they appear only after the tool has been manufactured and utilized. After more or less utilization, the edges of the tool which receive the heaviest use must be rejuvenated if the tool is to remain functional. Normally, this is accomplished by re-flaking the worn edge to create a new, sharp working edge. The flakes resulting from this process are called resharpening flakes, and the platform of each of these flakes is the former working edge of the tool being sharpened.

A total of 99 resharpening flakes were identified with a ten power hand lens in the whole and fragmentary flake samples. Of these, 48% (48) derive from chipped tools made of silicate rocks. Technological characteristics of these flakes are summarized in Appendix IV. The average dimensions of the flakes are considerably smaller than in the previous category of flake tools, and the average angle between the platform and ventral flake surface is also larger. This indicates that they are similar to Type D of the technological flake categories: final trimming flakes. Both resharpening and final trimming flakes derive from the tool in its complete or nearly complete form and result from specialized edge modification rather than thinning or primary core reduction.

The remaining 52% (51) of the resharpening flakes are basalt celt resharpening flakes. This is obvious because of the ground surface of the celt which becomes the dorsal surface and platform of the resharpening flake. When the working edge of the celt is worn out, it is first chipped and then re-ground to form a new edge. This is evidenced by the presence of several categories of resharpening flakes. In 53% of them (27), the entire dorsal surface of the flake is ground, in 35% (18) there is at least one negative flake scar but the rest of the dorsal surface of the flake is ground, and in only 12% (6) is there no evidence of grinding on the dorsal surface. No measurements were taken on these flakes because all of them are fragmentary.

The addition of these two categories of flakes, flake tools and resharpening flakes, allows the model to be refined for an even more complete picture of stone-working behavior at Sabana Grande. Larger flakes resulting from primary reduction and thinning activities were often deemed useful by the inhabitants of the site, and either with or without further modification, were used as tools and subsequently discarded.

Complex core-tools, e.g. large stemmed bifaces or celts, on the other hand, were often resharpened for further use before they were discarded as worn out. This resulted in the production of resharpening flakes which retain evidence of tool usage in the form of excessive wear on the platform and dorsal flake surface.

A number (108) of unidentifiable tool and core fragments were recovered from the site. These specimens are too incomplete to be assigned to any of the components of the tool manufacturing procedure and are thus grouped into a residual category with dimensions and artifact-specific characteristics noted (Appendix V) but not used in the analysis or model construction.

Summary

The final model (Fig. 9) represents the behavior of flintknappers at Sabana Grande as revealed through the chipped stone analysis. The model specifies the decisions of the flintknappers, the activities corresponding to those decisions, and the resulting artifacts on which the construction of the model is based.

The model was set up initially by examination of the core-to-tool reduction sequence and verified by statistical analysis of the complete unmodified flakes. Analysis of additional flake types (flake tools and resharpening flakes) enabled refinement of the model. The model represents only those patterns of flintknapping behavior which are predominant in the assemblage. Although deviations from this pattern may have occurred occasionally, the focus of this study is to identify the regularities in flintknapping behavior which characterize the site, rather than the idiosyncracies of single events or knappers.

TOOL FORM

Stylistic or formal tool categories are partially synonymous with technologically defined artifact categories, as regularity in form was one of the criteria for determining the core-to-tool reduction sequence. Description of formal patterning here is limited to technologically complete tools, that is, those tools which constitute the end-product of the core reduction process and have been intentionally shaped. The formal classes of tools are characterized primarily by regularity in the outline of the artifacts, degree of thinning, and overall size. Patterns of use are often consistent within the formal classes as well.

Large Ovoid to Rectangular Bifaces (3 specimens) (Plate 12, bottom: A)

Material: chert - 2 (66%), chert or petrified wood - 1 (33%)

Size: length - (all fragmentary)

width - (max.) 41 mm.; (min.) 36 mm.; (avg.) 38.6 mm.

thickness - (max.) 17 mm.; (min.) 12 mm; (avg.) 14 mm.

Form: ovoid to rectangular

Cross-section: longitudinal - biplano to biconvex

transverse - biconvex

Retouch: medium fine retouch around all edges

Use/wear: Step-scarring, unifacial in two cases, bifacial in one case, is present on straight or irregular edges. Edge angles prior to use vary from 35° to 50°. The two specimens with unifacial wear are probably scrapers, the specimen with bifacial wear is probably a knife.

Distribution: Pit 1, 20-30 cm, #10; Pit 2, 40-50 cm, #5; Pit 2, 90-100 cm, #3.

Comments: This class of artifacts is fairly homogeneous with regard to outline and cross-sections, as well as size. All specimens are fragmentary, but one almost-complete specimen is approximately 54 mm long and the other two are at least 60 and 66 mm long each. For the most part, then, they are about twice as long as they are wide and extensively thinned prior to final retouch.

Small Ovoid to Rectangular Bifaces (5 specimens) (Plate 12, top: A, C, D)

Material: chert - 5 (100%)

Size: length - (all fragmentary)

width - (max.) 31 mm.; (min.) 22 mm: (avg.) 27.4 mm.

thickness - (max.) 12 mm.; (min.) 8 mm.; (avg.) 9.4 mm.

Form: ovoid to sub-rectangular

Cross-section: longitudinal - biplano

transverse - biconvex

Retouch: fine retouch around entire periphery

Use/wear: No wear on two specimens. Remaining three specimens exhibit bifacial step-scarring on straight to concave edges with 35° to 50° angles prior to use. These tools were probably used to cut or saw a fairly resistant material.

Distribution: Pit 1, 100-110 cm, #5; Pit 1, 110-120 cm, #3; Pit 2, 30-40 cm, #2; Pit 2, 60-70 cm, #5; Pit 2, 70-80 cm, #9.

Comments: Variation within this formal category is minimal. Major differences between this group and the previous one are the size attributes. The form of the small tools are more homogeneous than for the previous class, and the cross-sections are more consistent as well. Final retouch flaking is finer than for the larger tools.

Large Stemmed Bifaces (10 specimens) (Plate 7: A, B, C)

Material: chert - 8 (80%), jasper - 2 (20%)

Size: length - (max.) 108 mm.; (min.) 67 mm.; (avg.) 93.3 mm.

width - (max.) 41 mm.; (min.) 31 mm.; (avg.) 37.2mm.

thickness - (max.) 14 mm.; (min.) 9 mm.; (avg.) 11.1 mm.

Form: blade - straight

point - sharp, unrounded

base - pointed to convex

stem - straight to sharply contracting

shoulders - rounded to abrupt

Cross-section: longitudinal - biplano

transverse - biconvex with one plano-convex and one plano-triangular

Retouch: medium fine to fine, sub-parallel along blade edges

Use/wear: No wear on five specimens. Remaining five have step-scarring along two lateral edges, all of which are straight. One has a convex end utilized as well. Six edges have unifacial wear with a 30°-40° edge angle. The remaining four edges have bifacial wear, one on a 30° edge angle, the other on 50° angled edges.

Distribution: Pit 1, 30-40 cm, #3; Pit 1, 50-60 cm, #3; Pit 1, 60-70 cm, #2; Pit 1, 70-80 cm, #10; Pit 2, 0-20 cm, #3; Pit 2, 20-30 cm, #3; Pit 2, 60-70 cm, #4; Pit 2, 70-80 cm, #5; Pit 2, 100-110 cm, #4.

Comments: This category may be labelled stemmed knives, as all but one fragment show use resulting from cutting activities. The exception is a tip fragment with an extended fracture which may have resulted from impact or use as a projectile. The formal characteristics of the specimens in this class are variable. The size range is great and the quality of retouch is variable. The characteristics of the stem and base range from extended stems with convex bases to short stems which contract sharply from the shoulder down. The widest part of the tool, at the shoulders, varies inconsistently with the length of the tool, resulting in some specimens which are short and wide and some which are long and relatively narrower. Use wear consisting of step-scarring along the lateral edges indicates that resistant materials were being worked. The bifacial wear on low-angled edges indicates cutting activities, the unifacial wear on low-angled edges indicates whittling and planing activities.

<u>Unstemmed Long Bifaces</u> (6 specimens) (Plate 10: A)

Material: chert - 6 (100%)

Size: length - 76 mm. (one complete specimen)

width - (max.) 35 mm.; (min.) 22 mm.; (avg.) 26.8 mm.

thickness - (max.) 20 mm.; (min.) 7 mm.; (avg.) 12.7 mm.

Form: long with one pointed end, one rounded end

Cross-section: longitudinal - biplano with one biconvex

transverse - biconvex with one plano-convex and one plano-triangular

Retouch: medium fine to fine retouch on all edges

Use/wear: No use on one specimen. On three specimens, two opposite edges were utilized; on one, the lateral edges and one end show use; on one, the entire periphery has wear. Two tools (four edges) were used as scrapers and have edge angles of

55° to 65°. An additional edge of one of these was used as a chopper and has an edge angle of 65°. Two tools (three edges) were used as knives and have edge angles of 30° to 45°. A second edge of one of the knives and the last tool have unifacial wear and low edge angles and were probably used to plane and whittle.

Distribution: Pit 1, 30-40 cm, #7; Pit 1, 70-80 cm, #6, #8; Pit 1, 110-120 cm, #2; Pit 2, 50-60 cm, #6; Pit 2, 110-120 cm, #5.

Comments: Although only one specimen is complete, the reconstructed form of artifacts in this group is apparently fairly regular. This class of artifacts was constructed from small long preforms, except for one specimen probably made from a large long preform. The complete specimen exhibits resharpening flake scars around the entire periphery. The range of uses of these tools is wide, varying from a chopping edge to scraping, planing, and cutting edges.

Wedges and Choppers (8 specimens) (Plate 3: A, B)

Material: chert - 8 (100%)

Size: length - (max.) 132 mm.; (min.) 77 mm.; (avg.) 99.4 mm.
width - (max.) 62 mm.; (min.) 47 mm.; (avg.) 53.6 mm.
thickness - (max.) 20 mm.; (min.) 31 mm.; (avg.) 27 mm.

Form: sub-triangular to ovoid with one sub-rectangular

Cross-section: longitudinal - biplano to plano-triangular with one convexo-triangular
transverse - plano-triangular to convexo-triangular

Retouch: crude to medium fine retouch

Use/wear: One unutilized specimen. Remaining seven show use on three edges or all four edges in the form of bifacial step-scarring. The edge angles vary from 45° to 65°. They were used as choppers or scrapers on resistant material. Utilized edges are straight to convex.

Distribution: Pit 1, 30-40 cm, #5; Pit 1, 40-50 cm, #2, Pit 1, 50-60 cm, #1; Pit 1, 70-80 cm, #2; Pit 2, 20-30 cm, #2; Pit 2, 60-70 cm, #1; Pit 2, 100-110 cm, #3.

Comments: Three and possibly four of these tools show evidence of the large thinning flute deriving from large biface blank reduction. Formally, the implements are rather homogeneous. The greatest variation is in the ratio of length to width, some being long and narrow, others being shorter and wider. Use wear is heavy step-scarring on straight or convex, high-angle edges, indicating general use as choppers and possibly scrapers and wedges.

<u>Hammers</u> (5 specimens) (Plate 3: C)

Material: chert - 5 (100%)

Size: length - (max.) 75 mm.; (min.) 64 mm.; (avg.) 68.8 mm.
width - (max.) 60 mm.; (min.) 41 mm.; (avg.) 48.5 mm.
thickness - (max.) 35 mm.; (min.) 25 mm.; (avg.) 28.3 mm.

Form: ovoid to discoid

Cross-section: longitudinal - biplano to biconvex
transverse - biconvex to bitriangular

Retouch: obliterated by battering, probably crude

Use/wear: battering on some or all edges

Distribution: Pit 1, 0-20 cm, #2; Pit 1, 20-30 cm, #7; Pit 1, 100-110 cm #1; Pit 2, 100-110 cm, #1, #2.

Comments: The group displays regularity in form, perhaps due to similar extensive use as hammers in part, but probably also as a result of manufacture.

GROUND STONE

A total of eleven groundstone artifacts were recovered, all of them in fragmentary condition. Of these, six are identified as metate fragments. All are constructed of basalt, although four are of relatively coarse and soft material and are therefore heavily corroded. On two of the specimens, both faces exhibit evidence of use; only one surface was utilized on the remaining four specimens. All but two surfaces are flat; the exceptions are slightly concave. Due to the high degree of corrosion, wear patterns could be identified with certainty on only five surfaces. Two of these surfaces, both occurring on fragments with only one utilized surface, exhibit extensive light parallel striations. Moderately deep parallel striations were observed on three surfaces, two of them on opposite faces of the same metate fragment. On two opposite surfaces of another fragment, occassional deep striations were noted; it is uncertain, however, if these resulted from use. No striations were present on the remaining metate fragments due to excessive corrosion of the surface.

Although evidence of wear is present in the form of parallel striations on the metate surfaces, they are too fragmentary to reconstruct specific patterns of mano movement or position. In addition, the original shape or size of the metate is not reconstructable (see Appendix VI for dimensions and attributes of specimens).

Three mano fragments were also recovered, all of them made of coarse basalt and heavily pitted. All of the specimens are segments of cylindrical manos. Two of them have a constant diameter of 52 and 54 mm each. The third is thicker at the end (49 mm) than in the middle (42 mm) and may have been used as a pestle. No wear patterns are observable due to excessive corrosion (Plate 21).

In addition, two unique ground artifacts were recovered (Plate 22). One is a tabular sandstone fragment. The sandstone is very fine grained and appears to have been deposited in successive concentric rings to form a long narrow bar. The transverse cross-section is rectangular, as is the reconstructed longitudinal cross-section. The wide surfaces of the specimen exhibit light parallel striations crossing the piece at an oblique angle. The narrower sides have fewer but longer and deeper striations running the length of the artifact. This implement may have been used as a celt sharpener or to grind or polish wood implements.

The remaining specimen is a piece of yellow ochre with two large worn intersecting surfaces. One of the surfaces is concave and polished very smooth with no striations evident. The other surface, intersected by the first, is flat to convex with several sets of rather deep parallel scratches. The remaining surfaces are unworn and rounded. The ochre was probably a paint source and powdered by abrasion prior to mixing with water or fats.

TOOL USE

Flaking technology is one important aspect of prehistoric behavior patterns, however, one must keep in mind that the tools were made to be used. Although behavior patterns are involved in both tool manufacture and use, the approach taken to determine patterns of tool use is slightly different than in the technological analysis. Rather than starting with a generalized model of use behavior, the data for determining tool uses is drawn from two sources: 1) published results of experimental wear pattern replication, and 2) the interpretation of wear patterns in other archaeological and ethnographic assemblages.

Replication of wear patterns has only recently become generally recognized as a source of valuable information. As a result, such studies are not uniform with respect to experimental procedure and variability control. Nevertheless, certain key factors in the formation of wear patterns have been identified.

Analysis of archaeological specimens are also variable in their results. The procedure in such an analysis is opposite to that of experimental replication. In an experimental situation, variables which may affect the resulting wear patterns are subject to controls by the experimenter, whereas in the opposite situation, the analyst can only observe the existing wear patterns and deduce the conditions which may have produced them.

Based on experiments by Crabtree and Davis (1968), Tringham et.al. (1974), Keller (1966), Hayden and Kamminga (1973), Ahler (1970), Sonnenfeld (1962), and Ranere (1975), and ethnographic and archaeological observations by Semenov (1964), Nance (1971), Hester (1970), Wilmsen (1968), Frison (1968), Keeley (1974), Hester et.al.

(1973), Gould et.al. (1971), and White and Thomas (1972), certain factors seem to contribute more heavily than others to the formation of distinctive wear patterns. These include the following:

1) Artifact material. MacDonald and Sanger remark that "the harder material...retained clear traces of tool manufacture but only poor evidence of tool use..." (1968:237)
2) Edge angle. White and Thomas (1972) found that edge angle is one of the primary features recognized as prerequisite for certain activities by New Guinea Highland aborigines.
3) Objective material. The relative resistance or hardness of the material being worked is critical to the establishment and degree of wear patterning.
4) Kinematics. The position of the tool against the objective material and the direction of movement affects the characteristics of the resulting wear patterns.

Other possible factors include edge shape, inclusion of abrasive agents, amount of applied force, and speed of work. All of these factors have demonstrated or hypothesized significance in wear pattern formation due to use.

Of the factors which may be experimentally controlled for, only three are known in artifactual assemblages: material type, edge shape, and edge angle. It is hoped that knowledge of material type and edge angle in addition to the distinctive wear patterns on the tools will allow inferences to be made regarding the type of material being worked and the way in which it was worked with the tools.

Based on the results of experimentally produced wear patterns, diagnostic attributes of wear were selected for analysis on the Nicaraguan tools. The number and type of attributes selected was governed in addition by the powers of observation (a binocular microscope at 10 to 30 times magnification was used).

The attributes are divided into two groups: morphological attributes of the working edge, and attributes of wear. The former category includes the following: edge angle, length of wear, location of wear, edge finish, and edge shape. The latter category consists of observations on the depth of wear and type of wear: edge attrition, edge scarring, impact fracture, and battering, defined below.

Edge angle (the average of the minimum and maximum angle of the utilized edge to the nearest 5 degrees) was calculated to the nearest 2.5 degrees using a contact goniometer. In cases where excessive edge damage had occurred, the original edge angle was reconstructed by extending the planes of the remaining surfaces adjacent to the damaged edge. Length of wear was noted to the nearest millimeter, as was depth of wear from the present edge. Location of wear refers to the number of utilized edges and their position relative to each other, that is, if they are adjacent or opposite to each other. Shape of the edges was noted as either concave, convex, and/or straight. Edge finish describes the type of retouch: either unifacially or bifacially flaked, ground, or unfinished.

Characteristics of edge damage due to use are described as scarring, attrition, impact fracture, and battering. Edge scarring (Plate 18), which generally consists of multiple step flake scars, may be distinguished from retouch flaking primarily on the basis of flake scar size. Edge scarring is usually very tiny and often not congruent with the retouched edge. Scarring may occur either unifacially or bifacially, depending on the relative position of the tool to the object being worked.

Edge attrition (Plate 19) appears as polish and or abrasion in varying degrees. Polish is identified by a gloss on the edge. This is not to be confused with corn gloss resulting from grass cutting and characterized by added layers of opaline compounds derived from the grasses (Witthoft 1955). Abrasion results in edge blunting and a roughened appearance. Degree of attrition is apparently a function of amount of use in large measure, as well as objective material and artifactual material. Attrition starts with abrasion and blunting, and with repeated use, may result in polish along the utilized edge (J. B. Wheat, personal communication 1976).

Impact fractured flakes result in large scars originating from the utilized edge. These are usually singular or intermittent, and often hinge or step terminated, rather than feathered.

Battering (Plate 20) is an extreme form of edge attrition resulting in completely rounded and pitted edges, often extending onto the surface of the artifact.

Each of the wear types thus defined by the presence of certain attributes is presumably the result of differences in tool usage on various materials. This provides the basis for interpretation of the Sabana Grande tool assemblage. Briefly, they are the following:

1) Edge scarring, bifacial - this results from either cutting or sawing a resistant material such as wood or bone with an acute angle tool edge. Chopping with a more obtuse edge angle results in the same wear type, in addition to possible impact fractures.
2) Edge scarring, unifacial - wear of this type occurs as a result of scraping with a relatively obtuse edge on a resistant material. An acute angle is more suitable for

adzing or planing.

3) Attrition - as the only evidence of wear, this indicates that probably a soft or non-resistant material such as soft wood, plant material, or hide was being worked. An acute angled edge would be required for cutting; a more obtuse angle for scraping.

4) and 5) Impact fractures and battering both result from repeated blows approximately perpendicular to the objective material. A fairly resistant material would produce impact fractures; a very resistant material would produce battering.

Methodology

The use-modified pieces of stone were separated from unmodified pieces on the basis of macroscopic observation of all edges. In many cases, use wear was marked; in less obvious cases, the decision was facilitated with the aid of a ten power hand lens.

Not all pieces are considered in the analysis. The criteria for the selection of the sample to be analyzed involved the completeness of the specimen and the completeness of the modified edge. Pieces of a fragmentary nature were successively eliminated, resulting in a sample of 127 artifacts. This sample includes complete specimens, broken specimens with whole working edges, and specimens with fragmentary working edges, but probably almost whole. In this way, the amount of missing data on working edge morphology and use wear patterns was minimized. Some of the specimens exhibited wear on more than one edge. In these cases, each edge was considered separately. Use wear on resharpening flakes and flake tools is considered separately.

Only two of the attributes were employed in the definition of use categories. Only edge angle and edge damage type were considered. This is not because the others are not indicative of tool use, but because the factors involved in their formation are too subtle to identify at this point. The use of broadly defined attributes, then, results in correspondingly broad use wear categories, each of which may be the result of a variety of activities. Clearly, the comparative base for wear patterns is drawn from a wide range of experimental studies which the variables of tool material, objective material, edge angle, and tool use are similar but not identical to the conditions which may have produced the wear patterns on Sabana Grande tools. To apply the specific experimental results to an assemblage where it is known that the conditions were not identical would be misleading, to say the least.

Separation of Sabana Grande tools into use wear categories, then, proceeded in the following manner. The first division was based on the five types of edge damage: unifacial edge scarring, bifacial edge scarring, edge attrition, impact fracture, and battering. Several of the categories are overlapping in many cases. For example, both edge scarring and attrition may appear on the same utilized edge. As previously noted, the presence of attrition in combination with edge scarring is considered to be a function of the amount of time used, rather than indicative of the mode of use. Thus, on edges where both edge scarring and attrition occur simultaneously, scarring takes precedence for the purpose of determining mode of use. Similarly, if both impact fracturing and scarring occur on the same edge, the presence of the impact fractures as indicative of chopping action takes precedence over edge scarring for determining tool use.

The second step involved determining the distribution of edge angles within each of three primary groups: unifacial edge scarring, bifacial edge scarring, and edge attrition. The distribution was bimodal in each case. These modes serve to inherently distinguish between the more acute angles which were efficient for cutting, sawing, and adzing activities, and the more obtuse angles suitable for chopping and scraping activities. In each case, the boundary was between 50 and 57.5 degrees (Fig. 10).

Thus far, eight categories of use wear are distinguishable (Table 7), each of which can be correlated with a set of activities or tool uses. The possible activities are the following: wood chopping and splitting, wood and/or bone cutting, whittling, scraping, and planing, plant fiber shredding, and soft material cutting and scraping. Several pieces exhibit bifacial flaking and impact fractures along one edge, while the opposite edge shows evidence of battering. It seems reasonable to deduce that these tools were used as wedges in wood splitting activities, the impact fractured edge having penetrated the wood while the opposite edge was pounded or hammered in order to force the wedge into the wood (Ranere 1975).

Resharpening Flakes

Analysis of edge wear (examined with a ten power hand lens) on resharpening flakes from chipped tools shows roughly the same variation as wear on tools (Table 8). The "crushing" category includes those resharpening flakes for which it was impossible to determine if the damage occurred on one or both surfaces, i.e. unifacially or bifacially, due to the small size of the flakes, hence utilized edge. Thus, it encompasses a greater proportion of the variation in use wear than the comparable tool wear category of "impact fracture".

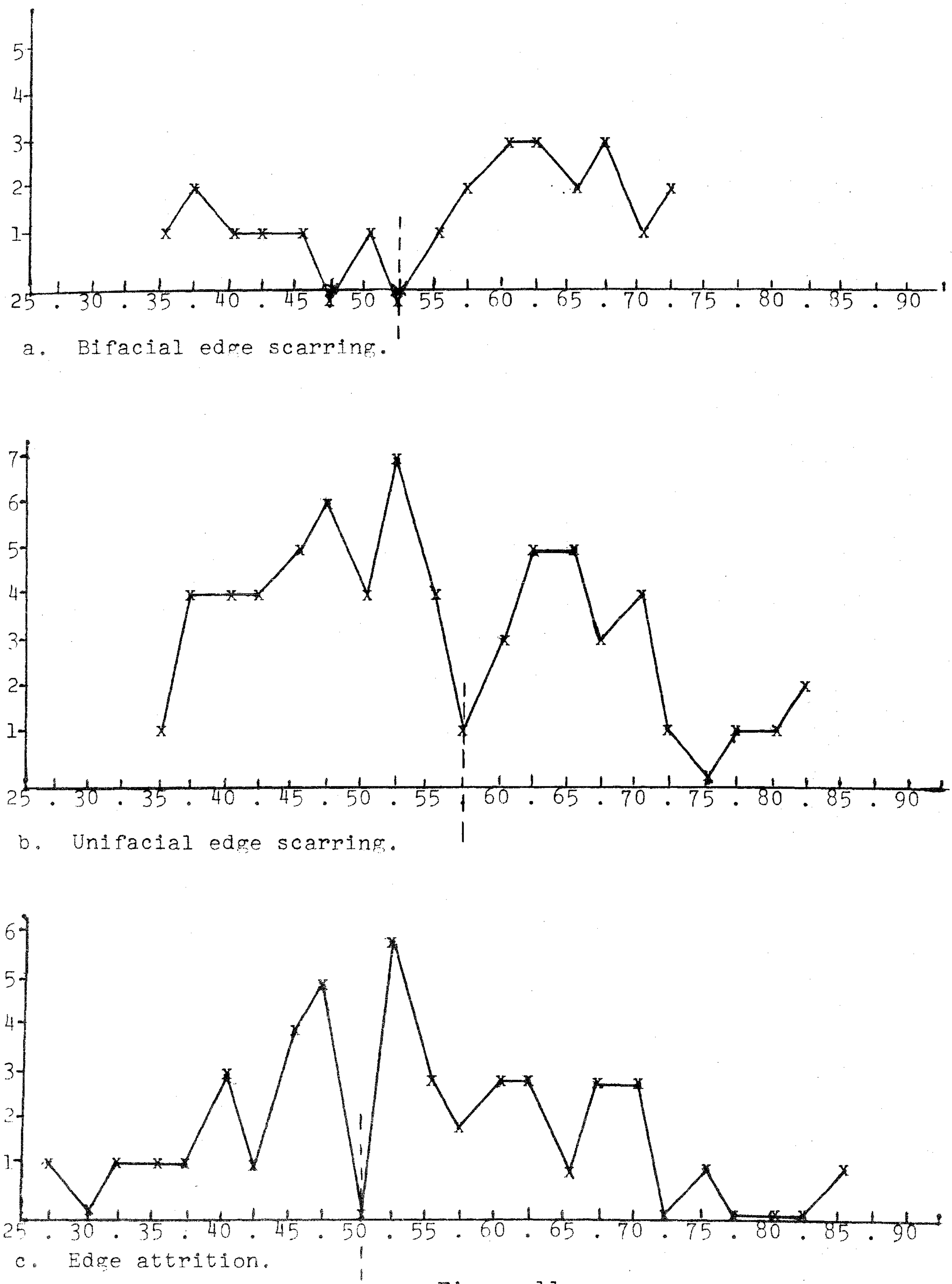


Figure 11.
Edge angle distribution per edge wear type.

EDGE DAMAGE	EDGE ANGLE	USE	FREQUENCY
bifacial scarring	less than 52.5 degrees	cutting, sawing; resistant material	6
bifacial scarring	greater than 52.5 degrees	chopping, bi-directional scraping; resistant material	16
unifacial scarring	less than 57.5 degrees	adzing, planing, shaving resistant material	35
unifacial scarring	greater than 57.5 degrees	scraping; resistant material	28
attrition	less than 50 degrees	cutting, sawing soft material	15
attrition	greater than 50 degrees	scraping; soft material	17
impact fracture		chopping, wedging; resistant material	5
battering		pounding, very resistant material	5

Table 7.
Wear categories and tool uses.

The distribution of edge angles on the utilized edges of the resharpening flakes, however, is not comparable to the distribution of tool edge angles. The resharpening flakes exhibiting unifacial edge scarring and blunting both have average edge angles of just over 70 degrees; the flakes with bifacial scarring and crushing average 65 degrees. The explanation for this similarity is rather simple: during use, the edge of the tool tends to wear down, especially if the edge angle was low to begin with. It seems that the angle of a worn tool edge stabilized at approximately 65 to 70 degrees, at which time it became largely ineffective. Thus, the flakes which are removed to rejuvenate the edge all exhibit approximately 65 to 70 degree edge angles.

The identification of the resharpening flakes and the tools from which they derive is substantiated by comparing the use wear characteristics with the angle of the platform and the ventral surface. As mentioned previously (see Technological Attributes, p. 22), a small ventral flake angle generally derives from a thinned core. This is verified by the positive correlation between ventral angle and flake size in the first factor (p. 23), and is also applicable to resharpening flakes. Logically, a tool edge that is used for heavy duty scraping will not be thinned as extensively as cutting tools. The resharpening flakes from the thicker scraping tools will have a lower ventral angle and exhibit scraper-type wear (unifacial scarring). Conversely, the resharpening flakes from thinned cutting tools will have larger ventral angles and use wear characteristics of knives (bifacial scarring and/or edge rounding). Table 9 shows this correspondence. Note that the angle of the utilized edge also shows some correspondence to the wear type and is

WEAR CATEGORY	PERCENT RESHARPENING FLAKES	PERCENT TOOLS
Unifacial scarring	52	50
Blunting	16	25
Crushing	10	4 (impact fracture)
Bifacial scarring	20	17
Battering	2	4

Table 8.
Proportion of each wear type in tools and resharpening flakes.

WEAR TYPE	AVERAGE VENTRAL ANGLE	AVERAGE WORKING EDGE ANGLE	NUMBER OF SPECIMENS
Unifacial scarring	104 degrees	70 degrees	26
Blunting	110	70	8
Crushing	114	65	5
Bifacial scarring	115	65	10

Table 9.
Correlation between ventral angle and working edge angle.

inversely correlated to the ventral angle, even though the range of working edge angles is limited.

All celt resharpening flakes recovered are fragmentary and do not exhibit any characteristic wear patterns which are distinguishable from striations produced during the initial celt manufacturing process.

Use vs. Function

At this point, it is important to consider the difference between the terms USE and FUNCTION. These concepts are quite different (Spier 1970:23), and the use of one or the other term implies certain underlying assumptions which should be clarified. The basic difference is this: the use of a tool is the direct and immediate purpose for which the tool is used; the function of the tool is the context in which the tool is used. For example, the use of a digging stick is to loosen the soil, but the function of the same digging stick may be either agricultural or for gathering wild roots.

Obviously, the analysis so far has only identified general probable tool uses without considering the contexts in which the tools were employed. An analysis of wear patterns alone does not provide the requisite information for determining tool function; other types of data, e.g. pollen analysis, must be available as well. Except for some general more or less speculative remarks, tool function will not be considered due to lack of supplementary information at this time.

Sources of Bias

The reconstruction of the context of tool usage is made difficult by factors other than the need for supplementary information. The relative importance of stone to perishable materials in the manufacture of tools is a potential source of bias (Collins 1975:15). Although recovery of lithic material at a site may be remarkable, it is rare that all tools are made only out of stone. For certain purposes, wood or bone may have proved more efficient than stone tools. At Sabana Grande, stone with good flaking characteristics was available, and evidently in sufficient quantities to fulfill minimal requirements. However, it has been noted ethnographically, that artifacts often made of stone in northern Central America, e.g. manos and metates, arrow and spear points, are increasingly constructed in wood toward the south (Haberland 1959:37). If this was the case at Sabana Grande, such specimens were not preserved for archaeological recovery.

Another possible source of bias may be the result of prehistoric population and exploitation patterns. Many activities relating to resource extraction may not have been carried out at the site itself. As a result, the tools which were used in these activities may not be represented in the assemblage. The same would be true if Sabana Grande were a special activity site itself.

The way in which a site was abandoned also has an effect on the assemblage. If a planned departure occurred, many if not all of the still-functional tools would have been removed. On the other hand, if the site was abandoned hastily, selective removal of tools may not have occurred.

It is not possible to account for the effect of these potential sources of bias in the stone tool assemblage of Sabana Grande at this time. In a more comprehensive functional analysis, these possibilities should be taken into account in order to ascertain the validity of the conclusions.

Discussion

The wear pattern analysis shows that a wide range of activities took place using the flaked stone tools. These activities, rather non-specific in themselves, become more meaningful in light of comparable ethnographically documented activities and their context.

Hunting and gathering societies of Central America are characterized by group movements depending on fish and game availability according to season (Stone 1966:215). Hunting is especially emphasized by inland groups (Joyce 1916:37), although lakes and streams, including Lake Nicaragua, provide excellent fish resources (Squier 1860:171, Lange 1972: 74). Both large and small mammals are hunted (deer, rabbit, boar, monkey) as well as birds and iguana (Stone 1949:7, 1962:14). Wild plants gathered include vines, palm inflorescences, berries, mushrooms, flowers, and ferns (Stone 1949:7, 1962:13-14).

The equipment used to obtain and process these resources includes the following: for hunting, bow and arrow, lances, nets, pits, traps, and blowguns are used (Stone 1966:217). The arrows and spears are furnished with stone, fish-spine, bone, or black palmwood points or barbs (Joyce 1916:16, Stone 1962:15, 1966:229). In addition, fire drives are used in Panama and Honduras (Stone 1966:217). Skins are often sun-dried without preservatives and picked clean by birds (Stone 1949:20). Fishing is carried out with the use of poisons, palmwood arrows and bow, nets, stick, and sometimes by hand (Stone 1962:15, 1966:218). Implements for plant preparation include grinding with natural boulders and river cobbles and wooden planks (Stone 1962:15) as well as mortars and pestles for nuts and berries (Lange 1972:74). Usually preparation involves simple boiling or roasting (Stone: 1966:221). Wood is important for the construction of implement shafts and fishing gear (Stone 1949:20).

Agricultural societies, in contrast to hunters and gatherers, are for the most part sedentary. Permanent village settlement involves extensive use of wood resources for house construction and furniture (Stone 1949:11, 1962:12, 1966:217, Lange 1972:423). In addition to wood, grasses or palms are used as roofing material and agave, vines, and bark provide fiber for fastenings (Stone 1949:12, 1962:16, 1966:216). House furnishings include wooden storage platforms, benches, mortars, and mashers (Stone 1949:12-15). Varied products such as cordage, basketry, weaving, pottery, bone objects such as needles and spindle whorls, and bark cloth are manufactured (Stone 1949:18-19, 1962:21-24).

Crops of tubers, corn, pejibaye palm, cacao, and plantains are cultivated using the slash and burn method (Stone 1949:6, 1962:12). Hunting and wild plant food collecting are still practiced to some extent, but their role is minimal.

Equipment used in the fore-mentioned activities include woodworking tools (axes, adzes, wedges, etc.) for house construction and field clearing. The primary tool for crop cultivation is the digging stick. Food processing tools are the mano and metate, and tools such as scrapers, and wood and bone-working tools for carving, cutting, and scraping are extensively used.

According to the summary just presented, many of the activities of hunters and gatherers are similar to those of agriculturalists, hence many tool requirements are similar. This is probably partially true, as scraping, whittling, and cutting wood and bone seem to be important to both types of societies.

However, certain activities and their associated tools are more important for one type of society than for the other. Wood chopping is an exceedingly important activity associated with agricultural societies. Permanent house construction and field clearing activities require heavy-duty wood-working tools such as axes, wedges, large scraper, and knives. Such activities and tools would not be heavily represented in sites occupied by hunters and gatherers. The same is true for food-processing equipment such as manos and metates. One of the basis of the above test implications which are supported by the data from the use wear analysis, it is proposed that the inhabitants of Sabana Grande were at least semi-sedentary agriculturalists. The recovery of large amounts of ceramics and the presence of architectural remains on the site corroborates this conclusion.

TECHNOLOGY AND USE

The technological and use wear analyses resulted in two sets of artifact categories, each based on different aspects of prehistoric behavior. The next problem to consider is whether these two sets of activities - tool manufacture and tool use - overlap, and if they do, how?

The procedure for determining the relationship between tool manufacture and use is by means of the contingency coefficient C. Three technological categories established in the technological analysis (cores and blanks, preforms, and completely reduced implements) were correlated with each of the eight use categories, and tested for non-random associations (Table 10). It was expected that the association would be non-random, i.e. that a higher frequency of use would correspond with a higher degree of tool reduction. The contingency coefficient C was calculated to be .41. The significance of this value is tested by referring to the significance of the Chi-square value used in computing the contingency coefficient (X^2 = 26.9, d.f. = 16). The value is insignificant at the 99% level of confidence, and the association between the use categories and technological categories may be considered random. What does this mean in terms of prehistoric behavior?

As shown in Table 10, not only were technologically complete tools such as knives used, but cores, blanks, and preforms were used as well. This information indicates several things concerning the behavior of the prehistoric mound occupants. Foremost is the fact that a recognizable usable edge did not necessarily have to be one that was created intentionally. The utilized edges of cores, blanks, and preforms were produced as by-product of the tool manufacturing process, and were utilized in the interim before the piece was subjected to final trimming. This type of behavior is, of course, very efficient in terms of satisfying the need for usable tools by making the material in the process of reduction available for use.

The stone is, in a sense, being recycled at least twice, and possibly three times (Fig. 11). First, it may be used while the raw material is still in the reduction process, second, the finished tool is utilized, and third, the utilized tool may be resharpened for further use before being discarded.

	CORES AND BLANKS	PREFORMS	TOOLS	TOTAL
None	11	5	5	21
Bifacial scarring, angle more than 52.5°	5	3	5	13
Bifacial scarring, angle less than 52.5°	0	1	3	4
Unifacial scarring, angle more than 57.5°	12	7	8	27
Unifacial scarring, angle less than 57.5°	15	8	6	29
Attrition, angle less than 50°	1	4	10	15
Attrition, angle more than 50°	2	7	5	14
Impact fracture	2	0	1	3
Battering	2	0	4	6
TOTAL	50	35	47	132

Table 10.
Use in core-to-tool sequence.

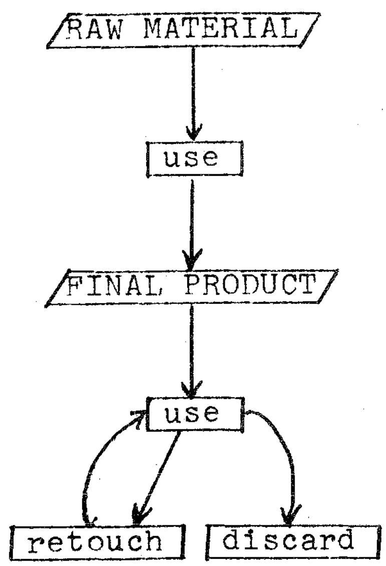


Figure 12.
Stone recycling process.

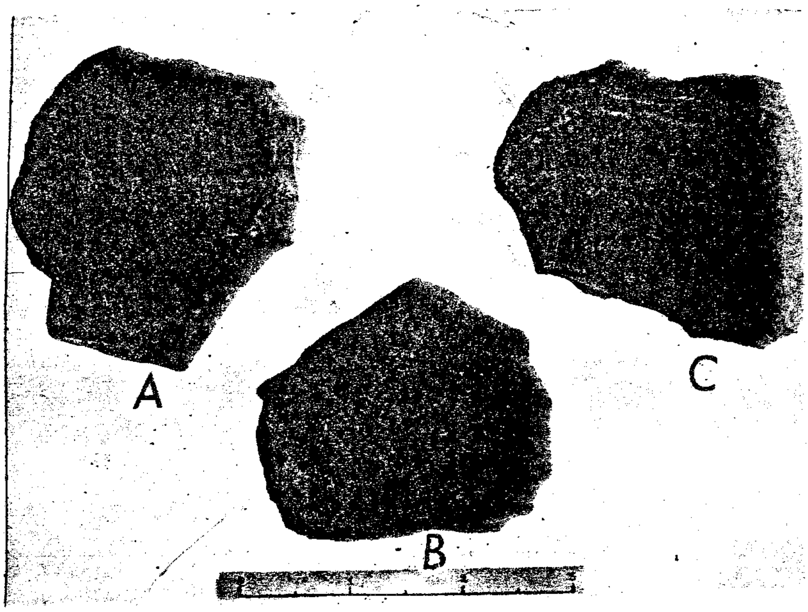


Plate 1. Raw Cores. Scale in inches. A. Pit 2, 70-80 cm, #10
B. Pit 2, 80-90 cm, #8
C. Pit 2, 0-20 cm, #8

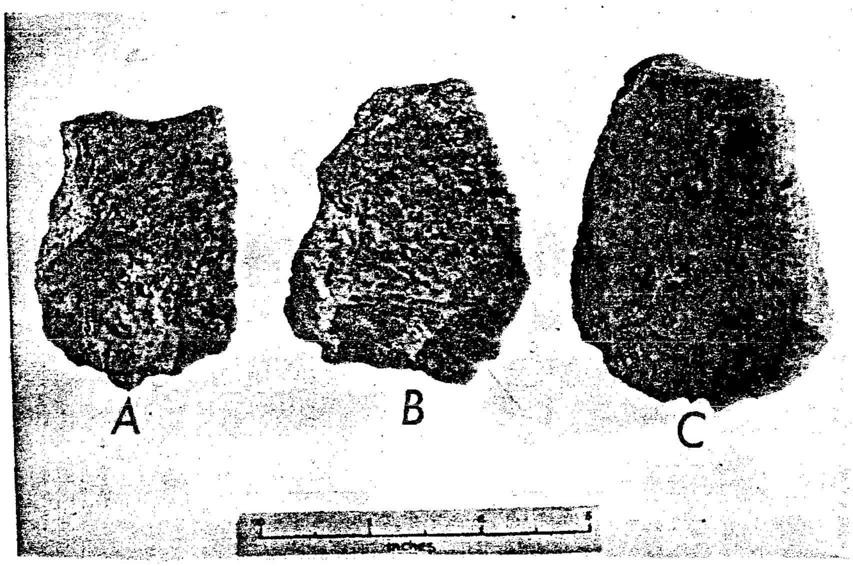


Plate 2. Large biface blanks. Scale in inches. A. Pit 1, 20-30 cm
B. Pit 1, 30-40 cm
C. Pit 1, 40-50 cm

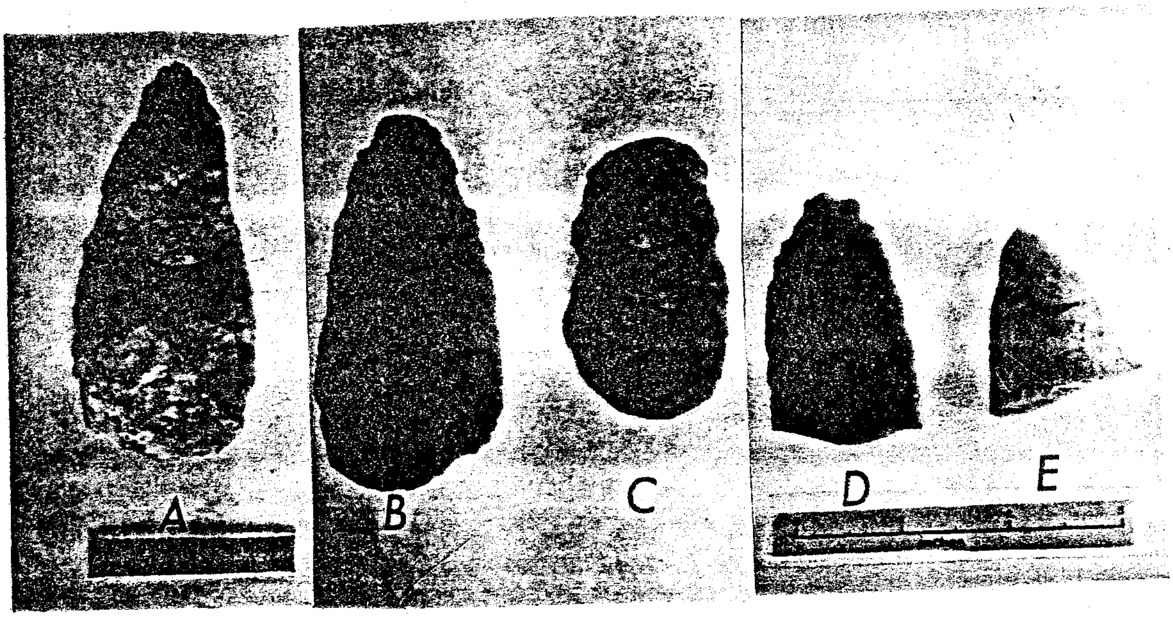


Plate 3. Large biface tools.
A. Pit 1, 70-80 cm, #2 chopper
B. Pit 1, 40-50 cm, #2 wedge
C. Pit 1, 20-30 cm, #7 hammer
D. Pit 1, 70-80 cm, #6 scraper
E. Pit 2, 70-80 cm, #8 scraper

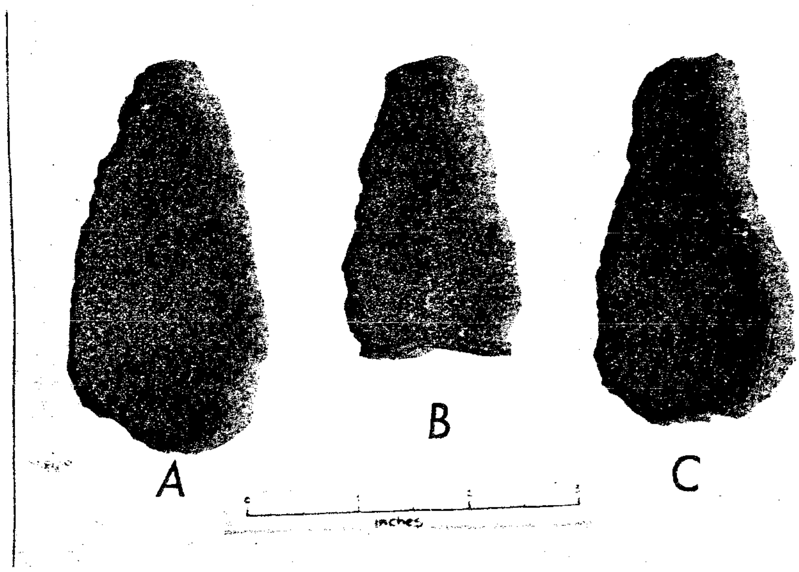


Plate 4. Celt preforms.
A. Pit 2, 60-70 cm, #2
B. Pit 1, 30-40 cm, #4
C. Pit 2, 120-130 cm, #1

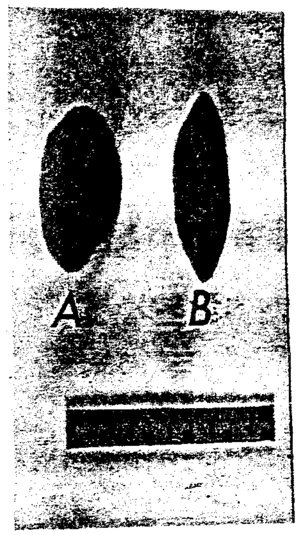
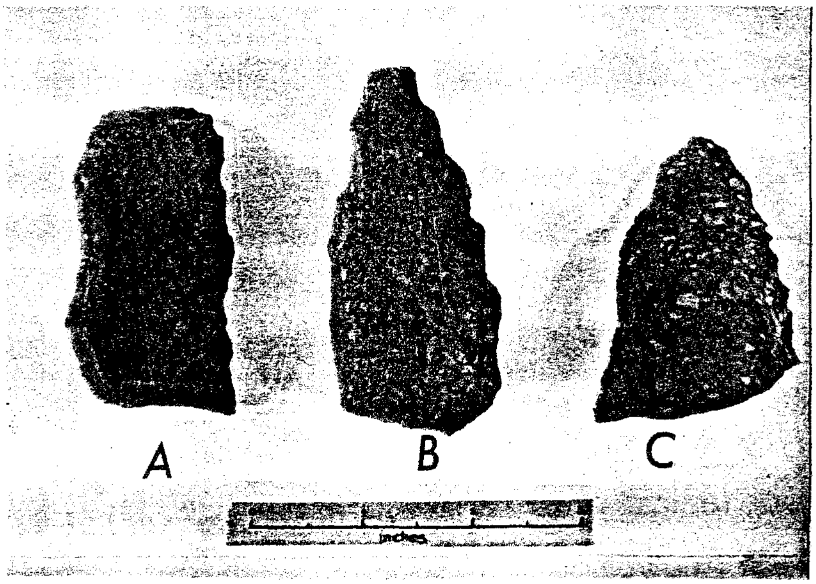


Plate 5. Celts. A. Pit 1, 70-80 cm, #5
B. Pit 1, 90-100 cm, #2



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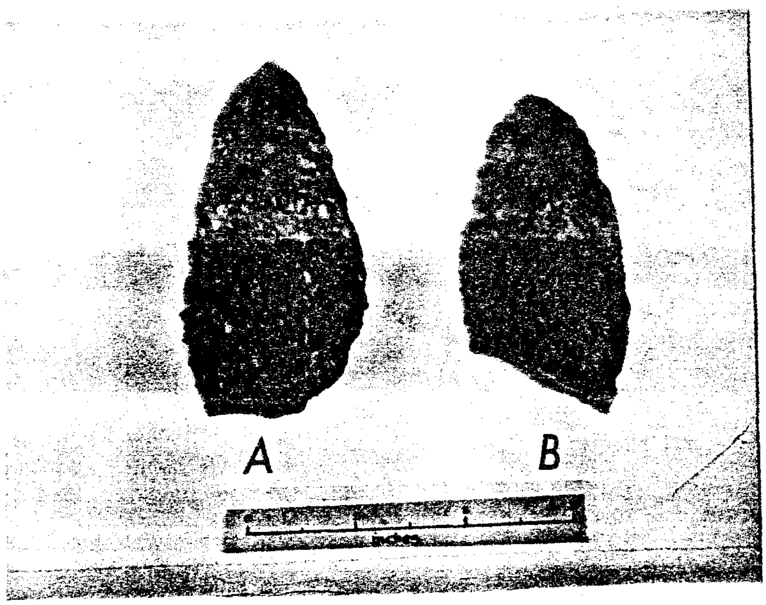


More reduced

Plate 6. Large long preforms. Top: A. Pit 1, 40-50 cm, #3
B. Pit 1, 30-40 cm, #3
C. Pit 1, 100-110 cm, #2
Bottom: A. Pit 1, 40-50 cm, #3
B. Pit 1, 40-50 cm, #5

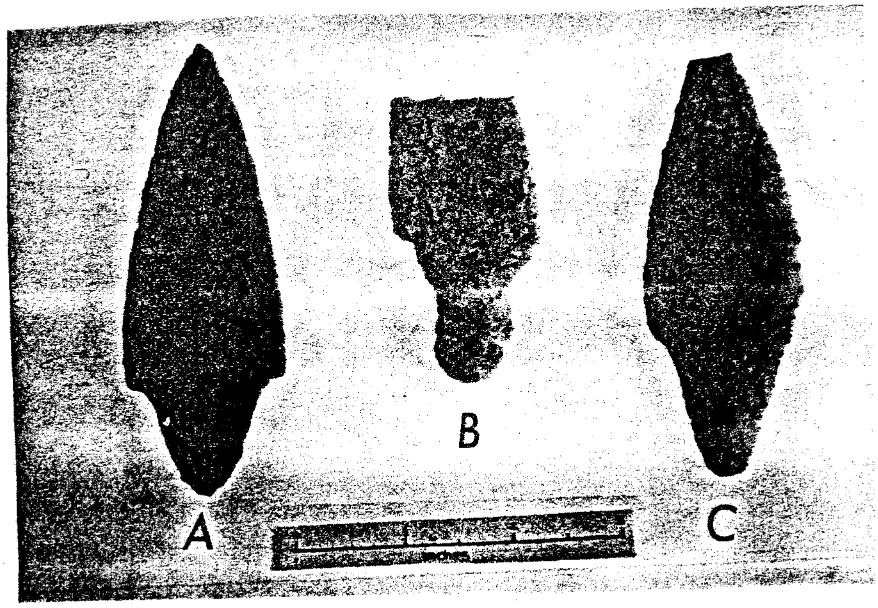


Plate 7. Large stemmed bifaces. A. Pit 1, 60-70 cm, #2
B. Pit 2, 70-80 cm, #5
C. Pit 2, 60-70 cm, #4

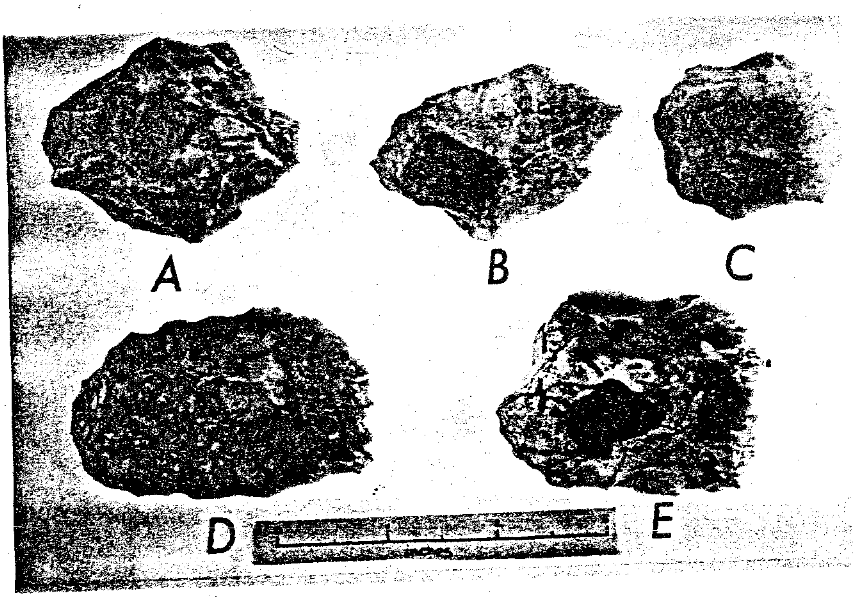
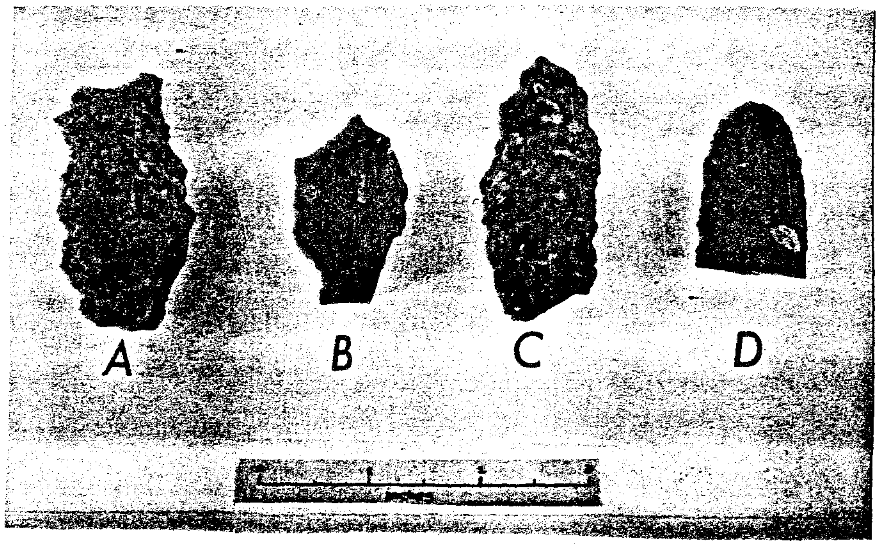


Plate 8. Small biface blanks. A. Pit 1, 70-80 cm, #1
B. Pit 2, 20-30 cm, #1
C. Pit 2, 70-80 cm, #1
D. Pit 1, 80-90 cm, #1
E. Pit 2, 50-60 cm, #4



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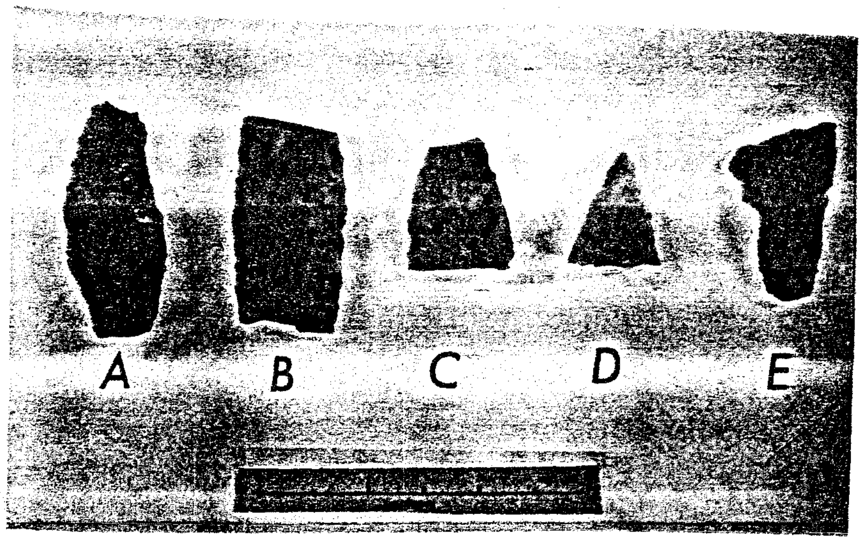


More reduced

Plate 9. Small long preforms. Top: A. Pit 2, 70-80 cm, #6
B. Pit 1, 30-40 cm, #6
C. Pit 2, 50-60 cm, #7
D. Pit 1, 30-40 cm, #7
Bottom: A. Pit 1, 110-120 cm, #1
B. Pit 1, 70-80 cm, #8
C. Pit 1, 110-120 cm, #2
D. Pit 2, 70-80 cm, #7
E. Pit 1, 30-40 cm, #11

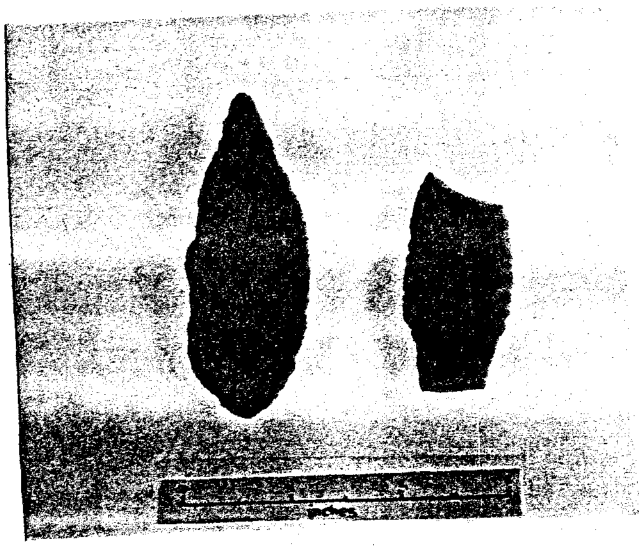


Plate 10. Small long bifaces. A. Pit 2, 50-60 cm, #6
B. Pit 2, 30-40 cm, #1

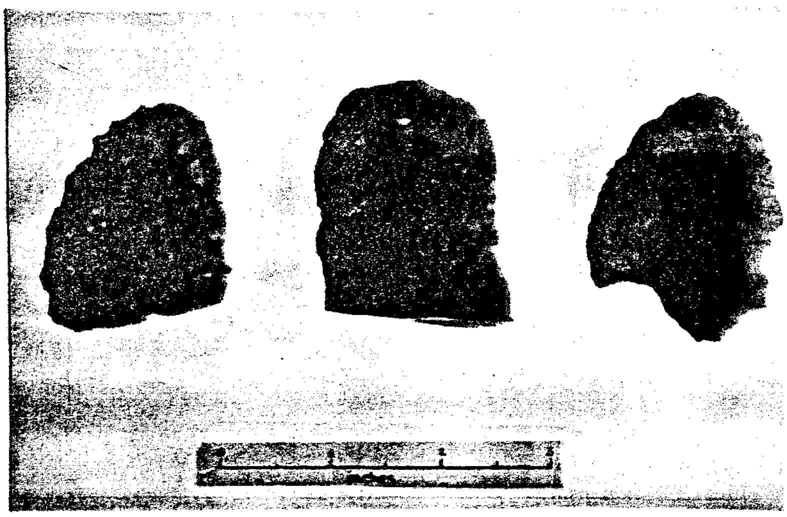
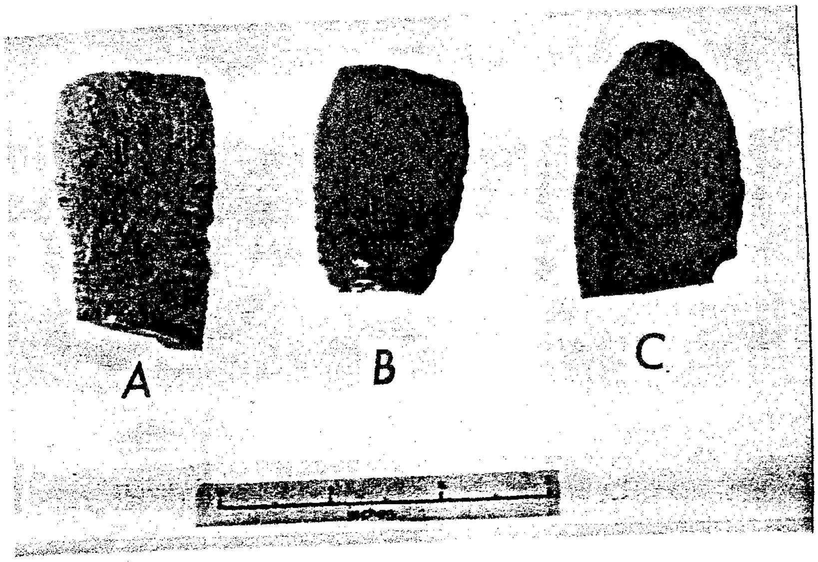
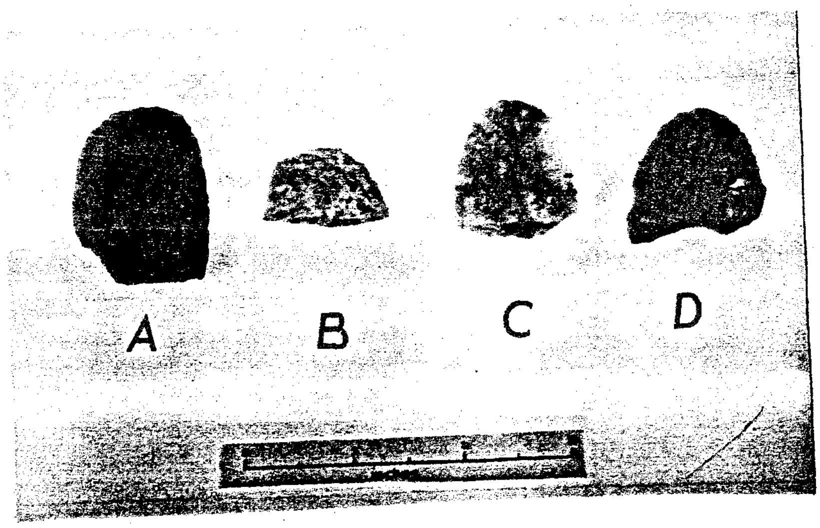


Plate 11. Ovoid to rectangular preforms. A. Pit 2, 80-90 cm, #2
B. Pit 2, 20-30 cm, #4
C. Pit 1, 60-70 cm, #1

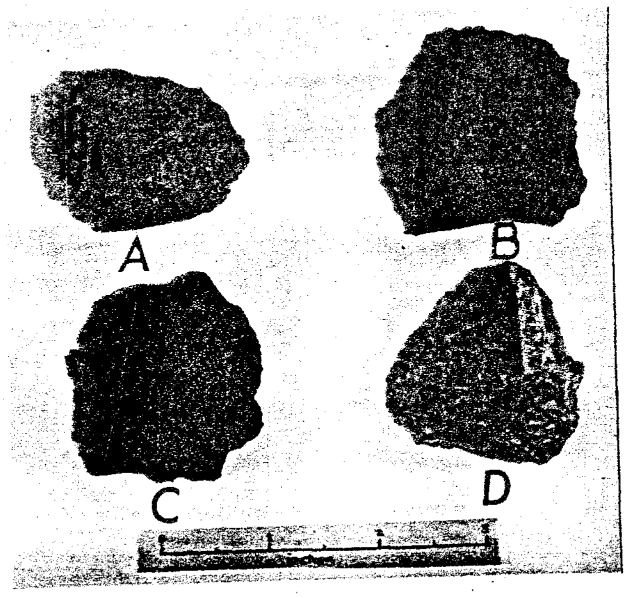


Large

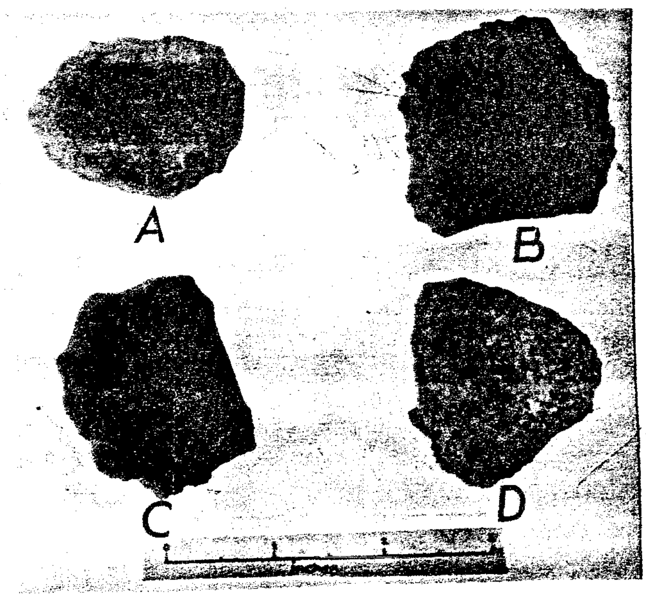


Small

Plate 12. Ovoid to rectangular bifaces. Top: A. Pit 2, 70-80 cm, #
B. Pit 2, 0-20 cm, #
C. Pit 1, 110-120 cm
D. Pit 2, 60-70 cm,
Bottom: A. Pit 1, 20-30 cm,
B. Pit 2, 40-50 cm,
C. Pit 2, 90-100 cm,



Dorsal surface



Ventral surface

Plate 13. Large flake blanks. Top & bottom: A. Pit 1, 20-30 cm, #2
B. Pit 1, 120-130 cm,
C. Pit 1, 70-80 cm, #3
D. Pit 2, 100-110 cm,

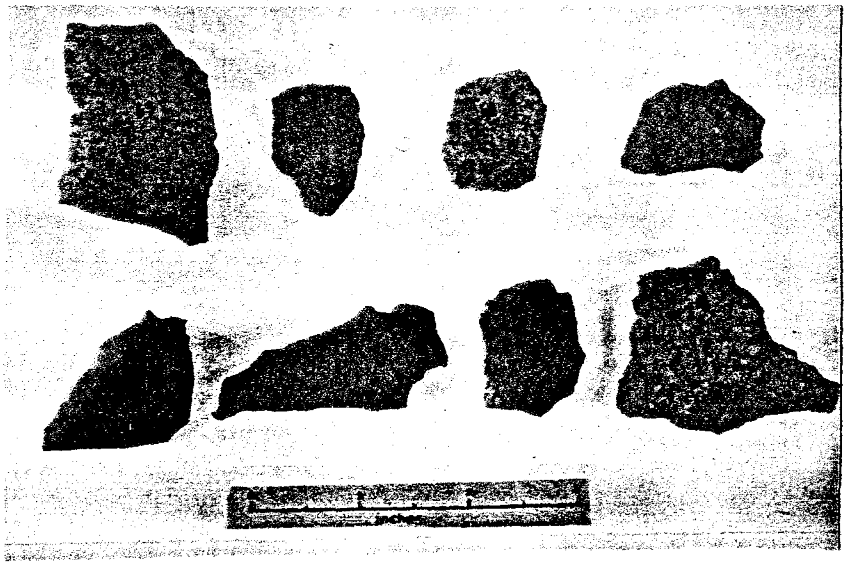


Plate 14. Primary reduction flakes from Pit 1, 20-30 cm. Top row: parallel sided flakes, bottom row: non-parallel sided flakes. Platform at top.

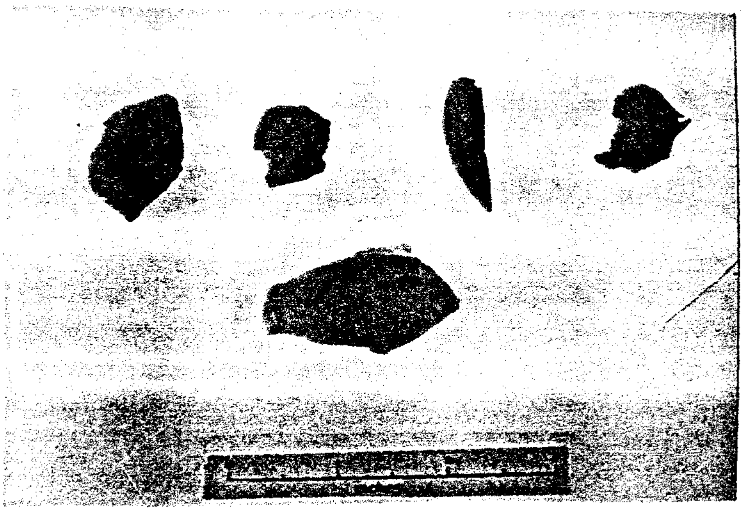


Plate 15. Large thinning flakes from Pit 1, 20-30 cm. Top row: parallel sided flakes, bottom row: non-parallel sided flakes. Platform at top.

Plate 16. Small thinning flakes from Pit 1, 20-30 cm. Top row: parallel sided flakes, bottom row: non-parallel sided flakes. Platform at top.

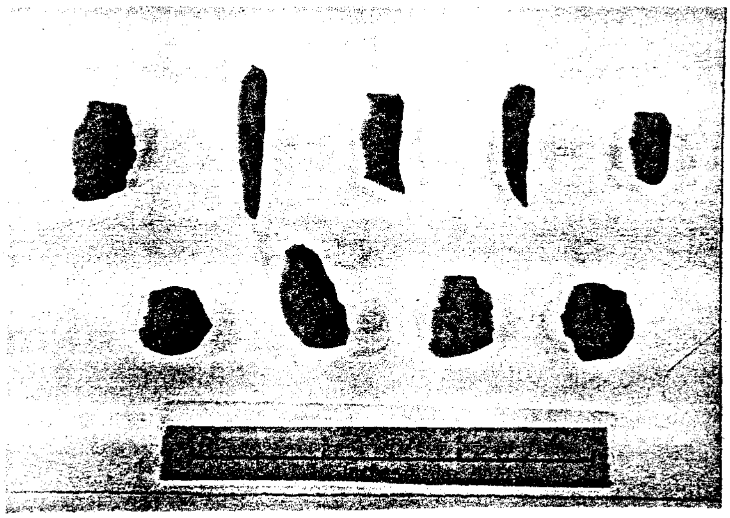


Plate 17. Final trimming flakes from Pit 1, 20-30 cm. Top row: parallel sided flakes, bottom row: non-parallel sided flakes. Platform at top.

A

B

Plate 18. Edge scarring. A. Pit 1, 100-110 cm, #2; 21x magnification
B. Pit 2, 30-40 cm, #1; 15x magnification

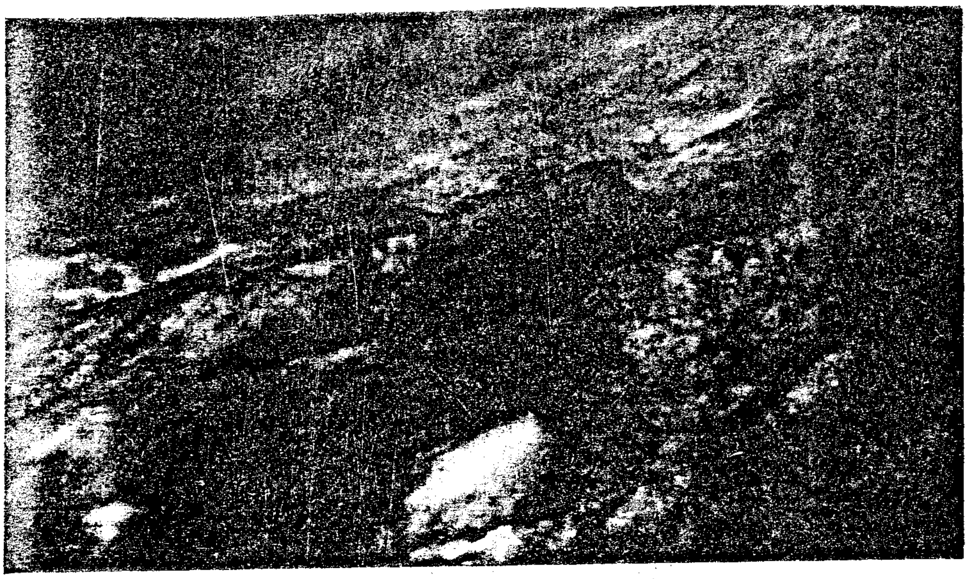


Plate 19. Edge attrition. A. Pit 2, 100-110, #35; 18x magnification

Plate 20. Edge battering. A. Pit 1, 20-30 cm, #7; 10x magnification

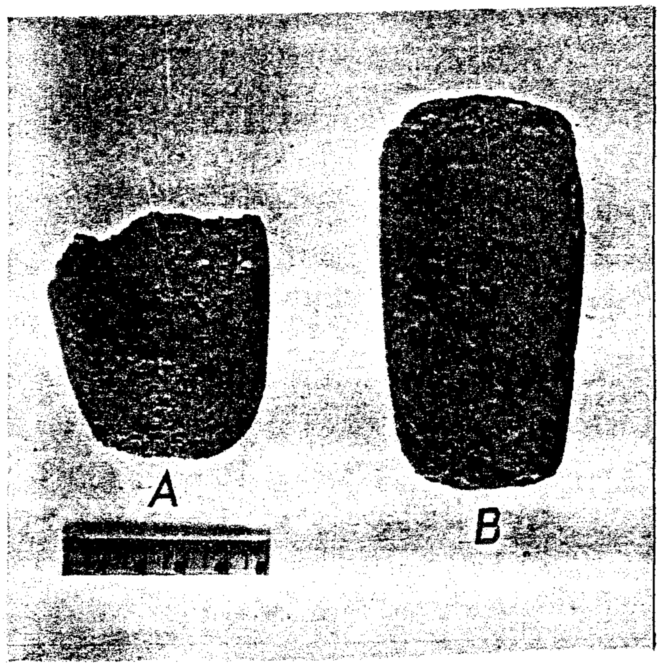


Plate 21. Mano fragments. A. Pit 1, 60-70 cm, #10
B. Pit 1, 50-60 cm, #20

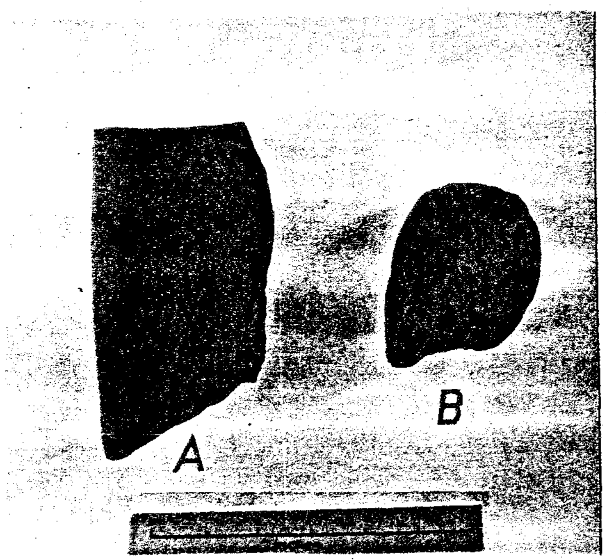


Plate 22. Sandstone implement (Pit 2, 20-30 cm, #13) and ochre (Pit 2, 90-100, #17)

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Appendix I. Cores, blanks, preforms, and tools: attributes

Unreduced cores

	(avg.)	(s̄)	(min.)	(max.)	(N)
Length:	74.8 mm	5.64 mm	64 mm	80 mm	5
Width:	64.2 mm	6.05 mm	55 mm	73 mm	5
Thickness:	48.4 mm	7.10 mm	38 mm	60 mm	5
# flake scars:	9.8	2.41	7	14	5
Longitudinal cross-section:		irregular - 2 triangular - 2 rectangular - 1			5
Transverse cross-section:		irregular - 3 trapezoidal - 1 biplano - 1			5
Percent cortex:	10%	12.65%	0%	30%	5
Material:	chert - 3 jasper - 2				5

Large biface blanks

	(avg.)	(s̄)	(min.)	(max.)	(N)
Length:	72.72 mm	9.8 mm	64 mm	84 mm	7
Width:	54.8 mm	4.95 mm	45 mm	65 mm	15
Thickness:	31.4 mm	3.96 mm	23 mm	39 mm	15
# flake scars:	10.73/11.4	3.42/3.43	7/4	18/17	15
Longitudinal cross-section:		biplano - 8 plano-triangular - 3 plano-convex - 1 biconvex - 2			15
Transverse cross-section:		biconvex - 3 convexo-triangular - 3 bitriangular - 3 assymetrically bitriangular - 4 plano-triangular - 2			15
Material:	chert - 14 basalt - 1				1

Consistency: fine - 6 15
medium fine - 5
medium coarse - 2
coarse - 2

Condition: whole - 7 15
fragmentary - 8

Small biface blanks

	(avg.)	($\bar{s}$)	(min.)	(max.)	(N)
Length:	53.56 mm	8 mm	44 mm	69 mm	9
Width:	42.77 mm	4.20 mm	35 mm	50 mm	17
Thickness:	24.82 mm	3.47 mm	24 mm	32 mm	17
# flake scars:	10.06/6.94	2.39/1.77	6/4	13/10	17

Longitudinal cross-section: biplano - 4 17
plano-triangular - 2
plano-convex - 3
biconvex - 2
asymmetrically bitriangular - 3
asymetrically biconvex - 1

Transverse cross-section: plano-triangular - 2 17
plano-convex - 2
bitriangular - 6
asymmetrically bitriangular - 2
convexo-triangular - 2
asymmetrically biconvex - 1
biconvex - 2

Condition: whole - 8 17
fragmentary - 9

Material: chert - 15 17
chalcedony - 1
petrified wood - 1

Consistency: fine - 12 17
medium fine - 5

Large flake blanks

	(avg.)	($\bar{s}$)	(min.)	(max.)	(N)
Length:	47.17 mm	9.59 mm	31 mm	77 mm	12
Width:	46.08 mm	7.1 mm	33 mm	57 mm	12
Thickness:	17.75 mm	4.68 mm	10 mm	24 mm	12
# flake scars:	6.66	2.77	3	11	12

Longitudinal cross-section:	concavo-convex - 2 biplano - 2 plano-triangular - 5 plano-convex - 1 bitriangular - 2	12
Transverse cross-section:	biplano - 2 plano-triangular - 4 plano-convex - 3 bitriangular - 1 convexo-triangular - 2	12
Material:	chert - 11 chalcedony - 1	12
Consistency:	fine - 8 medium fine - 3 medium coarse - 1 coarse - 1	12
Condition:	whole - 9 fragmentary - 3	12

Large flake tools - see Large flake blanks

Large biface tools

	(avg.)	($\bar{s}$)	(min.)	(max.)	(N)
Length:	84.3 mm	21.07 mm	64 mm	132 mm	10
Width:	52.36 mm	6.48 mm	41 mm	62 mm	14
Thickness:	26.57 mm	4.3 mm	23 mm	35 mm	14
# flake scars:	14.29/18	5.65/4.69	5/11	27/30	14

Longitudinal cross-section: biplano - 5 14
plano-triangular - 1
plano-convex - 6
convexo-triangular - 1
biconvex - 1

Transverse cross-section: plano-triangular - 5 15
plano-convex - 2
convexo-triangular - 4
bitriangular - 1
biconvex - 3

Form: triangular - 2 15
subtriangular - 4
subtriangular to ovoid - 2
subrectangular - 1
ovoid - 2
discoid - 2
irregular - 2

Condition: whole - 10 15
fragmentary - 5

Material: chert - 15

Consistency: fine - 9 15
medium fine - 5
medium coarse - 1

Large long preforms

Length: 88 mm (single specimen)

	(avg.)	($\bar{s}$)	(min.)	(max.)	(N)
Width:	40.2 mm	6.41 mm	31 mm	47 mm	10
Thickness:	20.17 mm	5.79 mm	13 mm	32 mm	12
# flake scars:	10.75/9.17	2.84/2.58	5/5	15/15	12

Longitudinal cross-section: biplano - 11 11

Transverse cross-section: biplano - 1 12
asymmetrically bitriangular - 3
bitriangular - 2
convexo-triangular - 1
plano-triangular - 2
biconvex - 3

Form: triangular - 4 11
subtriangular - 1
rectangular - 4
ovoid - 2

Condition: whole - 1 fragmentary - 11 12

Material: chert - 12 12

Consistency: fine - 10 medium fine - 2 12

Ovoid to rectangular preforms - large

Length: all fragmentary

	(avg.)	($\bar{s}$)	(min.)	(max.)	(N)
Width:	40.6 mm	4.59 mm	35 mm	45 mm	5
Thickness:	12 mm	2.45 mm	10 mm	15 mm	5
# flake scars:	16.8/13.4	4.58/2.87	11/9	23/17	5

Longitudinal cross-section: biplano - 5 5

Transverse cross-section: biconvex - 4 plano-convex - 2 5

Material: chert - 4 jasper - 1 5

Consistency: fine - 3 medium fine - 1 medium coarse - 1 5

Condition: fragmentary - 5

Ovoid to rectangular preforms - small

Length: 68 mm (single specimen)

	(avg.)	($\bar{s}$)	(min.)	(max.)	(N)
Width:	35.44 mm	2.83 mm	32 mm	42 mm	9
Thickness:	17.89 mm	2.77 mm	13 mm	23 mm	9
# flake scars:	10.75/7.67	2.86/3.17	6/3	18/15	12

Longitudinal cross-section: biplano - 10 plano-triangular - 1 11

Transverse cross-section: biconvex - 9 plano-convex - 2 convexo-triangular - 1 12

Form: ovoid - 11 12
subrectangular - 1

Condition: whole - 1 12
fragmentary - 11

Material: chert - 11 12
chalcedony - 1

Consistency: fine - 5 12
medium fine - 4
medium coarse - 3

Small long preforms

Length: 61 mm (single specimen)

Width:	(avg.) 30.33 mm	($\bar{s}$) 2.08 mm	(min.) 28 mm	(max.) 33 mm	(N) 3
Thickness:	18.67	1.91	16	20	3
# flake scars:	13/9.67	3.56/1.29	10/8	18/11	3

Longitudinal cross-section: biplano - 2 3
biconvex - 1

Transverse cross-section: bitriangular - 2 3
convexo-triangular - 1

Form: rectangular - 2 3
ovoid - 1

Condition: whole - 1 3
fragmentary - 2

Material: chert - 3 3

Consistency: fine - 3 3

Ovoid to rectangular biface tools - large

Length: all fragmentary

Width:	(avg.) 38.67 mm	($\bar{s}$) 2.05 mm	(min.) 36 mm	(max.) 41 mm	(N) 3
Thickness:	14 mm	2.16 mm	12 mm	17 mm	3
# flake scars:	27.33/22.67	2.87/1.25	24/21	31/24	3

Longitudinal cross-section: biplano - 2 biconvex - 1 — 3

Transverse cross-section: biconvex - 3 — 3

Form: ovoid - 1, rectangular - 1, subrectangular - 1 — 3

Condition: whole - 0, fragmentary - 3 — 3

Material: chert - 2, chert or petrified wood - 1 — 3

Consistency: fine - 3 — 3

Ovoid to rectangular tools - small

Length: all fragmentary

	(avg.)	(s̄)	(min.)	(max.)	(N)
Width:	27.4 mm	3.72 mm	22 mm	31 mm	5
Thickness:	9.4 mm	1.50 mm	8 mm	12 mm	5
# flake scars:	13/9.6	3.16/2.33	9/7	18/14	5

Longitudinal cross-section: biplano - 5 — 5

Transverse cross-section: biconvex - 5 — 5

Form: ovoid - 5 — 5

Condition: whole - 0, fragmentary - 5 — 5

Material: chert - 5 — 5

Consistency: fine - 5 — 5

Small long biface tools

Length: 56 mm (single specimen)

	(avg.)	(s̄)	(min.)	(max.)	(N)
Width:	25.83 mm	4.3 mm	23 mm	35 mm	6
Thickness:	10.92 mm	4.03 mm	6 mm	20 mm	12
# flake scars:	13.22/10.67	3.59/3.61	8/6	18/17	9

Longitudinal cross-section: biplano - 11 12
biconvex - 1

Transverse cross-section: biconvex - 6 12
plano-convex - 2
convexo-triangular - 2
bitriangular - 1
plano-triangular - 1

Form: ovoid - 2 7
rectangular - 2
subtriangular - 3

Condition: whole - 1 12
fragmentary - 11

Material: chert - 12 12

Consistency: fine - 11 12
medium fine - 1

Celt preforms

	(avg.)	(s̄)	(min.)	(max.)	(N)
Length:	88 mm	4 mm	84 mm	92 mm	2
Width:	45 mm	2.83 mm	41 mm	47 mm	3
Thickness:	23.75 mm	5.17 mm	15 mm	28 mm	4
# flake scars:	17.25	1	17	18	3

Longitudinal cross-section: biplano - 3 3

Transverse cross-section: plano-triangular - 1 4
asymmetrically bitriangular - 1
convexo-triangular - 1
biconvex - 1

Form: ovoid to subtriangular - 3 3

Condition: whole - 2 4
fragmentary - 2

Material: basalt - 4 4

Consistency: fine - 3 4
medium fine - 1

<u>Large stemmed biface tools</u>

	(avg.)	($\bar{s}$)	(min.)	(max.)	(N)
Length:	93.33 mm	18.66 mm	67 mm	108 mm	3
Width:	37.16 mm	4.43 mm	31 mm	41 mm	6
Thickness:	11.1 mm	1.5 mm	9 mm	14 mm	1
# flake scars	20.4/17.3	13.91/12.97	9/6	16/49	1

Longitudinal cross-section: biplano - 10 — 1

Transverse cross-section: biconvex - 8 — 1
plano-convex - 1
convexo-triangular - 1

Form: tip - 3 — 1
midsection - 3
stem and base - 1
whole - 3

Condition: whole - 3 — 1
fragmentary - 7

Material: chert - 8 — 1
jasper - 2

Consistency: fine - 9 — 1
medium fine - 1

<u>Celts</u>

Dimensions: all fragmentary

Longitudinal cross-section: indeterminate

Transverse cross-section: biplano - 2 — 2

Form: ovoid - 2 — 2

Condition: fragmentary - 2 — 2

Material: basalt - 2 — 2

Consistency: fine - 2 — 2

Appendix II. Complete Unmodified Flakes: Attributes

$\bar{x}$ = mean
$\bar{s}$ = standard deviation

VARIABLE		FLAKE TYPE A (110 SPECIMENS)	FLAKE TYPE B (92 SPECIMENS)	FLAKE TYPE C (124 SPECIMENS)	FLAKE TYPE D (173 SPECIMENS)	COMBINED (499 SPECIMENS)
Material color	$\bar{x}$ =	2.191	2.054	2.258	2.157	2.1663
	$\bar{s}$ =	1.200	1.083	1.202	1.182	1.1747
	min. =	1.00	0.00	1.00	0.00	
	max. =	5.00	5.00	5.00	5.00	
Material consistency	$\bar{x}$ =	1.582	1.174	1.532	1.221	1.3667
	$\bar{s}$ =	.828	.547	0.850	.516	.7140
	min. =	1.00	0.00	1.00	0.00	
	max. =	4.00	4.00	5.00	4.00	
Flake length	$\bar{x}$ =	34.236	23.576	26.371	16.953	24.2906
	$\bar{s}$ =	11.296	8.519	7.972	5.216	10.4415
	min. =	12.00	10.00	12.00	2.00	
	max. =	75.00	80.00	46.00	33.00	
Flake width	$\bar{x}$ =	29.90	22.120	18.403	13.442	19.8758
	s =	9.289	9.564	5.732	4.349	9.4323
	min. =	10.00	9.00	9.00	1.00	
	max. =	66.00	90.00	37.00	29.00	
Flake thickness	$\bar{x}$ =	7.518	6.228	3.935	2.773	4.7395
	$\bar{s}$ =	3.616	4.472	1.330	1.071	3.3173
	min. =	2.00	2.00	2.00	0.00	
	max. =	19.00	30.00	8.00	7.00	
Ventral angle	$\bar{x}$ =	109.955	114.728	98.468	102.651	105.4729
	$\bar{s}$ =	12.859	25.957	14.513	15.148	18.7685
	min. =	60.00	50.00	40.00	11.00	
	max. =	145.00	175.00	130.00	135.00	

VARIABLE		FLAKE TYPE A (110 SPECIMENS)	FLAKE TYPE B (92 SPECIMENS)	FLAKE TYPE C (124 SPECIMENS)	FLAKE TYPE D (173 SPECIMENS)	COMBINED (499 SPECIMENS)
Lateral angle	$\bar{x}$ =	38.136	42.011	30.726	34.506	35.6814
	$\bar{s}$ =	29.357	66.996	27.935	30.673	39.2748
	min. =	-30.00	-45.00	-45.00	-30.00	
	max. =	120.00	175.00	105.00	140.00	
Platform length	$\bar{x}$ =	14.300	14.783	8.395	7.041	10.3908
	$\bar{s}$ =	6.674	11.516	3.549	3.485	7.2998
	min. =	3.00	4.00	2.00	0.00	
	max. =	48.00	90.00	19.00	25.00	
Platform width	$\bar{x}$ =	4.600	5.391	2.347	2.105	3.3166
	$\bar{s}$ =	2.689	5.191	1.243	1.170	3.0465
	min. =	1.00	1.00	1.00	0.00	
	max. =	19.00	40.00	8.00	9.00	
Platform preparation: grinding	$\bar{x}$ =	1.064	.424	.871	.541	.7154
	$\bar{s}$ =	1.315	.892	1.175	.963	1.1154
	min. =	0.00	0.00	0.00	0.00	
	max. =	3.00	3.00	3.00	3.00	
Platform preparation: crushing	$\bar{x}$ =	0.255	0.141	.605	.221	.3086
	$\bar{s}$ =	0.710	0.482	1.096	.656	.7921
	min. =	0.00	0.00	0.00	0.00	
	max. =	3.00	3.00	3.00	3.00	
Platform preparation: faceting	$\bar{x}$ =	0.509	0.435	.629	.355	.4709
	$\bar{s}$ =	0.906	0.789	1.047	.715	.8670
	min. =	0.00	0.00	0.00	0.00	
	max. =	3.00	3.00	4.00	3.00	
Percent cortex	$\bar{x}$ =	2.782	0.978	.326	.640	1.0942
	$\bar{s}$ =	11.036	6.123	3.171	4.701	6.6659
	min. =	0.00	0.00	0.00	0.00	
	max. =	75.00	50.00	35.00	50.00	

VARIABLE	FLAKE TYPE A (110 SPECIMENS)	FLAKE TYPE B (92 SPECIMENS)	FLAKE TYPE C (124 SPECIMENS)	FLAKE TYPE D (173 SPECIMENS)	COMBINED (499 SPECIMENS)
Number Dorsal Flakes Scars	$\bar{x}$ = 4.218	2.826	4.218	2.727	3.4389
	s = 1.480	0.945	1.666	.810	1.3254
	min. = 1.00	0.00	0.00	0.00	
	max. = 8.00	5.00	9.00	5.00	
Index of parallelicity	$\bar{x}$ =-0.050	0.162	-0.036	-0.073	-0.0118
	s = 0.704	0.678	0.544	.660	0.6457
	min. =-3.50	-1.800	-2.600	-3.200	
	max. = 1.40	2.200	1.900	1.900	
Width ratio	$\bar{x}$ = 1.708	3.947	1.483	1.990	2.1587
	$\bar{s}$ = 0.684	6.330	.765	1.804	3.0750
	min. = 0.00	0.00	0.00	0.00	
	max. = 3.70	34.00	5.80	15.00	

Appendix III. Flake tools: attributes

Length:	(min.) 15 mm;	(max.) 67 mm;	(avg.) 28 mm;	$\bar{s}$ = 10.6 mm
Width:	11 mm	54 mm	24.5 mm	8.3 mm
Thickness:	3 mm	15 mm	7.5 mm	2.8 mm

Ventral angle: (min.) 40°; (max.) 140°; (avg.) 102.5°; $\bar{s}$ = 15.6°

Dorsal flake scars: (min.) 2; (max.) 8; (avg.) 5; $\bar{s}$ = 1.7

Platform preparation: not applicable - 11 (21%)
none - 23 (43%)
crushing - 8 (15%)
faceting - 5 (9%)
grinding - 6 (11%)

Condition: whole - 40 (75%)
fragmentary - 13 (25%)

Cortex: absent - 47 (88%)
on platform - 2 (4%)
on dorsal surface - 3 (6%)
on distal end - 1 (2%)

Retouch: none - 54 (53%); 26 analyzed, 28 not analyzed
unifacial - 1; analyzed
bifacial - 46 (47%); 25 analyzed, 21 not analyzed
unifacial and bifacial - 1; analyzed

Total: 102; 53 analyzed

Appendix IV. Resharpening flakes: attributes

Non-celt resharpening flakes:

Length:	(min.) 10 mm;	(max.) 47 mm;	(avg.) 23 mm;	$\bar{s}$ = 9 mm
Width:	9 mm	45 mm	24 mm	9.5 mm
Thickness:	2 mm	14 mm	7 mm	3 mm

Ventral angle: (min.) 80°; (max.) 140°; (avg.) 112°; $\bar{s}$ = 14°

Dorsal flake scars: (min.) 2; (max.) 10; (avg.) 5; $\bar{s}$ = 2

Condition: whole - 40 (83%)
fragmentary - 8 (17%)

Total: 48, all analyzed

Celt resharpening flakes:

Length: all fragmentary

Width: all fragmentary

Thickness: all fragmentary

Ventral angle: all fragmentary

Dorsal flake scars: none (all ground) - 27 (53%)
(partially ground dorsal surface) - 18 (35%)
(unground dorsal surface) - 6 (12%)

Condition: all fragmentary

Total: 51, all analyzed

Appendix V. Residual core and tool fragments: attributes

Core Fragments

cm.	mm.	
Pit 1, 30-40, #31	48x30x19	fine white to pink chert
2, 140-150, #1	43x35x30	fine yellow jasper - bifacial battering on one side
2, 50-60, #3	66x38x25	fine white chert - bifacial scarring on edges
2, 90-100, #7	52x32x37	fine white chert - bifacial scarring on 1 edge
1, 30-40, #34	50x31x25	fine red chert with cortex
2, 100-110, #32	42x31x26	fine pink chert with cortex
2, 50-60, #32	45x38x19	fine red with white chert
2, 60-70, #7	37x27x25	fine red chert with unifacial scarring
1, 70-80, #4	46x30x16	fine brown chert, bifacially flaked
2, 110-120, #40	37x30x17	green amphibolite, bifacially flaked
2, 0-20, #7	35x20x15	fine red with white chert, bifacially flaked
1, 70-80, #33	35x20x11	fine red chert, bifacially flaked
2, 40-50, #7	45x45x20	fine red chert, bifacially flaked
1, 90-100, #9	61x30x17	fine white chert
2, 40-50, #2	62x38x20	fine white chert
2, 50-60, #23	29x10x6	fine red chert, bifacially flaked
1, 30-40, #30	61x16x14	fine yellow chert, bifacially flaked
1, 100-110, #35	46x13x8	fine yellow chert, bifacially flaked
1, 110-120, #13	23x24x14	fine grey-white chert, unifacially flaked
2, 50-60, #14	39x21x13	red and yellow jasper, fine
1, 30-40, #24	24x22x8	fine white chert, bifacially flaked
1, 0-20, #11	22x21x15	fine yellow jasper or petrified wood, unifacially flaked

Core Fragments

cm.	mm.	
Pit 1, 0-20, #4	43x30x27	fine red chert
1, 130-140, #5	44x24x18	fine white chert - battered and bifacially scarred edges
1, 100-110, #38	38x26x15	fine yellow and white chert with cortex
2, 70-80, #29	45x28x16	medium fine purple chert, unifacially flaked
2, 120-130, #3	26x28x15	fine white chert, bifacially flaked
1, 80-90, #5	34x25x10	fine red chert
1, 60-70, #9	42x30x23	fine white chert
1, 100-110, #40	44x43x22	fine white chert with cortex
1, 20-30, #24	47x34x22	fine pink and red chert
1, 100-110, #39	31x35x37	fine white chert
2, 110-120, #	59x47x22	medium fine banded yellow and white chert
2, 100-110, #33	53x26x23	fine white chert
2, 90-100, #6	39x36x22	fine yellow and white mottled chert
1, 80-90, #7	35x36x15	fine red, green, and white mottled chert
1, 20-30, #25	32x28x16	fine red with white chert
1, 130-140, #2	55x24x14	fine yellow and red chert with heavy unifacial scarring
1, 70-80, #23	31x25x13	fine red chert or jasper, bifacially flaked, heated
1, 30-40, #35	42x22x16	fine red with white chert, battered ridge
1, 50-60, #19	43x30x28	fine white, red banded petrified wood, battered ridges
2, 110-120, #4	51x20x15	fine red and white chert, bifacially flaked
1, 20-30, #23	56x33x20	fine yellow chert, bifacially flaked
2, 60-70, #13	26x14x8	fine red and pink chert
1, 50-60,	9x8x4	fine red chert

Core Fragments

cm.	mm.	
Pit 1, 70-80, #21	57x39x20	granite or basalt, unflakeable
1, 130-140, #3	35x34x18	medium coarse grey chert
1, 50-60, #18	33x33x20	medium coarse grey and pink chert
2, 0-20, #6	26x13x9	medium coarse grey chert
2, 0-20, #4	16x7x6	fine red chert
1, 30-40, #16	21x8x5	fine red chert
1, 0-20, #8	10x8x6	fine red chert
1, 70-80, #18	34x26x13	medium fine red chert
1, 130-140, #4	34x22x18	fine yellow and red chert
1, 40-50, #24	36x36x20	fine white chert, bifacially flaked
2, 100-110, #6	48x35x17	yellowish red and yellow fine chert
1, 30-40, #26	30x26x12	fine red with white chert, bifacially flaked
1, 70-80, #19	46x34x27	fine greenish-grey to black chert with bifacially scarred edge
1, 70-80, #26	85x40x28	fine greenish-grey to black chert with cortex
2, 20-30, #12	79x36x28	medium coarse red chert with unifacially scarred edge
2, 50-60, #28	55x33x2	fine white chert
1, 120-130, #2	35x26x21	fine yellow-brown jasper or chert
1, 70-80, #31	34x27x13	half basalt, half green chert (?), fine, with heavy unifacial wear on chert edges.

Flake fragments

Pit 1, 70-80, #11	37x30x13	fine red chert, primary flake
2, 50-60, #19	18x6x1	fine white chert
1, 100-110, #7	12x21x6	medium fine grey basalt

Flake Fragments

	cm.	
Pit 1, 0-20, #6	17x13x5	fine red chert with unifacial retouch and bifacial use
1, 0-20, #9	21x9x3	fine brown and yellow chert or jasper
1, 30-40, #33	41x35x10	fine white with yellow chert
2, 120-130, #6	27x21x7	fine dark red chert, heated
2, 140-150, #5	34x32x8	fine red chert, heated
2, 100-110, #29	15x9x5	fine red chert
2, 90-100, #9	38x26x13	fine yellow and grey mottled chert with unifacial flaking
2, 60-70, #10	52x18x16	fine dark red chert
2, 20-30, #9	67x25x10	medium fine yellow jasper
1, 110-120, #16	38x26x10	fine red chert with bifacial flaking
1, 100-110, #36	27x23x7	fine red chert with bifacial flaking
2, 50-60, #3	31x17x9	fine white chert with bifacial flaking
1, 70-80, #14	29x20x7	fine white chert with unifacial flaking
1, 90-100, #4	35x19x9	fine white chert
1, 110-120, #15	36x15x13	fine pink chert
1, 20-30, #19	26x22x8	fine white chert with bifacial flaking
1, 40-50, #19	35x16x7	fine white chert
1, 40-50, #18	31x15x6	fine purple and white chert with unifacial flaking
1, 60-70, #6	23x10x10	fine red chert
1, 100-110, #24	27x9x4	medium fine white chert with bifacial flaking
1, 20-30, #13	15x13x6	fine red chert
1, 90-100, #6	21x15x8	fine red chert
1, 100-110, #22	26x15x9	fine red chert
1, 40-50, #10	26x13x6	fine red chert

Flake Fragments

cm.	mm.	
Pit 1, 30-40, #14	17x9x5	fine red chert with unifacial flaking
1, 20-30, #11	14x7x6	fine red chert
1, 20-30, #12	14x9x6	fine pink chert
1, 110-120, #10	22x14x7	fine white chert

Waterworn Flake Fragments

Pit 2, 0-20, #5	19x15x2	fine white chert
2, 80-90, #6	14x11x4	fine pink and white chert
2, 50-60, #21	11x10x3	fine pink chert
2, 80-90, #7	24x18x6	fine yellow and brown chert
2, 90-100, #15	18x6x3	fine white chert
2, 30-40, #9	12x13x3	fine white chert
2, 30-40, #6	20x8x2	fine white chert
2, 60-70, #9	16x15x8	fine white chert

Biface Point Fragments

Pit 1, 20-30, #21	12x13x5	tip, fine white chert, medium fine retouc
2, 50-60, #33	23x19x8	tip, medium fine red chert, no final trimming
2, 100-110, #23	12x17x9	midsection, fine red chert, medium fine retouch, heated
2, 60-70, #15	12x13x6	tip, fine white chert, medium fine re-touch, heated
2, 30-40, #3	21x10x6	tip, fine yellow and brown jasper, no final retouch, slight drill or knife use

Appendix VI. Ground stone: attributes

Metates

Material: basalt - 6 (100%)

Condition: all fragmentary

Specimen No.:

Pit 1, 90-100 cm, #8	One smooth surface; no striations; flat; heavily corroded.
Pit 1, 120-130 cm, #3	One smooth surface; light parallel striations; flat; moderately corroded.
Pit 1, 120-130 cm, #4	Two smooth surfaces; moderate parallel striations on both sides; flat; moderately corroded. Corner of metate, rounded.
Pit 1, 70-80 cm, #22	One smooth surface; light parallel striations; slightly concave; none or slight corrosion.
Pit 1, 60-70 cm, #11	Two smooth surfaces, deep parallel striations on both surfaces; one flat, one slightly concave; none or slight corrosion.
Pit 1, 70-80 cm, #15	One smooth surface; moderate parallel striations; flat; heavily corroded.

Manos

Material: basalt - 3 (100%)

Condition: all fragmentary

Specimen No.:

Pit 1, 60-70 cm, #10	Midsection; very smooth; no striations evident; heavy corrosion; 52 mm diameter.
Pit 1, 50-60 cm, #20	Midsection or endpiece; diagonal striations; heavy corrosion; 49 mm diameter at end; 42 mm diameter in middle.
Pit 2, 70-80 cm, #3	Midsection or endpiece; no wear evidence; heavy corrosion; 54 mm diameter.

Miscellaneous

Pit 2, 20-30 cm, #13	Sandstone bar; 43 mm wide, 23 mm thick, undetermined length; very fine grain, red to yellow; transverse parallel striations on wide sides, longitudinal parallel striations on narrow sides (fewer but deeper).
Pit 2, 90-100 cm, #17	Ochre, yellow with red unworn surfaces; two large worn surfaces: a) oblique concave, very smooth without striations b) shortened by surface a, several deep sets of scratches made on separate occasions, flat to convex, slightly faceted surface.