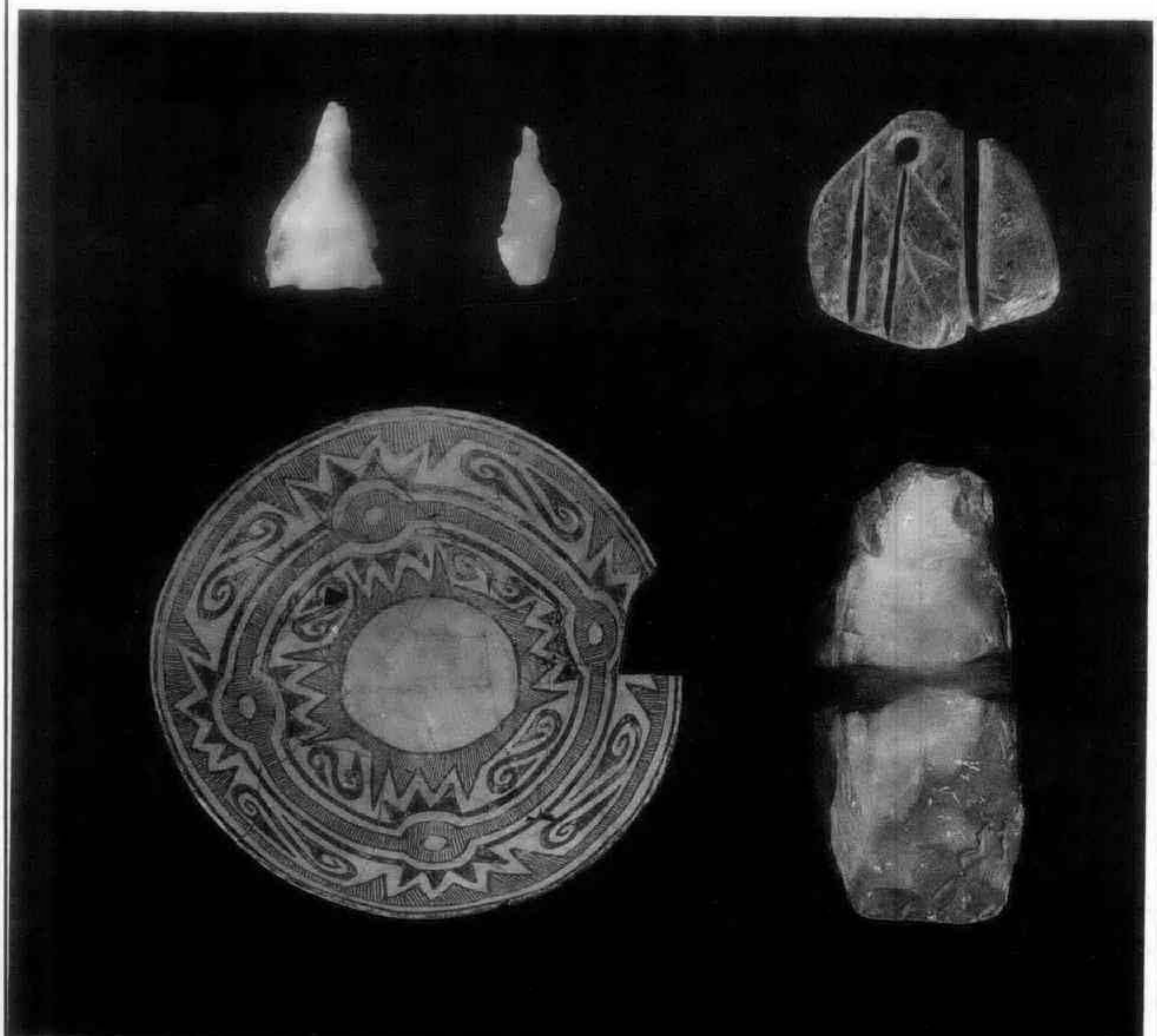
Ceramics, Lithics, and Ornaments of

Chaco Canyon



Ceramics, Lithics, and Ornaments of

Chaco Canyon

Analyses of Artifacts from the Chaco Project 1971-1978

Volume III. Lithics and Ornaments

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Chapter Six

A Preliminary Analysis of Hammerstones From Chaco Canyon, New Mexico

W. H. Wills

Experience......has shown that time spent in the meticulous weighing, measuring, and classifying of hammers, for the most part, is time lost. E. Haury

Preface

This analysis was done as an undergraduate research project in 1976, supervised by W. James Judge. In the nearly twenty years since the analysis was completed, hammerstones remain largely ignored in Southwestern lithic studies, and this is perhaps the way it should be. Hammerstones are such generalized tools that their relevance to explanatory models is probably minor in most cases since functional interpretations tend to be extremely ambiguous (Dodd 1979). At Chaco, however, there are temporal patterns in hammerstone material selection that are interesting and point to some sort of shift in functional requirements for hammers. I am inclined to think that increased use of petrified wood through time was linked to flaked stone production but there was no way to assess this idea in the original analysis. I hope in the future that a more thorough consideration of hammerstones at Chaco will build on this preliminary work.

Introduction

Hammerstones must surely rate as one of the least studied of archeological remains. Unlike ceramics or projectile points, hammerstones do not lend themselves to easily constructed typologies or functional classes being, to paraphrase several authors, made from any available tough stone. Yet, as almost all Southwestern archeologists note, hammerstones are among the most common and expected artifacts to be recovered during any excavation. The lack of attention these tools have received seems to be related to an accepted rule of thumb that hammerstones are too general in nature to be worth studying; i.e., they were used for just about any manner of percussion and made of whatever sort of rock happened to be available at the time (Judd 1954:177).

The major thesis of this chapter is that hammerstones, at least in Chaco Canyon, cannot be tossed off so lightly. They convey a wide variety of meanings for the researcher patient enough to seek them.

As the title suggests, this paper is only an initial summary of analysis undertaken in 1977. Its main purpose is to elucidate the types of problems that need answers, to define specific characteristics to be studied in seeking these answers, and to present the methodology and justification for the way in which such answers are sought. In this regard, this paper is tediously long and burdened by graphics. I hope that the mundane detail herein will preclude its presentation in the final report and that this will allow a concentration on the more important questions which were not possible in this report.

The remainder of the chapter is comprised of various analytical results produced in the hammerstone study. Before proceeding to that, we must first define the term, "hammerstone." The definition employed here is broadly functional; a hammerstone is a modified or unmodified piece of stone showing evidence of percussion; i.e., presence of crushing (c.f. Judge 1973:2). This is the implicitly accepted archeological definition and it will be noted, includes both original hammerstones and other tools reutilized as hammers.

A total of 813 hammerstones were included in the study although, as it turns out, not all of these were hammers. Each hammerstone counts as one statistical case and with the exception of site 29SJ 627, all sites were 100 percent sampled. Specimens from 29SJ 627 included all floor/floor fill/sub-floor hammerstones plus a rough grab assortment of other proveniences. Table 6.1 gives counts per site.

Table 6.1. Sites from which hammerstones were analyzed.

Site Number	Number Present	Number Analyzed
29SJ 423	41	41
29SJ 299	30	30
29SJ 721	1	1
29SJ 628	58	58
29SJ 724	16	16
29SJ 629	272	272
29SJ 1360	80	80
29SJ 627	535	140
29SJ 389	176	176

Variables

The variables monitored in the analysis were selected on the basis of their hoped-for relevance in providing information pertinent to the solution of several specific research problems. These problems can be subsumed under the rather broad categories of technology, resource location and variability. They are as follows:

1) Are there different kinds of hammerstones?
2) Do functional differences exist among hammerstones?
3) Where was hammerstone material procured?
4) Is there temporal variation among sites?
5) Are there intrasite spatial differentiations?

The variables described below were considered meaningful in approaching these questions. This assumption is both a mixture of intuition and experience. All derivation of relevant data is dependent upon the researchers' feelings as to what is useful in solving their specific problem and, in this particular case, it is assumed that a hammerstone is a tool and the best way to discover the meaning behind it, as such, is a consideration of its functional attributes; i.e., material type, morphology, wear patterns, etc. No further justification should be necessary with respect to criteria of variable selection, but it should be noted that a different variable assemblage (e.g., color, luster, texture) might well support different interpretations. The variables chosen here are thought to be the best in terms of answering (however inadequately) the questions outlined above.

The variables are:

1) Weight. Weight was measured to the nearest 0.1g on a Dial-O-Gram scale.

2) Material Type. Material type was determined in accordance with Helene Warren's (1967) four digit lithic code. During later stages of the analysis, the specific types were at times combined into four groups: petrified wood, chert, sandstone, and quartzite.

3) Parent State. This variable represents a classification of various possible original or initial forms from which the hammerstone was derived. The values are: 1) cobble, 2) tabular, 3) petrified wood, 4) other, and 5) unknown. Tabular was taken to mean forms having two or more flat sides as a result of natural sedimentary or crystallization processes. The value "other" was employed when the parent state of the hammerstone was recognizable but could not be entered in any of the first three values.

4) Cortex. A working definition of cortex was taken to be the surface of the material exhibiting weathering. Occurrences of "false cortex," such as is often seen on petrified wood, was considered to be cortex and entered as such.

5) Technology of Manufacture. This variable refers to whether or not the initial form of the hammerstone had been altered. The values are: 1) shaped by flaking, 2) shaped by other, and 3) not shaped. In a number of cases, it was not possible to

attribute flake scars to human behavior; i.e., the possibility of natural action seemed equally warranted. In these instances, the value shaped by flaking was entered. The second value, shaped by other, refers to alteration of the original form not caused by flaking. If these two values were present on the same artifact, the predominant one was selected.

6) Morphology. Morphology is simply a generalized category designed to take into account a number of dimensions contributing to form without monitoring a large number of dimensional variables. The values are: 1) angular, 2) spheroidal, 3) discoidal, and 4) slab. Angularity was, in general, defined operationally as the presence of an edge. Cases where this did not hold true were in the recognition of the discoidal and slab values which could also possess edges but in distinctive configurations. Perhaps a clear definition of angularity might be obtained if we say that it is characterized by edges which are irregular and do not contribute to the definition of a regular, specific morphological type. Spheroids were more or less round.

7) Wear. Four categories of wear were distinguished: abrasion, battering, step fracture, and other. Combinations of these categories were also recognized. In assigning causation to the wear patterns observed, it was assumed that abrasion could be identified by the presence of striations and battering by a characteristic shattered and pitted surface. In the actual analysis, however, such distinctions were difficult to make. In most cases, abrasion of petrified wood was fairly easy to recognize, but in the case of quartzite, the differentiation between abrasion and extensive battering was not often easy, especially when the wear occurred on edges. Wear patterns on quartzite are very difficult to distinguish and polish rather than striation seems to be more common to this material when abraded (Toll 1976:1-39). Consequently, abrasion was often entered if the wear observed was present at edge locations not easily accessible to battering, i.e., the lateral sides. Planed-down surfaces and, of course, striae, when present, were also considered indicative of abrasion. This may well be the weakest portion of the analysis in that misinterpretation is certainly not uncommon. Nevertheless, the analysis should be internally consistent since conceptions of what constituted a particular type of wear did not change substantially during the analysis.

8-10) Degree of Wear. This variable monitored the amount of specific wear types present as a percentage of the total wear observed. For example, if battering and step fracture had been noted in equal proportions, they would have been entered as 50 percent battering and 50 percent step fracture.

11) Function. Each artifact examined was assigned a subjective function based upon the analyst's conception of the type of tool it represented. The values are: 1) abrader, 2) hammer, 3) masonry, 4) chopper, 5) manuport, 6) unknown, and 7) core. In general, abraders exhibited more abrasion than other wear types; hammers were thought to be characterized by battering and step fracture; masonry was assigned (usually) to those specimens characterized by greater relative weight, extreme battering and rounded morphology. Choppers were dependent upon flaking and steepness of edge angle; the steeper the angle the more likely to be a chopper. Often an artifact appeared to have been a chopper that had been exhausted and was subsequently used as a hammer. In these cases, the latest function was assigned. The values of unknown and core are fairly self-explanatory. Manuports are imported (to the site) items which do not exhibit signs of wear; they are not common.

The hammerstone analysis form (Appendix 6A) summarizes the coding system used for this study.

Classification

One of the questions for which this analysis seeks an answer is the possible existence of different kinds of hammerstones. The method for examining this problem involves some sort of classification scheme. For the purposes of this paper the following assumption was considered basic to establishing a classification: if types of hammerstones exist, then similarities and differences among given attributes will vary significantly in relation to these types. Implicit in this approach is the notion that one can distinguish types of a specific artifact, providing that the prehistoric makers actually recognized such types. This has been a debated point. Ford (1952) and Brew (1946:46), on the one hand, have suggested that classification attempts are basically artificial and imposed upon the data since it is their belief that change is continual in every aspect of cultural endeavor and hence, grouping artifacts as to types can only serve as an aid to the archeologist rather than a true reflection of prehistoric concepts. Spaulding (1953, 1972, 1976), however, champions the viewpoint that types do exist and that they are definable.

> ...within a class of quite similar artifacts, classification into types is a process of discovery of combinations of attributes favored by the makers of the artifacts, not an arbitrary procedure of the classifier (Spaulding 1953:305).

Obviously, I have chosen to accept the perspective that if specific kinds of hammerstones exist, they will be revealed by the demonstration of consistency in attribute correlations. Conversely, if specific kinds of hammerstones do not exist, if there is only one basic sort of hammerstone, then the relationship of attributes should also be indicative of this. In this sense, the existence of "real" types corresponding to prehistoric norms is irrelevant. If significant correlations exist, they will be treated as proper types.

There are a variety of ways of classifying prehistoric artifacts. Some are more useful than others, depending upon the kinds of questions one wants to answer. In this particular case, I accept that the method for finding types of hammerstones, if they exist, is in consistent relationships among attributes. The problem then lies not in determining that patterns of covariation exist, but rather in demonstrating that such associations have or do not have a significant degree of association. The fact that the most reliable method for measuring covariation between attributes is statistical should be obvious. As Spaulding writes:

> ...with the aid of statistical techniques, the degree of consistency in attribute combinations can be discovered in any meaningful archeological assemblage provided sufficient material is at hand and, hence, valid types can be set up on the basis of analysis of material from one component (Spaulding 1953:305).

The statistical methodology available to the archeologist is wide-ranging and sophisticated. It is the nature of the archeologist's problem, however, which dictates the methods that can be utilized most meaningfully.

The particular techniques chosen for this analysis were taken from the Statistical Package for the Social Sciences (Nie et al. 1975), a computer user packet providing a number of machine manipulated programs involving statistical computations. Three of these programs were employed; subprogram FREQUENCIES, subprogram CROSSTABS, and subprogram DISCRIMINANT. Although the user manual gives detailed explanations of the statistics and the analytical properties of their associated programs (to which the reader is encouraged to refer), a brief description will be presented here along with the justifications for their selection and a discussion of the results.

Subprogram FREQUENCIES gives the researcher a number of useful descriptive statistics from his raw data which may have some value in revealing underlying distributions of the attributes being monitored (Nie et al. 1975:181). These statistics include, among others, the mean, standard error, standard deviation, variance and range, as well as optional graphic displays. Such summary statistics are very useful as the first portion of an analysis which can, in turn, provoke new questions or suggest significant patterning. As Thomas (1976:41) notes, "Science data never speak for themselves, an initial step in the analysis of anthropological data usually involves summarizing raw field data." This was the rationale behind the use of FREQUENCIES in the hammerstone analysis. That is, it allowed for an initial assessment of the number and occurrence of the variables under study.

Two FREQUENCIES runs were done; one was performed on all the data cases lumped as a group, while the second considered the cases particular to each site. The results immediately suggested certain groupings of attributes as well as changes through time. These revolved specifically around such variables as morphology, parent state, material type, and weight. It seemed, for example, that morphology might be closely related to material type and that these both might be related to weight. It also appeared that there was probably a shift in the types of material being utilized from one site to another, specifically in that percentages of quartzite hammerstones decreased from the earlier to the later sites while petrified wood hammerstones increased proportionately (Figure 6.1).

These suggestive distribution patterns were then the first guides for seeking specific attribute correlations that would aid in defining or negating some sort of attribute organization; i.e., the presence or absence of observable types. It also hinted at temporal changes in hammerstone characteristics, a very important question which was proposed as one of the principal research problems. It is to the question of classification that this paper now primarily addresses itself.

Subprogram CROSSTABS moves the analysis up from the level of descriptive statistics to that of contingency statistics, to the analysis of joint frequency distributions and their significance (Nie et al. 1975:218). This is the sort of analysis which, as previously suggested, would be most relevant to distinguishing artifact classes—measures of correlation between attributes. CROSSTABS provides for several significant tests including Chi-square, Phi, Cramer's V, and various other coefficients of contingency. A number of variables were selected for input in the CROSSTABS program, some on the basis of hunches developed during the actual tabletop examination of the hammerstones, others from the distribution patterning resulting from the FREQUENCIES runs. Although the CROSSTABS method of 2-by-2 contingency analysis was used to approach most of the problems outlined above, I now describe how it was specifically applied to the development of a hammerstone classification scheme.

The scheme should, perhaps, be elaborated on at this point, or at least the guidelines used in searching for possible hammerstone classes. First, I have assumed that hammerstones have a single basic and underlying function, that being percussion. This point of view is explicit in the very definition of a hammerstone which stipulates that battering (wear resulting from impact) is the diagnostic criteria for assigning an artifact to the category, "hammerstone." Hence, the classification attempt is concerned with function. The reason for this is simple; a hammerstone is a tool and tools are created for a purpose. Therefore, while there may be stylistic or secondary functional differences within a tool class (Binford 1972b:200; Jelinek 1976:19), the primary aspect of a tool is its intended function. In regard to hammerstones specifically, we might note that Longacre (1970:36) assigns hammerstones to a functional subgroup composed of percussion instruments (not to be confused with drums, however). Bordaz (1970:44) does likewise. In short, and to reiterate, the role of the hammerstone within the technological subsystem of the more inclusive cultural system is seen as functional and the attributes anticipated as important to differentiating classes are those thought to have functional significance.

What, then, might these attributes be? In effect, all of those which were analyzed since all were considered relevant to functional interpretations. So, the problem then becomes one of determining which attributes are the most important in relation to function. It soon became obvious that CROSSTABS would be of little help in this area for while it did provide tables and tests of significance, these turned out to all have high degrees of significant correlation. The contingency approach did seem to isolate certain correlations of variables but was unable to differentiate as to variable importance. Consequently, there seemed a need for a stronger test, one which would bring some insight to the phenomenon of consistently high correlations among most of the study variables.

Fortunately, SPSS has in the form of its DISCRIMINANT subprogram a method for measuring the degree to which individual variables can be used to predict on other variables. Very simply, DISCRIMINANT takes a set of groups specified by the researcher and a collection of variables expected to measure differences between those groups, weighs the variables statistically, and then combines them in such a way as to permit the researcher to discriminate between one or more groups on the basis of certain variables (Nie et al. 1975:435). In effect, it makes statistical distinctions between groups. It also provides a ranking system which indicates which variables are most useful in the discriminating process.

The first step in the application of this technique is to select the groups among which one wants to distinguish differences. This choice is important in that the groups specified should be relevant to the problem at hand: "These groups are defined by the particular research situation" (Nie et al. 1975:435). For the purposes of the hammerstone analysis, it was thought that the most useful attribute to be able to

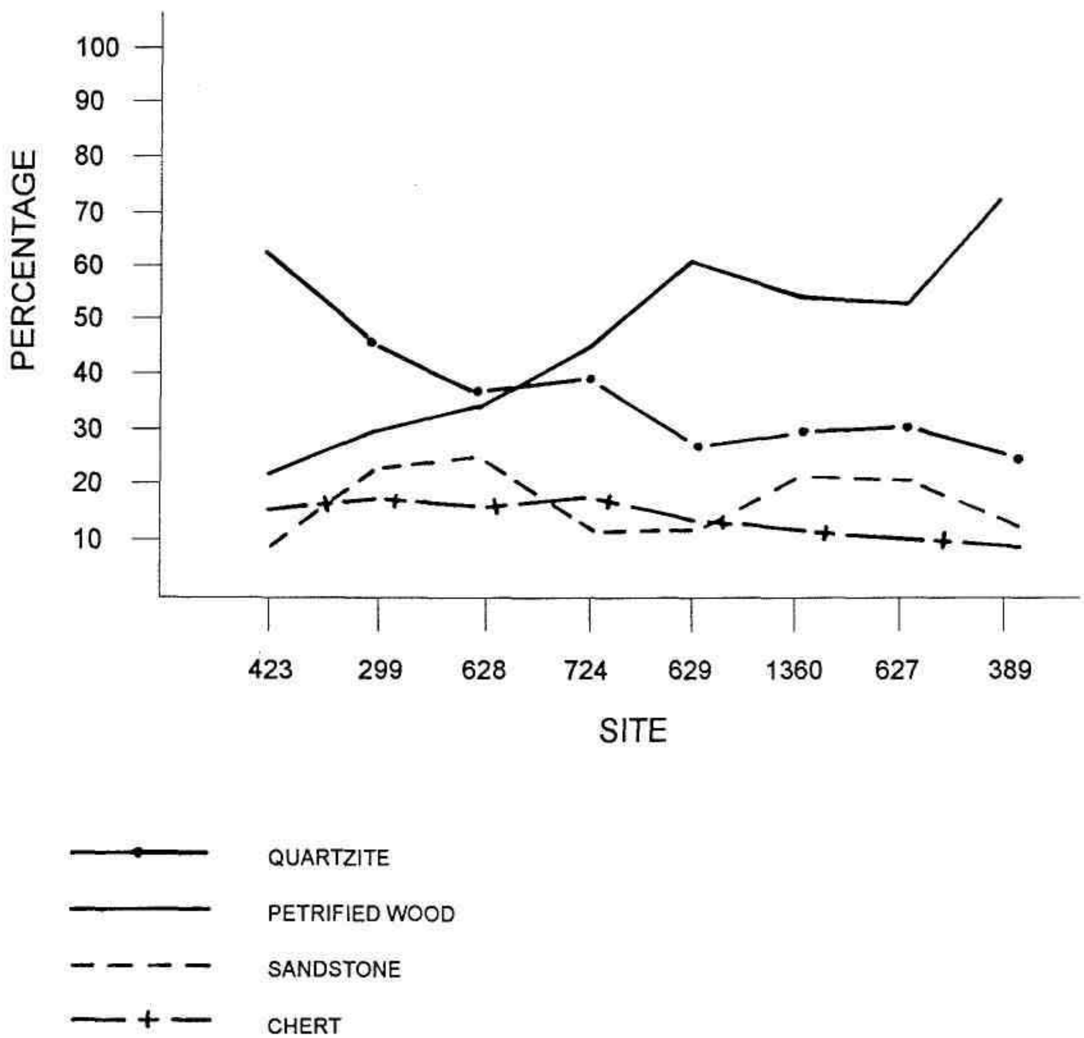

Figure 6.1. Percentages of material types by site.

distinguish was morphology. The justification for using morphological criteria is twofold:

1) During the initial tabletop analysis of a sample of 50 hammerstones, it seemed that certain distinct shapes or forms were present within the group as a whole. Consequently, a variable category was created with four values: angular, spheroidal, discoidal, and slab. This was not entirely arbitrary but was arrived at by a combination of what was seen in the Chaco material and what other researchers had noted, especially Haury (1976:279), Kidder (1932:60), and Woodbury (1954:89-91).

2) Previous descriptions of hammerstones not only listed different shapes but also suggested that such shapes were the result of deliberate modification or specific types of use. For example,

> Examination shows that the original rounded contours of the stone were deliberately destroyed by striking chips more or less at random from various parts of the surface, the intention evidently having been to produce angular projections...(Kidder 1932:60).

> Any tough stone that might be grasped in the hand sufficed for a hammer, but its surface was invariably fractured with another stone to produce jagged faces and, thus, increased its effectiveness (Judd 1954:117).

In the Medio Period of Casas Grandes, Di Peso notes that most hammerstones were:

> Simply angular stones selected for size and shape that fit hand and purpose. Others were waterworn pebbles with one end or several surfaces flaked to sharp angles, or in other instances merely battered from pounding (Di Peso 1974: 108).

Or, compare Hayes and Lancaster's description of hammerstone morphology from Badger House at Mesa Verde:

> The sharp or angular edge of the break was then used as the striking platform of the tool...the smaller the area of impact the greater the efficiency of the blow (Hayes and Lancaster 1975:149-150).

Angularity is not the only hammerstone shape reported. Witness Kluckhohn's statement that, "Unworked cobblestones were used for temporary hammers" (Kluckhohn 1971:175). Haury (1976:279) has a specific category for spheroidal hammerstones, and most sites list hammerstones made from river cobbles, an obvious spheroidal or at least round form. In fact, a recent artifact analysis form obtained from the Office of Contract Archeology in Albuquerque declares (probably incorrectly) that only stones having broad round surfaces associated with battering are to be considered hammerstones. The point is that the morphology of the implement has always been the primary characteristic noted by investigators and the types of morphology explicitly recognized by them have been angular (edges) and spheroidal. Because the present analysis is geared towards a functional explanation and the morphologies reported seem to transect other variables such as material type, method of manufacture, and type of wear, I assume that the morphology of a hammerstone is probably its most distinctive characteristic.

Given the importance of morphology, we may now come back to the discriminant analysis. The object in this case is to determine if such classes exist (i.e., morphological classes) and if so, what variables are most important in differentiating between the classes.

The DISCRIMINANT program was first run using three of the morphology values as groups. These were angular, spheroidal, and discoidal. The value "slab" was not included because of its low frequency and because I thought that it was probably subsumed under the broader value of angular rather than as a separate and distinct value or class unto itself. Portions of the summary table from that first run are reproduced in Table 6.2. All variables were utilized and the stepwise method chosen was Wilks. As can be seen from the table, there are four main discriminating variables: weight, function, parent state, and technology of manufacture (hereafter referred to as technology). Material type, surprisingly, did not seem to be correlated with weight and function, or with morphology. This result did not seem quite satisfactory in that the function variable was subjectively assigned and often the basis

Table 6.2. Results of first discriminant run.

A. Summary Statistics.

Step Number	Variable Entered	Variable Removed	F to Enter or Remove
1	Weight		17.39854
2	Function		12.95191
3	Parent State		10.82182
4	Technology		8.53900
5	Percentages of Wear-Step Fracture		2.63864
6	Material Type		1.66054

B. Standardized Discriminant Function Coefficients.

Variable	Function 1	Function 2
Weight	0.63585	-0.27871
Material Type	0.25776	0.05058
Parent State	-0.36566	-0.18442
Technology	0.38958	0.30788
Percentage of Wear-Step Fracture	-0.20664	0.22524
Function	0.14595	0.83732

for the assignment was dependent upon the morphology of the artifact. For example, discoidals were often called choppers if the edge angle was particularly steep. Therefore, it was decided to run the program again without including the variable function in the analysis.

Table 6.3 is a summary of the second DISCRIMINANT run. If the sequence in which variables are entered into the analysis is examined, it can be seen that although the variable function has been deleted, the other variables with the most discriminating power (the higher the "F to Enter or Remove," the better the variable for differentiating between groups) remain unchanged from the first DISCRIMINANT run. This suggests that, indeed, a possible underlying relationship pertaining to the morphology of individual hammerstones has been isolated. The analysis has also derived two functions, the first of which seems strongly contingent upon the variable weight, while the second appears to represent a combination of types of wear. The Wilks' Lambda for function 1 is .8826; for function 2 it is .9733. Since the lower Lambda indicates a stronger degree of discrimination, we might tender for the moment a possible interpretation involving weight as the primary characteristic associated with morphology although the types of wear may be suggestive of secondary characteristics.

In addition to this evidence, the second run also presented some insight into the appropriateness of the three categories used to define the groups. Specifically, when examining the predicted results versus the group assignments made during the tabletop examination, we find that the computer had grouped 67.0 percent of angular hammerstones correctly, 57.1 percent of spheroidal, but only 26.3 percent of discoidals (Table 6.3). This led me to believe the Group 3 might not be a particularly valid classificatory category; therefore, I decided to check this suspicion by initiating another DISCRIMINANT run using only the values of angular and spheroidal as the groups. The reason for this was the thought that perhaps the discoidal characteristic was secondary to the angular, i.e., all of the discoids would certainly have been called angular if it had not been decided that the regularity of the form warranted a separate category. Consequently, it seemed somewhat logical that if better prediction results could be obtained from an analysis involving only two categories of morphology, then there might be a stronger basis for postulating morphological distinctiveness among hammerstones; in this case, a dichotomous relationship between angularity and sphericity. So, as might be expected by now, a third DISCRIMINANT program was run using angular and spheroidal as the groups.

The results of this run were the hoped for increase in prediction accuracy plus further confirmation of the association among the variables already identified as contributing the most to the distinctiveness between morphological categories (Table 6.4). In particular, it seems that the discoidal hammerstones are, in fact, merely a subset of angular.

This presents a rather interesting problem, for if, in fact, those hammerstones in the original discoidal category cannot be adequately distinguished from "ordinary" angular hammerstones, then why their distinctive outline? The answer to this question probably lies in what Jelinek (1976:22) calls the "Frison Effect" (cf. Frison 1968:152). That is, the modification of an original tool form to a different form during use in a succession of tasks. A large number of the discoids were, as pointed out above,

Table 6.3. Results of second discriminant run.

A. Summary statistics.

Step Number	Variable Entered	Variable Removed	F to Enter or Remove
1	Weight		17.71092
2	Parent State		10.55776
3	Technology		7.97316
4	Percentage of Wear-Battering		4.56390
5	Percentage of Wear		2.93712
6	Percentage of Wear-Abrasion		1.73094
7	Percentage of Wear-Step Fracture		1.76327
8	Material Type		1.51992

B. Standardized Discriminant Function Coefficients.

Variable	Function 1	Function 2
Weight	0.64993	0.35090
Material Type	0.24316	0.04743
Parent State	-0.34599	0.24190
Technology	0.35136	-0.26127
Percentage of Wear	-0.04800	0.44913
Percentage of Wear-Abrasion	-0.25081	0.34711
Percentage of Wear-Battering	-0.25081	0.83676
Percentage of Wear-Step Fracture	-0.35741	-0.22710

C. Prediction Results

Actual Group	Number of Cases	Predicted Group Membership: Group 1	Group 2	Group 3
Group 1	639	428 67.0	143 22.4	68 10.6
Group 2	98	31 31.6	56 57.1	11 11.2
Group 3	38	19 50.0	9 23.7	10 26.3
Ungrouped cases	30	23 76.7	1 3.3	6 20.0

Percent of "grouped" cases correctly classified: 63.74 percent.

Table 6.4. Results of third discriminant run.

A. Summary Statistics.

Step Number	Variable Entered	Variable Removed	F to Enter or Remove
1	Weight		28.59593
2	Parent State		19.76012
3	Technology		14.96705
4	Material Type		3.94888
5	Wear		2.83204

B. Standardized Discriminant Function Coefficients.

Variable	Function 1
Weight	-0.62003
Material Type	-0.25209
Parent State	0.37125
Technology	-0.39628
Wear	0.20998

C. Prediction Results.

Actual Group	Number of Cases	Predicted Group Membership: Group 1	Predicted Group Membership: Group 2
Group 1	639	438 68.5	201 31.5
Group 2	98	26 26.5	72 73.5
Ungrouped	68	52 76.5	16 23.5

Percent of "grouped" cases correctly classified: 69.20 percent.

originally classified as choppers. This was one of the probable reasons that prediction results on Group 3 (discoids) was most accurate during the first DISCRIMINANT run. In light of this, it seems reasonable to conclude that many of the discoidal hammerstones were originally choppers, but with extended use the functional edge for chopping became dulled and was either discarded or reutilized as a hammer. This is a question which deserves more attention than it has received here because it has implications for the amount of tool curation practiced. Hopefully, a more conclusive examination can be presented in future analyses. For the moment then, it will be assumed that discoidals are essentially angular hammerstones regardless of their original morphological function.

Having thus postulated that the distinctiveness of discoidal hammerstones lies in prior functional contexts, we turn again to the question of why angular hammerstones are different from spheroidal ones. In this regard, it was thought that CROSSTABS would most likely be the place to search for the reasons behind the high correlations between morphology and the variables weight, parent state, and technology. Before proceeding to that aspect of the analysis, however, I thought it was important to consider one more feature of the DISCRIMINANT runs.

This involved the consistently low discriminating power of the variable material type on all discriminant runs. To me, this variable seemed to correlate highly with morphology and that it should not show up in the statistical output was puzzling. The first attempt to confirm the inadequacy of material types in discriminating for morphology involved still another DISCRIMINANT run in which the various material types were lumped into four basic groups: chert, petrified wood, sandstone, and quartzite. I thought that this might have some influence on the discriminant results (Table 6.5). Consequently, a new tact was adopted in order to crosscheck the previous results. Again, a DISCRIMINANT program was run, this time using the recoded material types as the groups among which were to be discriminated. The results are summarized in Table 6.6 and are very interesting for two reasons:

1) They show morphology to be of little value in predicting material type.

2) They show parent state and weight to be the strongest discriminating variables for material type.

The observation that has already been made that morphology and material type are not highly correlated, seems confirmed. In reality, the situation is not so clear-cut. The problem is not related to the consistently high association of parent state to morphology and to material type, but the lack of association between the latter two. One possible reason for this might be in Dean's concept of the "surrogate" variable (Judge, personal communication 1977). In effect, one variable can be subsumed under another. In this case, it seemed that either parent state was surrogate to material type or vice versa. The rationale for this viewpoint was that Warren's type code accounts for both cobbles and silicified wood which are, of course, two of the four parent state values. Intuitively, I felt that material type was surrogate to parent state, but the statistical analysis seemed to indicate otherwise since parent state always weighed more heavily. Yet another

Table 6.5. Results of fourth discriminant run.

A. Summary Statistics. Material Types Recorded.

	Variable		
Step Number	Entered	Removed	F to Enter or Remove
1	Weight		17.71092
2	Parent State		10.55776
3	Technology		7.97316
4	Percentage of Wear-Battering		4.56390
5	Wear		2.93712
6	Percentage of Wear-Abrasion		1.73094
7	Percentage of Wear-Step Fracture		1.76227
8	Material Type		1.07289

B. Standardized Discriminant Function Coefficients.

Variable	Function 1	Function 2
Weight	-0.67139	-0.39131
Material Type	0.13990	-0.17451
Parent State	0.48548	-0.18550
Technology	-0.35782	0.24590
Wear	0.07770	-0.44550
Percentage of Wear-Abrasion	0.23884	-0.33612
Percentage of Wear-Battering	0.36252	-0.80057
Percentage of Wear-Step Fracture	0.37487	0.24700

C. Prediction Results

		Predicted Group Membership		
Actual Group	Number of Cases	Group 1	Group 2	Group 3
Group 1	639	416 65.1	145 22.7	78 12.2
Group 2	98	23 23.5	58 59.2	17 17.3
Group 3	30	20 66.7	4 13.3	6 20.0

Percent of "grouped" cases correctly classified: 63.35 percent.

Table 6.6. Results of fifth discriminant run. Material types as groups.

Step Number	Variable Entered	Variable Removed	F to Enter or Remove
1	Parent State		187.88557
2	Weight		21.46497
3	Wear		9.08524
4	Technology		4.11561
5	Percentage of Wear-Abrasion		3.19504
6	Cortex		2.27699
7	Morphology		2.14993
8	Percentage of Wear-Battering		1.76099
9	Percentage of Wear-Step Fracture		1.69065

DISCRIMINANT program was run using morphology as the groups but eliminating parent state from consideration.

The results of this run seem to confirm a suspected surrogate relationship for it can be noted in Table 6.7 that material type immediately assumes a discriminating power not evidenced in previous runs. In fact, material type has assumed the rank position of parent state, although not its degree of predictiveness. In light of this, it appears reasonable to suggest that parent state is surrogate to material type. This interpretation has some significance in the

Table 6.7. Results of sixth discriminant run. Parent state removed from the analysis.

Step Number	Variable Entered	Variable Removed	F to Enter or Remove
1	Weight		17.49100
2	Material Type		9.02682
3	Technology		7.09201
4	Percentage of Wear-Battering		5.21856
5	Wear		3.25687
6	Percentage of Wear-Abrasion		2.27976
7	Percentage of Wear-Step Fracture		1.75650
8	Cortex		1.19960

determination of the attributes which cause the two morphological groups to differ statistically.

The variables contributing the most to the differentiation between angular and spheroidal have already been identified as weight, parent state, and technology. To further clarify precisely why these contribute so much, various combinations of the variables weight, parent state, technology, and morphology were input into a CROSSTABS program. As might be expected, in every case the Chi-square statistic produced significant levels of 0.0, indicating extremely strong correlations. This, however, did not reveal why such good correlations were found.

Finding the "why" essentially involved a detailed examination of individual cell frequencies in the CROSSTABS contingency tables. Because further explication of this particular procedure would be tedious and of little informative value, I will simply summarize those differences which are thought to have resulted in the statistical recognition of two hammerstone classes.

These classes, if it has not become apparent by now, are angular and spheroidal. They differ from each other in a very basic manner. Indeed, the difference is explicit in the working definitions used to assign morphological values; angular hammerstones have edges, spheroidal hammerstones are more or less round with broad curvilinear surfaces. These values have been isolated statistically by comparing attributes other than morphology and, hence, we are forced to look for differences that are not so obvious.

The first of these is weight, the variable which shows the most consistency in discriminating between the two morphological classes. Essentially, the cell frequencies reveal that within certain weight classes there are different proportions, the outstanding of which is a concentration of spheroids in the 401-900 gm range. Table 6.8 gives specific cell frequencies, but it might be noted that the gross pattern seems to be as follows: angular hammerstones make up about 92 percent of all hammers in the 1-200 gm range, about 80 percent of the 201-400 gm range, around 60 percent of the 401-900 gm range, and 100 percent of all hammerstones over 900 gm (Figure 6.2).

The implication seems to be that tasks requiring spheroidal (assuming that spheroids are functionally different from angular) hammers were

Table 6.8. Cross-tabulations of weight by morphology.[a]

Weight		Angular	Spheroid	Discoidal	Slab	Row Total
1 to 100 gm	3	142	11	16	9	181
	1.7	78.5	6.1	8.8	5.0	
	75.8	22.1	10.9	40.0	34.6	
	0.4	17.5	1.4	2.0	1.1	22.3
101 to 200 gm	1	299	25	15	12	352
	0.3	84.9	7.1	4.3	3.4	
	25.0	46.6	24.8	37.5	46.2	
	0.1	36.8	3.1	1.8	1.5	43.3
201 to 300 gm	-	112	29	7	4	152
	-	73.7	19.1	4.6	2.6	
	-	17.4	28.7	17.5	15.4	
	-	13.8	3.6	0.9	0.5	18.7
301 to 400 gm	-	45	12	1	-	58
	-	77.6	20.7	1.7	-	
	-	7.0	11.9	2.5	-	
	-	5.5	1.5	0.1	-	7.1
401 to 500 gm	-	14	13	1	-	28
	-	50.0	46.4	3.6	-	
	-	2.2	12.9	2.5	-	
	-	1.7	1.6	9.1	-	3.4
501 to 600 gm	-	10	6	-	-	16
	-	62.5	37.5	-	-	
	-	1.6	5.9	-	-	
	-	1.2	0.7	-	-	2.0
601 to 700 gm	-	4	2	-	-	6
	-	66.7	33.3	-	-	
	-	0.6	2.0	-	-	
	-	0.5	0.2	-	-	0.7
701 to 800 gm	-	6	3	-	1	10
	-	60.0	30.0	-	10.0	
	-	0.9	3.0	-	3.8	
	-	0.7	0.4	-	0.1	1.2
801 to 900 gm	-	3	-	-	-	3
	-	100.0	-	-	-	
	-	0.5	-	-	-	
	-	0.4	-	-	-	0.4
901 to 1000 gm	-	4	-	-	-	4
	-	100.0	-	-	-	
	-	0.6	-	-	-	
	-	0.5	-	-	-	0.5
1001 to 1100 gm	-	3	-	-	-	3
	-	100.0	-	-	-	
	-	0.5	-	-	-	
	-	0.4	-	-	-	0.4
Column Total	4	642	101	40	26	813
Percent	0.5	79.0	12.4	4.9	3.2	100.0

[a] Data presented in columns as counts, row percentages, column percentages, total percentages.
Chi-square = 92.56151 with 40 degrees of freedom.
Significance = 0.0000.
Cramer's V = 0.16871.
Contingency Coefficient = 0.31971.

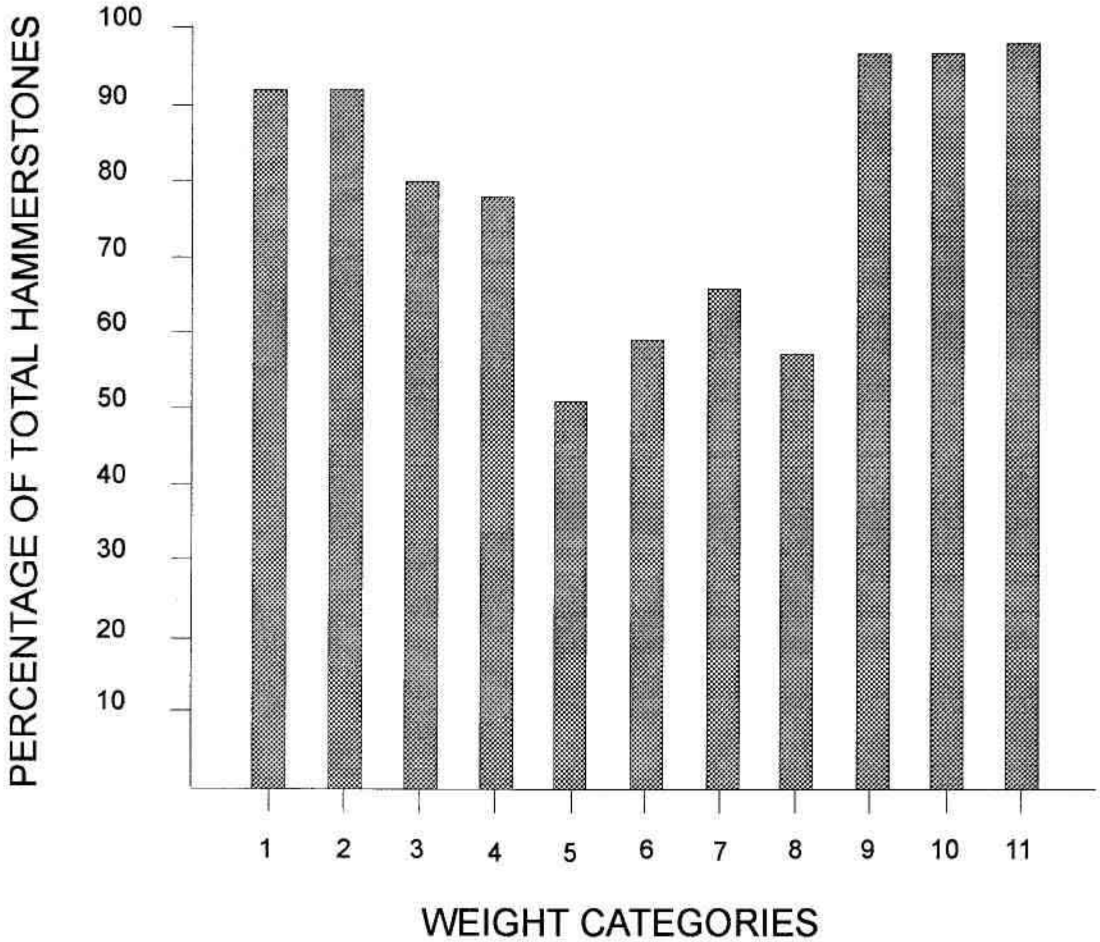

Figure 6.2. Angular hammerstones by weight class.

more likely, proportionately, to require a medium-sized implement. There are other interesting patterns which emerge such as 94.5 percent of the discoidal subset occurring below 400 gm, but the fact that 35.7 percent of all spheroids weigh more than 400 gm, while only 6.9 percent of angular hammers fall in this range seems the most obvious difference. More subtle differences may be influencing the statistical analysis but if so, this is not apparent at the moment.

When we turn to the importance of parent state, we must keep in mind that Values 3 and 4 of the variable morphology should be considered as angular (Value 1). This aside, it can be noted that there are two important correlations:

1) Spheroids have an almost even chance of being cobbles.
2) Cobbles show a 72.4 percent occurrence in the angular category.

It might also be noted that petrified wood occurs predominantly in the angular class (93.1 percent) as does the value other (85.4 percent). The tentative conclusion seems to be that the primary difference between angular and spheroid, as reflected in parent state, is the observation that 44.9 percent of all spheroids were originally cobbles (Table 6.9).

The final variable with good discriminating power, technology, can be accounted for fairly easily with the aid of CROSSTABS. Examination of cell frequencies reveals that spheroids are almost always either unmodified or shaped by other. Personal observation suggests that rarely, if ever, did other refer to anything but battering. As for angular hammerstones, they result from flaking, battering or selection for naturally occurring edges, but when intentionally modified, flaking is the prevalent mode. It is also interesting, though not extremely pertinent to the problem at hand, that 44.2 percent of all hammerstones are unmodified (Table 6.10). In conclusion, it would seem that the way in which hammerstones are modified is related to their final form, specifically in that spheroids are usually shaped by battering.

To bring this tortuous narration to a quick and deserved end, I simply state that statistically, as well as intuitively, there do seem to be two morphologically distinct classes of hammerstones which can be differentiated on the basis of weight, parent state, and technology of manufacture.

Function

The stated objective for developing a classificatory system of hammerstones was to provide an aid in determining whether hammerstones could be functionally differentiated. It might be asked now if the dichotomous grouping postulated in the preceding portion of the paper does indeed shed some proverbial light on the question of functionality.

As determined so far, the morphological dichotomy isolated in the analysis only suggests functional differences; it does not reveal what the nature of such differences might be. Haury seems to have anticipated this problem without the benefit of extended statistical verification of his classes:

> ...it appears that the sharp edges on angular stone and the softer contours of a rounded one may have been preferred for different kinds of work. The latter was probably best adapted for reducing bulk by pecking, as in the shaping of a mano, while the former was best suited for coarse work where regular scarring was not a factor or was desirable, as in the sharpening of a metate (Haury 1976:279).

The author (Chapman) of the previously cited OCA analysis form, is more general in his thoughts but also thinks that form may be related to task:

> Hammerstones exhibiting rather broad and relatively flat surfaces can be assumed to have been used in contexts which did not necessitate a great degree of control over the specific locus of force application. Essentially, lenticular cobbles, exhibiting restricted areas of battering along their highly convex ridges or ends, might, on the other hand, be assumed to have been used in contexts which necessitated a considerable degree of control over the specific locus of force application. These latter contexts could be expected to include flint knapping usage of the hammerstone (Chapman 1977:413).

These two passages explicitly relate the morphology of the hammerstone to a type of need. There is, however, another line of thought of which we must be cognizant. This is the idea that the

Table 6.9. Cross tabulation of parent state by morphology.[a]

Parent State	Wear	Angular	Spheroid	Discoidal	Slab	Row Total
Cortex	2	-	-	-	-	2
	100.0	-	-	-	-	
	50.0	-	-	-	-	
	0.2	-	-	-	-	0.2
Cobble	-	142	44	10	-	196
	-	72.4	22.4	5.1	-	
	-	22.2	44.9	26.3	-	
	-	17.6	5.5	1.2	-	24.3
Tabular	-	1	-	-	1	2
	-	50.0	-	-	50.0	
	-	0.2	-	-	3.8	
	-	0.1	-	-	0.1	0.2
Petrified Wood	2	35.4	31	26	25	448
	0.4	81.3	6.9	5.8	5.6	
	50.0	57.0	31.6	68.4	96.2	
	0.2	45.2	3.9	3.2	3.1	55.7
Other	-	132	23	2	-	157
	-	84.1	14.6	1.3	-	
	-	20.7	23.5	5.3	-	
	-	16.4	2.9	0.2	-	19.5
Total	4	678	98	38	26	805
Percent	0.5	79.4	12.2	4.7	3.2	100.0

[a] Data in columns are presented as counts, row percentage, column percentage, and total percentage.
Chi-square = 470.34180 with 16 degrees of freedom.
Significance = 0.0.
Cramer's V = 0.38219.
Contingency coefficient = 0.60729.
Number of missing observations = 8.

spheroidal hammers are simply angular hammerstones which through extended use have lost their effectiveness and have been subsequently discarded. Judd provides two good examples of this reasoning. In discussing modern replication experiments he notes, "...Gill found that the effectiveness of a stone hammer was materially reduced when its faceted surface became smooth through use; that it was easier to make a new hammer than to refracture an old one" (Judd 1954:118). In defining a hammerstone he says, "When the rough edges were worn away, the hammer was discarded" (Judd 1954:117). Other examples are numerous (Kidder 1932:61, Hayes and Lancaster 1975:149, Judd 1959:134-135).

A problem then, which is basic to a functional interpretation, is whether spheroids are functionally distinct from angular hammers or whether they are merely exhausted forms of angular hammerstones. For the Chaco material, we can apply two lines of circumstantial evidence to this question. The first is the logical proposition that if spheroidal hammers result from exhaustion of angular ones, then it would seem evident that it was easier, or more efficient, to completely utilize a hammer than it was to create a new one (cf. Judd above). The preponderance of angular hammerstones (87.5 percent of the total sample), however, suggests that this is not so, that in fact, the total exhaustion of hammerstones was not

Table 6.10. Cross-tabulation of parent state by technology of manufacture.[a]

Parent State	Morphology	Shaped by Flaking	Shaped by Other	Not Shaped	Row Total
Cortex	2	-	-	-	2
	100.0	-	-	-	
	100.0	-	-	-	
	0.2	-	-	-	0.2
Cobble	-	81	20	95	196
	-	41.3	10.2	48.5	
	-	28.4	12.3	26.7	
	-	10.1	2.5	11.8	24.3
Tabular	-	-	-	2	2
	-	-	-	100.0	
	-	-	-	0.6	
	-	-	-	0.2	0.2
Petrified wood	-	151	110	187	448
	-	33.7	24.6	41.7	
	-	53.0	67.9	52.5	
	-	18.8	13.7	23.2	55.7
Slab	-	53	32	72	157
	-	33.8	20.4	45.9	
	-	18.6	19.8	20.2	
	-	6.6	4.0	8.9	19.5
Total	2	285	162	356	805
Percent	0.2	35.4	20.1	44.2	100.0

[a] Data in column is presented as counts, row percentage, column percentage, and total percentage.
Chi-square = 825.41284 with 12 degrees of freedom.
Significance = 0.0.
Cramer's V = 0.58462.
Contingency coefficient = 0.71152.
Number of missing observations = 8.

common. The second shaky line of reasoning is concerned with the frequencies of spheroidals by site. As Table 6.11 shows, the proportion of spheroids to angulars is somewhat constant or more precisely, present, which in turn suggests a constant "desire for spheroidal hammers." These propositions are put forth with full knowledge that we lack information concerning length of use, nature of the tasks involved, and lifespan of different materials under different conditions of use. Despite the lack of such insight, however, I feel at least partially justified in suggesting that the current state of the data indicates functional differences as responsible for morphological differences.

This leads into the sticky question of what specific tasks hammerstones were used for. Archeologists always seem to expand their descriptions of hammerstones through ethnographic analogy. Hence, hammerstones were used in maintenance of ground stone implements, flint knapping, pounding meat, hides and pigment, breaking up bone, and shaping building stones.

Table 6.11. Percentages of angular and spheroidal hammerstones by site.

Site	Angular	Spheroidal
29SJ 423	85.4	14.6
29SJ 299	56.7	43.3
29SJ 628	81.1	18.9
29SJ 724	93.8	6.3
29SJ 629	93.4	6.6
29SJ 1360	76.3	23.7
29SJ 627	82.2	17.8
29SJ 389	95.4	4.6

Almost certainly these suggestions are correct. As to what hammerstone shapes or weights or material types can be correlated with specific tasks, I simply cannot say at this point. Probably we are indeed dealing with a situation where the general purpose nature of the tool precludes attributing that tool to only one type of activity. I am optimistic, however, that as yet there are undefined functional differences between angular and spheroidal and once these have been delineated, more information pertinent to the question of specific task-related functions will be forthcoming.

Source Areas

Identification of source areas for materials represented by Chacoan artifacts is one of the prime goals of on-going research at the Chaco Center. Basic to this primacy are the subsequent implications for direction and intensity of prehistoric importation of objects within the canyon. Analysis of the stone material from which hammerstones were made indicates that locally available (within 5 km of the canyon) materials comprise the bulk of the hammers but imported materials generally accounted for around 25 percent or more of the hammerstones by site. The purpose of this section of the analysis is purely descriptive and to that end Table 6.12 has been constructed.

Temporal Variation

One very important aspect of this study is monitoring possible change in hammerstone characteristics. Variation through time has great relevance, especially if such change can be related to technology.

> Changes in the technology of tools will arise in response to a technological need and will be directly related to changes in subsistence patterns and patterns in communication (Martin and Plog 1973:215).

This is the systemic view of culture proposed by Binford (1972a:22) in which culture is seen as the articulation of a number of functioning subsystems. According to this approach, the understanding of any one subsystem or component has the inherent capacity to give meaning to all the other subsystems with which it is articulated. In theory at least, any subsystem can be expected to give insight into the nature of other subsystems; in reality, that expectation is compromised by the extent to which the individual researcher is capable of extracting the necessary information.

Several changes involving the variables material type, parent state, and morphology are postulated here with a degree of caution. To begin with, I have already observed that quartzite hammerstones show a decrease through time (Figure 6.1). Observation has also shown a proportional increase in petrified wood from early to late sites. Still further observation reveals that concomitant with the decrease in quartzite is a decreased selection for cobbles as a morphological raw form for hammerstones. Because the cobbles involved are almost always quartzite, it naturally occurs to ask if the decreased proportions of quartzite hammerstones might not be the result of a decreased selection for cobbles, or vice versa. Rephrasing this question gives the following hypothesis: the decrease in quartzite hammerstones is due to a decreased selection for cobbles. To test this hypothesis, we need to make the assumption that a selection for cobbles would indicate a preference for distinctive morphological attributes, i.e., round, broad surfaces. Given this assumption, we would not expect cobbles to be modified. This, however, is not the case. Nearly 73 percent of all cobbles are flaked to produce edges or are naturally angular (Tables 6.9 and 6.10). The hypothesis is, therefore, rejected. The important implication of this is that the quartzite decrease is indicative of a decreased selection for quartzite, not its form.

The next question might well be whether or not this decrease is unintentional or deliberate. In other words, are the prehistoric Chacoans depleting a local resource or are they purposely choosing not to make hammerstones from quartzite. Essential to this question is establishing that a local quartzite resource was available. William Gillespie, having recently completed the lithic analysis for the Chaco Outlier Survey, indicates that quartzite cobbles not only were available locally in prehistoric times, but that even today there are abundant quantities within easy access of the canyon, especially at the site of Bis'sa ani (Gillespie, personal communication 1977). This, in itself, should be enough to suggest that the quartzite decrease was not caused by local depletion but one further bit of evidence can be noted. According to Warren's lithic code, a number of the hammerstone materials were coming from the San Juan Basin. Importation, as noted, increased through time. In combination with the fact that the San Juan River is an excellent source of quartzite cobbles, this would seem to suggest that even if local supplies were being

Table 6.12. Material type by site.

Material Type[a]	Local/Nonlocal	29SJ 423 %	29SJ 299 %	29SJ 628 %	29SJ 724 %	29SJ 629 %	29SJ 1360 %	29SJ 627 %	29SJ 389 %
1011	Nonlocal	4.9	-	-	-	2.6	-	-	-
1040	Nonlocal	-	-	1.7	6.3	0.7	-	0.7	0.6
1041	Nonlocal	-	-	-	-	-	-	0.7	-
1042	Local	-	-	-	-	0.7	-	0.7	1.1
1050	Local	-	-	-	-	-	1.2	0.7	-
1051	Local	2.4	3.3	6.9	6.3	0.7	-	1.4	-
1052	Local	-	3.3	-	-	1.1	-	0.7	-
1053	Local	-	6.7	-	-	-	3.7	1.4	-
1070	Local	-	-	-	-	-	-	0.7	-
1073	Nonlocal	-	-	-	-	-	1.2	-	0.6
1075	Local	-	-	-	-	0.4	-	-	-
1091	Nonlocal	-	-	-	-	1.8	-	-	-
1100	Local	-	-	-	-	-	-	1.4	1.7
1110	Local	7.3	3.3	5.2	18.8	42.3	31.3	40.7	65.7
1111	Local	-	-	-	-	0.4	-	-	-
1112	Nonlocal	9.8	13.3	24.1	18.8	14.3	18.8	7.9	4.6
1113	Nonlocal	-	3.3	-	-	0.7	-	-	-
1120	Local	-	-	-	-	1.1	1.2	-	-
1130	Local	-	-	-	6.3	0.4	1.2	1.4	1.1
1140	Local	-	-	1.7	-	1.5	-	-	-
1142	Local	2.4	6.7	-	-	-	-	-	-
1231	Nonlocal	-	-	-	-	0.4	-	-	-
1234	Local	-	-	1.7	-	-	-	-	-
1425	Local	2.4	-	1.7	-	-	-	-	-
1660	Local	-	-	-	-	-	-	0.7	-
2101	Nonlocal	-	-	-	-	1.1	-	-	-
2123	Local	-	3.3	-	-	1.1	1.2	0.7	0.6
2124	Local	-	-	-	-	-	-	0.7	1.7
2125	Local	-	-	1.7	-	0.4	-	0.7	2.3
2126	Local	-	-	6.9	-	-	1.2	1.7	0.6
2200	Local	-	-	3.4	-	-	5.0	1.4	0.6
2201	Nonlocal	-	3.3	-	-	1.1	2.5	1.4	-
2202	Nonlocal	2.4	3.3	8.6	-	0.4	6.3	10.0	1.7
2204	Nonlocal	2.4	3.3	-	6.3	-	1.2	0.7	-
2850	Local	-	-	-	-	4.8	-	-	-
4000	Local	17.1	10.0	-	25.0	0.4	7.5	5.7	1.1
4001	Nonlocal	2.4	3.3	1.7	-	-	-	1.4	1.7
4002	Local	14.6	3.3	3.4	-	1.1	5.0	2.1	3.4
4005	Local	29.3	26.7	25.9	12.5	14.7	8.7	15.0	10.3
4200	Local	-	-	-	-	0.4	-	-	-
4370	Local	-	-	-	-	0.7	1.2	-	-
4525	Nonlocal	2.4	-	-	-	-	1.2	-	-
5100	Local	-	-	1.7	-	-	-	-	-
5200	Local	-	-	1.7	-	-	-	-	-
Totals		99.8	96.4	98.0	100.3	95.3	99.6	100.6	99.4

[a] For a definition of material types, see Appendices 3A and 3B or Warren (1967).

exhausted, the ability to obtain these elsewhere was not. Consequently, we might conclude that the basic cause for the drop in quartzite proportions was related to an intentional selection for alternative raw material, rather than the exhaustion of a locally available resource.

I accept that the decrease in quartzite was related to the increase in petrified wood. If this was so, then we need to know if petrified wood merely replaced quartzite and assumed the same function, or whether there was a technological shift requiring a different material for hammers.

If we assume that the hypothesis concerning local depletion is more or less correct, then we might logically propose that replacement without functional correlates is incorrect because that would be a capricious change and capriciousness cannot explain causation; there are usually reasons for causes. The resulting conclusion is that quartzite was not actually replaced by petrified wood but rather the need for quartzite decreased as some functional change requiring petrified wood increased.

This conclusion is, however, without much foundation unless it can be demonstrated that technological differences do indeed exist between quartzite and petrified wood, especially material type 1110. That, unfortunately, is easier to contemplate than demonstrate. Certain quantifications can be produced but they are in large measure intuitive and so lack the desired strength to show differences and similarities. Nevertheless, some simple observations may be helpful. The first attribute of significance might be hardness. On the Moh's scale, quartzite rates between 6.5 and 7.0 (Toll 1976:7), a figure comparable to the range shown for material type 1110 as evidenced in experimentation by Marcia Truell (personal communication). A similar relationship exists with the variable weight, in that a CROSSTABS survey (not verified statistically) seems to show that the proportions of quartzite hammerstones in various weight categories is about the same for proportions of material type 1110. In these respects, there seems to be little appreciable difference.

Other attributes likewise seem to show little difference. For example, the vast majority of both types have angular morphologies. Still another and weaker similarity could be the fracture characteristics of quartzite and material type 1110; quartzite flakes, but not easily; material type 1110 is distinctive in not having conchoidal fracture. These are inconclusive; they do not hint at particular differences between the material types under discussion other than their physical-chemical structure nor do they suggest strong similarities.

Based upon my handling of the actual material in question, I believe there is a definite difference. Though unsubstantiated, I think it is a matter of density and precision—density because quartzite seems to be "tougher" than petrified wood; precision because petrified wood can provide (and seems to have) smaller, more manageable edges for percussion. In short, I believe differences exist but lack the means at present for delineating them.

Although unable to pinpoint specific physical differences between quartzite and petrified wood, it might still be profitable to attempt to discover functional activities with which they could be associated. Such an endeavor might be counted as suspect on the basis that the actual physical differences relative to technology have not been demonstrated to any appreciable extent. Nonetheless, circumstantial reasoning may provide clues to possible answers and as such has some heuristic merit. For example, a number of authors have identified quartzite as a preferred material for hammerstones used in flint knapping. In his discussion of the physics of fracture processes, Speth notes:

> We will assume the core is chert and the indenter is fine-grained quartzite. This last assumption does not seem unreasonable when dealing with hard-hammer percussion because modern flint workers often specifically recommend quartzite as a suitable material and quartzite cobbles, believed to have been used as hammerstones, are commonly found in archeological deposits (Speth 1972:39).

In two separate papers, Knowles (1944, 1953) details his own knapping experimentation and why he used quartzite hammerstones:

1) Its (quartzite) weight and toughness and the fact that it is a good flaker.

2) Its range of size.
3) Its compact size.
4) Its convenient shape.
5) Its ubiquity.

From ethnographic accounts, we find Cushing's (1919:366) somewhat idealized description of flint knapping in which the hammer had to be a "tough, granular stone" and Malik's (1959:163) documentation that in Stone Age cultures of India, flint knapping was accomplished by means of white quartzite hammers.

The gist of the preceding paragraph should be apparent; quartzite is both reported and hypothesized to be an integral component in chipping stone, specifically chert or chalcedonic materials. While this cannot be proven, it does suggest a way, perhaps plausible, for interpreting the observed shift from quartzite to petrified wood predominance in hammerstone materials. That interpretation is relatively simple; if quartzite is essential to flint knapping, then its decline suggests a decline in that activity. Interesting in this regard is the decrease in chert through time, especially since most chert hammers seem to be exhausted cores.

The test of this idea is probably impossible without correlation with other data not yet available, such as the ongoing lithic analysis. Alternatively, though, we might also suggest that petrified wood was used in manufacturing chipped stone, but in the latter stages of the process—that which involved more precise percussion control—rather than the primary stages where quartzite might have been most effective in reducing bulk material as suggested by Knowles (1944:118). This would in turn suggest that although we find that through time more and more bulk reduction took place elsewhere, the "blanks" or whatever, were imported and the final stages of production occurred in the canyon. That proposition, of course, borders on pure speculation and is, therefore, hardly acceptable. If, however, either of these two propositions can be tested then it may be that speculation will metamorphose into probability.

The quartzite replacement problem is not the only temporal issue. The change in imported materials used as hammers was mentioned before. Essentially, chert shows a gradual increase through 29SJ 724 with a gradual tapering off thereafter although there is a slight anomalous jump at 29SJ 1360 (Figure 6.1). The basic observation is that imported materials constitute around 25 percent or better of all hammerstones at each site.

The peak at 29SJ 724 becomes particularly interesting when compared with other sorts of evidence. For instance, a look at individual material types shows that 1112 (dark wood) increases proportionally until 29SJ 724, then like imported material in general, it drops off. In fact, the drop in imported material seems to be accounted for primarily by the drop in material type 1112. This pattern is replicated by other correlations between material type and the time period represented by 29SJ 724 and 29SJ 629.

In Table 6.12 diversity in material types is greatest at this period (A.D. 1000s), especially among the cherts. We also find that quartzite cobbles are proportionately stable through 29SJ 724, at which point they suddenly drop. Conversely, material type 1110, which is thought to have replaced quartzite, also is proportionately consistent until Pueblo I, e.g., at 29SJ 724, when it skyrockets upward. Finally, Figure 6.1 shows that at 29SJ 724 and 29SJ 629, there is a real drop in the percentages of angular hammerstones which picks up again at 29SJ 627.

It does not seem possible at this time to integrate coherently these several variations through time; that must wait until an additional analysis is completed. As a guide to further research, however, we might note that the changes seen at sites in Chaco Canyon in hammerstone characteristics seem to be at least superficially related to the transition period between Basketmaker III and Pueblo I that Plog (1974) has described for the Hay Hollow Valley in Arizona. This transition phase is characterized by technological change, population growth, diversity in material culture, and "experimentation." It might be well to keep this in mind as a jumping off place for further interpretation. This is very important in that it pertains to the question of whether the "Chaco Phenomenon" was a unique sequence, or whether changes in the canyon follow similar developments elsewhere in the Southwest.

Spatial Distribution

Spatial distribution is one of the major sources of evidence for inferences as to internal site utilization. Because this report covers a number of

Table 6.13. Distribution of hammerstones by provenience.

Site Number	Provenience	Provenience Number	Level Category	Level Number	Morphology*	Total Number
29SJ 423	Surface	1	1	-	3A, 1S	4
	Pithouse	1	1	-	1S	1
	Pithouse	2	-	1	1A	1
	Pithouse	2	2	1	1A	1
	Pithouse	2	8	1	1A	1
	Great Kiva	1	1	-	5A, 1S	6
	Great Kiva	1	2	1	5A, 1S	6
	Great Kiva	1	2	2	7A, 2S	9
	Great Kiva	1	Floor	3	1A	1
	Ramada	1	1	-	3A	3
	Ramada	1	2	1	4A	4
	Trash	1	2	1	3A	3
29SJ 724	Pithouse	1	-	-	1A	1
	Pithouse	1	2	11	1A	1
	Pithouse	1	Floor	-	1A	1
	Room	1	2	-	1S	1
	Room	1	2	1	1A	1
	Room	1	Floor	1	1A	1
	Room	10	Floor	1	1A	1
29SJ 721	Pithouse	3	-	-	1A	1
29SJ 299	Surface	2	2	1	1S	1
	Test Trench	1	2	1	1A	1
	Pithouse	1	2	1	1A	1
	Pithouse	1	Floor	1	3A	3
	Pithouse	2	2	2	1A, 1S	2
	Pithouse	2	2	3	1S	1
	Pithouse	2	2	5	1A	1
	Pithouse	2	2	7	1S	1
	Pithouse	2	Floor	1	2A	2
	Pithouse	3	2	1	2S	2
	Pithouse	3	2	3	1A, 1S	2
	Pithouse	4	2	-	3A, 1S	4
	Pithouse	4	Floor	1	1A, 1S	2
	Pithouse	5	2	4	1S	1
	Pithouse	5	Floor	1	2S	2
	Room	7	2	-	1A, 1S	2
29SJ 1360	Surface	3	2	-	1A	1
	Surface	5	2	-	6A, 1S	7
	Room	1	2	1	1A	1
	Room	2	2	-	2A	2
	Room	2	2	1	2A	2
	Room	3	2	1	1S	1
	Room	5	2	-	1A	1
	Room	7	2	1	1A	1
	Kiva	1	2	-	1S	1
	Kiva	1	2	1	4A, 1S	5
	Kiva	1	2	2	1A, 2S	3
	Kiva	1	2	3	4A, 2S	6
	Kiva	1	2	4	3A, 1S	4
	Kiva	2	-	1	2A, 1S	3
	Kiva	2	2	-	1A	1
	Kiva	2	2	4	1A	1
	Kiva	2	Floor	1	6A, 2S	8
	Plaza	1	2	-	5A, 2S	7
	Plaza	1	Floor	3	1S	1
	Plaza	2	2	-	1S	1
	Plaza	3	Floor	2	3A	3

Table 6.13. (continued)

Site Number	Provenience	Provenience Number	Level Category	Level Number	Morphology[a]	Total Number
	Ramada	2	2	-	3A	3
	Trash	1	2	-	1A, 1S	2
	Back dirt	1	1	-	1A	1
	Back dirt	1	8	-	3A, 1S	4
	Back dirt	2	2	-	1A	1
	Back dirt	2	8	-	1A	1
	Back dirt	4	8	-	4A, 2S	6
29SJ 627	Surface	3	1	-	1A	1
	Test Trench	1	2	1	3A	3
	Test Trench	19	2	1	2A, 1S	3
	Test Trench	55	2	2	1A	1
	Pithouse	1	2	1	1A	1
	Pithouse	1	2	3	3A	3
	Pithouse	1	2	7	1A	1
	Pithouse	1	2	8	1A	1
	Pithouse	2	2	3	1A	1
	Pithouse	2	Floor	-	1S	1
	Room	5	Floor	-	1S	1
	Room	5	Floor	1	12A, 6S	18
	Room	5	Subfloor	1	3A	3
	Room	5	Subfloor	3	1S	1
	Room	6	Floor	1	1A	1
	Room	7	-	2	1A	1
	Room	8	Floor	1	1A, 1S	2
	Room	8	Floor	2	1A	1
	Room	9	Floor	4	1A	1
	Room	9	Subfloor	4	1S	1
	Room	9	Subfloor	7	1A	1
	Room	10	Floor	2	3A	3
	Room	10	Subfloor	1	2A, 1S	3
	Room	10	Subfloor	2	10A, 2S	12
	Room	15	2	1	1S	1
	Room	15	2	2	1A	1
	Room	15	Subfloor	1	1A	1
	Room	16	Floor	3	1A, 1S	2
	Room	17	Floor	-	1A	1
	Room	17	Floor	1	3A	3
	Room	18	2	1	1A, 1S	2
	Room	18	2	2	1A, 1S	2
	Room	19	Floor	-	1A	1
	Room	19	Floor	1	1A	1
	Room	23	5	1	1A	1
	Kiva	1	2	-	1A	1
	Kiva	1	2	9	3A	3
	Kiva	1	2	11	3A	3
	Kiva	1	2	16	2A	2
	Kiva	1	Floor	1	2A	2
	Kiva	2	2	5	3A	3
	Kiva	2	2	7	1S	1
	Kiva	2	Floor	1	10A, 3S	13
	Kiva	3	2	6	3A, 2S	5
	Kiva	3	2	8	1A	1
	Kiva	4	2	5	5A	5
	Plaza	1	2	-	1A	1
	Plaza	1	2	1	1A	1
	Plaza	4	2	1	1A, 1S	2
	Plaza	4	Subfloor	1	1A	1
	Ramada	1	Floor	1	2A	2
	Trash	5	2	2	6A	6
	Trash	6	2	1	1S	1
	Trash	7	2	2	1A	1
29SJ 628	Surface	3	-	-	1A	1

Table 6.13. (continued)

Site Number	Provenience	Provenience Number	Level Category	Level Number	Morphology[a]	Total Number
	Pithouse	1	2	1	1S	1
	Pithouse	1	2	2	2A, 1S	3
	Pithouse	3	2	-	1A	1
	Pithouse	3	2	1	1A	1
	Pithouse	3	2	2	3A	3
	Pithouse	3	2	3	8A, 4S	12
	Pithouse	3	2	5	1S	1
	Pithouse	3	Floor	1	3A	3
	Pithouse	4	-	-	1A	1
	Pithouse	4	-	1	1A	1
	Pithouse	4	2	1	3A	3
	Pithouse	4	2	2	1A	1
	Pithouse	4	2	4	1A	1
	Pithouse	4	Floor	1	1A	1
	Pithouse	5	2	1	7A	7
	Pithouse	5	2	2	1A	1
	Pithouse	5	2	3	1A	1
	Pithouse	5	2	4	1A	1
	Pithouse	5	Floor	-	2A	2
	Pithouse	5	8	1	1A	1
	Pithouse	7	2	-	2S	2
	Pithouse	7	2	2	1A	1
	Pithouse	7	2	3	1S	1
	Pithouse	7	Floor	1	1A	1
	Antechamber	3	2	2	1S	1
	Antechamber	4	2	1	1A	1
	Antechamber	4	2	3	1A	1
	Antechamber	4	2	4	2A	2
	Antechamber	4	Floor	1	1A	1
29SJ 629	Surface	10	1	-	2A	2
	Surface	26	1	-	1A	1
	Surface	31	1	-	1A	1
	Surface	36	1	-	1A	1
	Test Trench	8	2	1	5A	5
	Test Trench	21	2	7	1S	1
	Test Trench	28	2	1	1A	1
	Test Trench	53	2	1	1S	1
	Test Trench	53	2	2	1A	1
	Pithouse	1	2	49(?)	1A	1
	Pithouse	1	5	11(?)	1A	1
	Pithouse	1	Floor	1	1S	1
	Pithouse	2	2	4	1A	1
	Pithouse	2	5	5	1A	1
	Pithouse	2	5	6	1A	1
	Pithouse	2	Floor	1	1A	1
	Pithouse	3	2	3	1A	1
	Pithouse	3	2	4	1A	1
	Pithouse	3	2	5	1A	1
	Pithouse	3	2	7	9A, 2S	11
	Pithouse	3	2	8	8A, 1S	9
	Pithouse	3	2	9	1A	1
	Pithouse	3	2	12	6A	6
	Pithouse	3	2	13	1A, 2S	3
	Pithouse	3	2	36(?)	1A	1
	Pithouse	3	5	10(?)	1A	1
	Pithouse	3	Floor	1	5A, 1S	6
	Room	2	2	2	1A	1
	Room	2	Floor	1	1A	1
	Room	3	Floor	1	1A	1
	Room	3	Subfloor	2	2A	2
	Room	4	2	1	1A	1
	Room	7	8	-	3A	3
	Stone circle(?)	1	76(?)	-	1A	1

Table 6.13. (continued)

Site Number	Provenience	Provenience Number	Level Category	Level Number	Morphology[a]	Total Number
	Plaza	8	2	2	11A	11
	Plaza	9	2	4	2A	2
	Plaza	14	-	1	10A	10
	Plaza	14	2	1	11A	11
	Plaza	14	2	3	116A, 7S	123
	Plaza	15	2	1	1A	1
	Plaza	16	2	1	1A	1
	Plaza	20	2	-	1A	1
	Plaza	20	2	3	1A	1
	Plaza	22	2	3	1A	1
	Plaza	35	5	1	1A	1
	Plaza	35	Floor	1	1A, 1S	2
	Plaza	35	Subfloor	1	2A	2
	Ramada	1	-	1	3A	3
	Ramada	1	2	1	1A	1
	Trash	58	2	1	1A	1
	Trash	64	2	5	1A	1
	Trash	65	2	4	2A	2
	Trash	65	2	5	3A	3
	Trash	65	2	6	2A	2
	Trash	70	2	1	1A	1
	Trash	70	2	3	1A	1
	Trash	70	2	5	1A	1
	Trash	76	1	-	1A	1
	Trash	76	2	3	1S	1
	Trash	82	2	5	3A	3
	Trash	88	1	-	1A	1
	Trash	88	2	2	5A	5
	Trash	88	2	4	1A	1
29SJ 389	Room	103	5	-	6A	6
	Room	103	Floor	7	1A	1
	Room	104	2	-	1A, 2S	3
	Room	106	2	-	1A	1
	Room	114	2	-	2A	2
	Room	145	2	-	1A	1
	Room	145	5	-	1A	1
	Room	145	Floor	-	1A	1
	Room	159	2	-	2A	1
	Room	164	2	-	4A, 2S	6
	Room	171	2	-	2A	2
	Room	176	2	-	2A	2
	Room	185	2	-	2A	2
	Room	193	2	-	6A	6
	Room	198	2	-	1A	1
	Room	200	2	-	1A	1
	Room	203	2	-	3A	3
	Room	204	2	-	1A	1
	Room	211	2	-	5A	5
	Room	212	2	-	1A	1
	Room	216	2	-	1A	1
	Room	219	2	-	1A	1
	Room	231	5	-	5A, 2S	7
	Kiva	1	2	-	2A	2
	Kiva	3	2	-	1A	1
	Kiva	5	2	-	2A	2
	Kiva	8	2	-	1A	1
	Kiva	11	2	-	1A	1
	Stone Circle (?)	1	2	-	2A	2
	Circular Structure	1	1	-	1A	1
	Circular Structure	1	2	-	2A	2
	Circular Structure	2	2	-	11A, 1S	12
	Plaza	1	-	-	2A	2
	Plaza	1	2	-	6A, 1S	7
	Plaza	135	2	-	1A	1
	Plaza	201	5	-	1A	1

Table 6.13. (continued)

Site Number	Provenience	Provenience Number	Level Category	Level Number	Morphology[a]	Total Number
	25 Plaza Feature	1	2	-	1A	1
	25 Plaza Feature	2	-	-	1A	1
	25 Plaza Feature	4	2	-	1A	1
	Other Structure	3	2	-	2A	2
	Other Structure	4	2	-	53A	53
	Other Structure	6	1	-	1A	1
	Other Structure	7	2	-	2A	2
	Other Structure	8	2	-	2A	2
	Other Structure	10	2	-	2A	2
	Other Structure	11	2	-	1A	1
	Other Structure	12	2	-	7A	7
	27	1	2	-	2A	2
	27	5	2	-	1A	1
	27	999?	1	1	1A	1
	28	12	2	-	1A	1
	72	3	2	-	3A	3
	90	10	-	-	1A	1

[a] Morphology: A = angular; S = spheroid.

different sites that were excavated by a number of archeologists, it is thought that their problems can best be served by simply tabulating the provenience data (Table 6.13) and allowing the researchers involved to use this information at their own discretion. If their interpretations seem to contribute more information to the understanding of hammer-stones, then this can be treated at length in future reports.

Conclusions

The results of the analysis of hammerstones from Chaco Canyon have shown that contrary to wide-spread opinion, these tools are not limited in the amount of information which they convey. Indeed, it can easily be argued that it is the limitations previously imposed by researchers upon their data rather than the function of the nature of hammerstones that affects the analysis. It has been suggested in this report that two basic types of hammerstones exist in terms of morphology and that these are most likely related to functional differences. It has also been suggested that functional differences can be related to the type of material from which hammerstones were made and that the types, and hence functions, change through time. The purpose of this report was, in part, to examine the usefulness of the criteria selected for analysis. It can be concluded that these were indeed successful in delineating a number of important problems. Unfortunately, these criteria have not proven to have substantial power in further addressing the very problems they have isolated. Consequently, I would recommend a refinement of the analysis form which could subsequently be applied to a sample of the analyzed material. The preliminary analysis has determined the problems; further work is needed to solve them.

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Appendix 6A

Hammerstone Analysis Form

Variable	Category Description	Columns[a]	Column Numbers
01	Weight	5	43-47
		X	48
02	Material Type	4	49-52
		X	53
03	Parent State	1	54
	1) Cobble		
	2) Tabular		
	3) Silicified wood		
	4) Other		
	5) Unknown		
		X	55
04	Cortex	1	56
	0) Absent		
	1) 1-25%		
	2) 26-50		
	3) 51-75		
	4) 76-100		
	5) Unknown		
		X	57
05	Technology of Manufacture	1	58
	1) Shaped by flaking		
	2) Shaped by other		
	3) Not shaped		
		X	59
06	Morphology	1	60
	1) Angular		
	2) Spheroid		
	3) Discoid		
	4) Slab		
		X	61
07	Wear	1	62
	0) Absent		
	1) Abrasion		
	2) Battering		
	3) Step fracture		
	4) Abrasion/battering		
	5) Abrasion/step fracture		
	6) Abrasion/battering/step fracture		
	7) Battering/step fracture		
		X	72
11	Function (subjective)	1	73
	1) Abrader		
	2) Hammer		
	3) Masonry		
	4) Chopper		
	5) Manuport		
	6) Unknown		
	7) Core		

[a] X = blank column.

Chapter Seven

An Analysis of Axes and Mauls from Chaco Canyon, New Mexico

Cory Dale Breternitz

Introduction

The 25 axes, mauls, and miscellaneous grooved sandstone implements analyzed in this chapter come from eight sites located within Chaco Culture National Historical Park (formerly Chaco Canyon National Monument). These sites (29SJ 627, 29SJ 628, 29SJ 629, 29SJ 1360, 29SJ 721, 29SJ 724, 29SJ 389 and 29SJ 390) range temporally from late Basketmaker III through Pueblo III and include the Classic Bonito Phase site of Pueblo Alto (29SJ 389). All of the sites were excavated between 1973 and 1976, with the exception of Pueblo Alto, which was excavated in 1976 through 1978, during and after the preparation of this report. Reports that were in progress or in manuscript form when this paper was written are, in some cases, completed (McKenna 1984; Truell 1975, 1992; Windes 1976a, 1976b, 1987, 1993). Windes' (1993) report on 29SJ 629 does update some of the discussion included in this chapter.

This sample consists of 25 artifacts, which limits extensive analysis and comparison. To enlarge this study, a brief comparison of axes and mauls from other sites within Chaco Canyon is included, as well as those from sites elsewhere in the Southwest.

The artifacts in this sample are divided into axes and mauls for practical reasons. The literature on grooved stone artifacts is full of varying definitions of similar artifacts like mauls, hammers, picks, and clubs. The definitions used in this paper are taken from A. V. Kidder's The Artifacts of Pecos (1932) and Richard Woodbury's Prehistoric Stone Implements from Northeastern Arizona (1954). An axe is defined as any tool that is designed specifically for chopping and working wood. It has a sharpened bit, is "hafted by means of a wooden handle fitted against or into grooves or notches" (Woodbury 1954:25), and is usually manufactured out of a dense igneous or metamorphic rock rather than sandstone. Mauls are defined as large, grooved implements manufactured out of slightly modified, coarse-grained soft sandstone, or a naturally shaped river cobble that is basically unmodified except for the groove. Most of the sample could be classified in either one or the other of these two categories. There were several problematical artifacts that were simply termed "miscellaneous grooved stone implements," mainly because of their extreme size and crudeness of manufacture.

A form for recording the artifacts was designed especially for this study. This was done after surveying most of the available literature on grooved artifacts and compiling a list of attributes and measurements that were believed to be important in determining the function of the artifact and its method of manufacture. Because there is currently no consistent method of recording axes and mauls, it is hoped that this form will prove useful in further studies of this type. A copy of the form is included (Figure 7.1), along with a drawing illustrating nomenclature used and the location of the measurements taken on each artifact (Figure 7.2).

AXE & MAUL FORM

Site #__________ Field Specimen # __________

Provenience: *(Top part self-explanatory)*

Description:

1) Type: *Type of artifact: axe, maul, hammer, etc.*
2) Condition: *Complete or fragment*
3) Material: *Helene Warren's material code no, source areas*
4) Weight: *Weight of artifact in grams*
5) Dimensions: Length: *Bit to poll* Poll length: *Poll to groove*

   Width: *Measured on the bit side of groove on shoulder* Face Length: *Bit to groove*

   Thickness: *Same place as width* Bit Width: *Width of cutting edge*
6) Nature of Groove: *Full groove, 3/4 groove, notched, how manufactured, pecked, ground, etc.*

   Groove Width: *Measured either at the inner or outer side*

   Groove Depth: *Same as groove width*

Manufacture:

1) Parent state: *River cobble, tabular sandstone, etc.*
2) Cortex, P/A: *Presence or absence of cortex and where on artifact*
3) Shape: Ovid, *Ellipsoid, rectangular, etc.*
4) How shaped: *Ground, pecked, flaked, abraded*

Function: (wear) Things to look for:

Abrasion	Direction and patterning of striations	
Battering	Ground surfaces	
Stepfracturing	Regrooving	
Multiple use	Reshaped	
Previous use	Function:	Woodworking
Polish		Light chopping
Striations		Pounding/crushing

Figure 7.1 *Axe and maul form.*

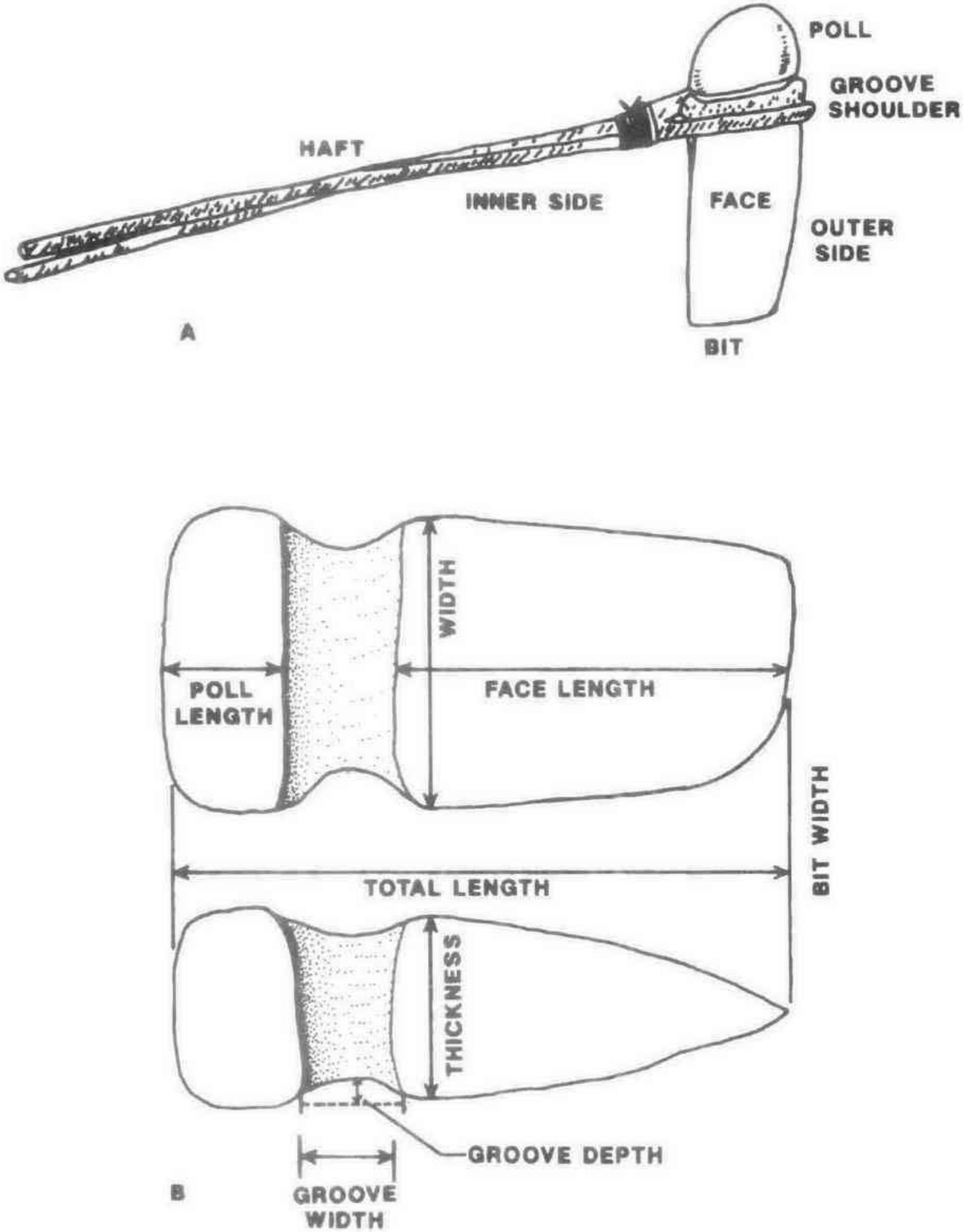

Figure 7.2. *A) Axe terminology (after Kidder 1932:45).*
B) Dimensions taken on stone axes.

The Sample

A brief description of the artifacts by site is presented below. For a complete list of artifacts, their provenience, measurements and weights, see Table 7.1.

29SJ 627

The most prolific site, as far as grooved stone artifacts are concerned, is 29SJ 627, which is represented by four axes and nine mauls (Truell 1992). Three of the four axes are complete, or complete enough to be functional. None of the three have sharpened bits and could not be used to cut wood efficiently. Instead, their bits show signs of battering, flaking, and abrasion; they had been reused as hammers when the bits could no longer be resharpened. Eventually, all stone axes end up as hammers or hammerstones because they either become so worn down from numerous resharpenings that the edge angle forms a bit that is too shallow to cut effectively, or the bit is broken off so that resharpening is impractical. Rather than being discarded, the artifact is used as a hafted hammer; this is indicated by battering and abrasion on both the bit and poll. Two of the three complete axes have full grooves pecked around their circumference; the third one is only 3/4 grooved. This is unusual for both the time period and area; 3/4 grooved axes are more common to the south and occur later in time. The material of the full-grooved axes is Cliff House sandstone (Figures 7.3 and 7.4), while the 3/4 grooved axe is claystone, possibly from the Mancos shale formation (Figure 7.5). Claystone is slightly harder than sandstone and may account for its not being fully grooved. All that remains of the fourth specimen is the face, which had been fractured along the forward shoulder of the groove. It is made from a river cobble of hornblende diorite and is slightly battered.

The nine mauls from this site are made of two materials, Cliff House sandstone and hornblende- diorite river cobbles. Six of the mauls (66 percent) are made of Cliff House sandstone. Five of these mauls are complete and three of them have full grooves (Figures 7.6 and 7.7); the other three are notched, usually at the corners of the stone. One of the full-grooved sandstone mauls has been split longitudinally and then regrooved over the flake scar in the same position as the original groove (Figure 7.8).

The three remaining mauls are all made of hornblende-diorite river cobbles (Figures 7.9 and 7.10). This material was probably desired because of its hardness and natural shape, which required little modification. All of these artifacts are either notched on the edges or only partially grooved where absolutely necessary.

Temporally, 29SJ 627 contains both Pueblo I and Pueblo II components (Truell 1992). The artifacts occur in all portions of the site, with a concentration in Room 8 where there was a cache of ground stone. One axe and three mauls (30.7 percent of the total sample) from the site come from this cache (Figures 7.5, 7.6, and 7.10). None of the axes would presently function as woodworking tools. When the bits broke off or reached the point where they could no longer be resharpened, they were retired, probably for use as hammers. The mauls all show signs of being used for heavy battering and crushing, possibly associated with masonry stoneworking or temper crushing for ceramics.

Of the materials used in the manufacture of these artifacts from 29SJ 627, the Cliff House sandstone occurs abundantly in the canyon. The closest source of the hornblende-diorite river cobbles is probably the San Juan River, ca. 75 kilometers to the north. The claystone probably originates from outcroppings of Mancos shale, located south of Chaco Canyon near Crownpoint. The Cliff House sandstone accounts for 61.5 percent of the material used, hornblende-diorite for 30.7 percent, and the claystone for 7.6 percent.

29SJ 628

This site yielded three grooved artifacts, two axes and one maul. Both axes are modified greenstone river cobbles. One of these axes is complete, the other is fractured along the forward shoulder of its groove so that just the face remains.

The complete axe (Figure 7.11) can be considered a full-grooved axe although the groove does not quite meet on one face. This is an irrelevant distinction because the stone is slightly concave at this point and, therefore, does not require a full groove for adequate hafting. This axe is the finest and most complete example represented in the collection. It is the only example in the collection

Table [illegible].1. Axes and mauls of the work sample.

Site No.	Artifact Type	Condition	Material	Provenience	FS No.	L.	W.	Th.	Poll Length	Face Length	Bit Width	Weight (gms)
29SJ 627	Axe[a]	Comp.	2125	Kiva C, Level 8, (north of masonry wall)	2074	12.4	8.5	3.3	4.7	6.6	-	473
	Axe[a]	Comp.	2500	Room 8, floor contact, storage area	1676	14.4	6.5	4.4	5.8	8.1	4.6	755
	Axe[a]	Comp.	2126	Area immediately west of Cist 8	2152	21.9	7.7	5.1	9.5	10.3	6.5	1528
	Axe[a]	Frag.	3241	Test Trench #2, Level 3	1295	7.9	8.2	2.6	-	7.9	6.2	270
	Maul[a]	Comp.	3241	Room 8, floor, ground stone cache northwest corner	138	29.2	9.0	6.9	12.4	13.9	3.8	2775
	Maul[a]	Comp.	2125	Room 8, floor, ground stone cache northwest corner	138	21.6	8.8	4.1	9.2	9.4	4.0	1186
	Maul	Comp.	3241	Room 8, floor contact, storage area	1675	22.2	9.5	6.9	8.6	11.4	-	2100
	Maul[a]	Comp.	3241	Room 4, Bell-shaped storage cist	776	23.6	8.1	7.2	8.6	12.1	4.4	1877
	Maul[a]	Comp.	2125	Test Trench #4	1139	14.9	10.3	8.8	6.7	7.0	-	1814
	Maul	Comp.	2126	Feature 1, Level 2	1928	19.8	12.7	3.7	-	-	11.4	1538
	Maul	Comp.	2125	Room 18, Level 1	1406	23.2	8.1	7.7	7.1	13.9	-	2333
	Maul	Comp.	2125	Room 5, Level 3	162	22.3	10.8	9.3	9.8	9.7	-	3742
	Maul[a]	Frag.	2125	Room 10, Floor 2 (wall perpendicular to west wall)	5133	24.5	11.0	7.0	8.9	13.6	-	2722
29SJ 628	Axe[a]	Comp.	3040	Pithouse D, antechamber, floor contact	310	14.2	8.1	3.3	5.0	6.3	4.8	557
	Axe	Frag.	4525	Pithouse D, antechamber, floor contact	334	13.0	9.1	4.7	-	13.0	-	731
	Maul[a]	Comp.	2125	Pithouse C, Level 2	401	15.3	9.1	6.0	7.0	6.9	3.8	996
29SJ 629	Axe	Frag.	4526	Room 9, surface	320	7.4	5.5	3.3	-	7.2	-	237
	Maul	Comp.	2125	Pithouse 1 (Kiva)	1509	28.8	13.0	7.7	12.2	15.3	9.0	4462
	Hammer-stone.[a]	Comp.	2125	Pithouse 3, fill, backdirt	3327	7.8	6.0	5.4	3.0	3.3	-	351
29SJ 1360	Axe[a]	Comp.	4515	House 2, Kiva A, Level 3, 90-130 cm.	381	14.8	7.8	3.4	4.6	7.6	4.7	708
	Axe	Frag.	3020	House II, Kiva trench overburden	227	9.6	9.2	2.9	5.4	-	-	400
29SJ 721	Maul	Frag.	3241	Kiva	40	12.0	10.6	5.3	-	9.9	-	860
29SJ 724	Maul	Comp.	2125	Room Block 1, Test Trench Level 7	97	23.0	13.8	7.0	10.0	10.0	6.0	2332
29SJ 289	Maul	Comp.	2125	Other Structure 6, wall clearing	434	33.0	16.0	10.0	14.5	16.5	-	6641
29SJ 390	Axe[a]	Comp.	4526	Room 11, east wall, wall clearing	12	12.1	6.7	5.3	3.2	6.8	-	770

[a] Illustrated.

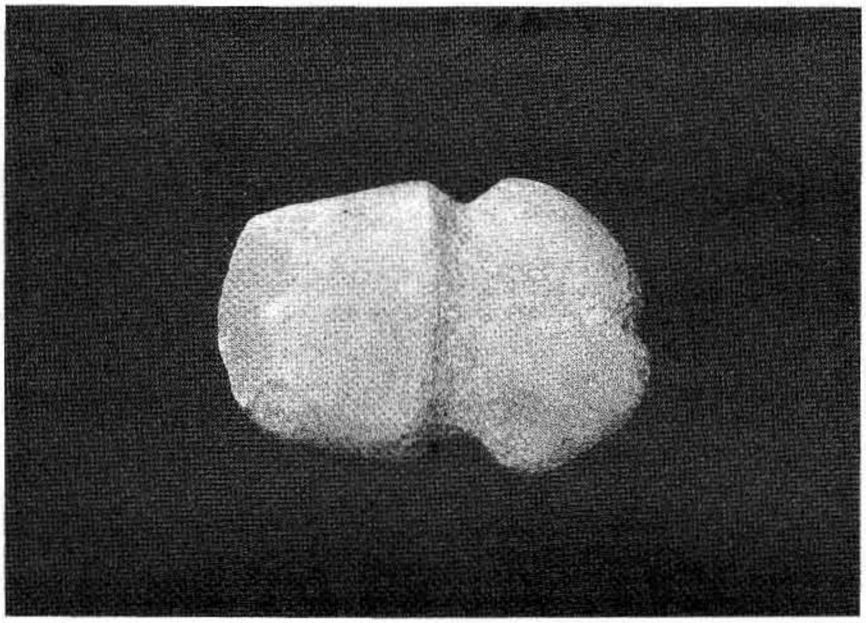

Figure 7.3. *Small axe Cliff House sandstone with a poll groove from 29SJ 627, FS 2074. (NPS Chaco Archive Negative No. 31646).*

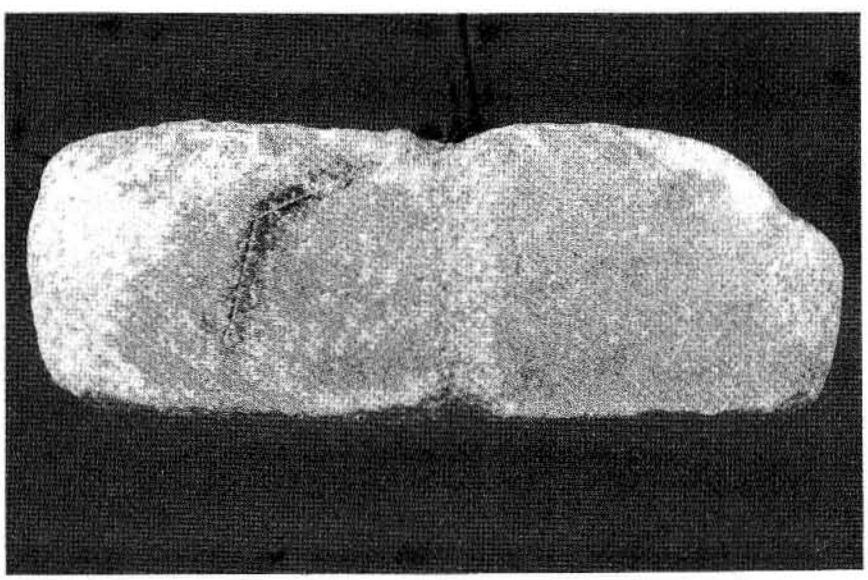

Figure 7.4. *Rectangular Cliff House sandstone axe with sharp bit, shaped by pecking and grinding, from 29SJ 627, FS 2151. (NPS Chaco Archive Negative No. 31645).*

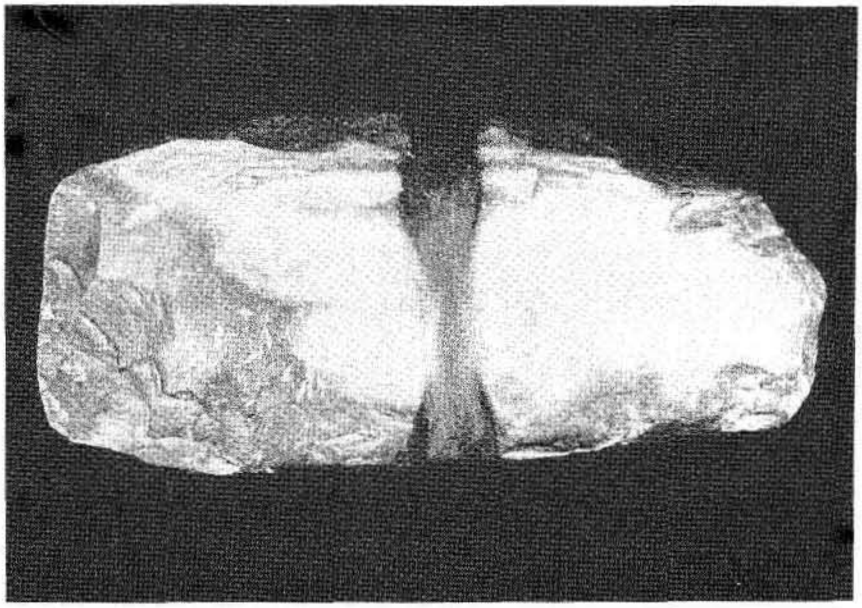

Figure 7.5. *Very battered 3/4 grooved claystone axe, polished and with many striations, from 29SJ 627, FS 1676. (NPS Chaco Archive Negative No. 31643).*

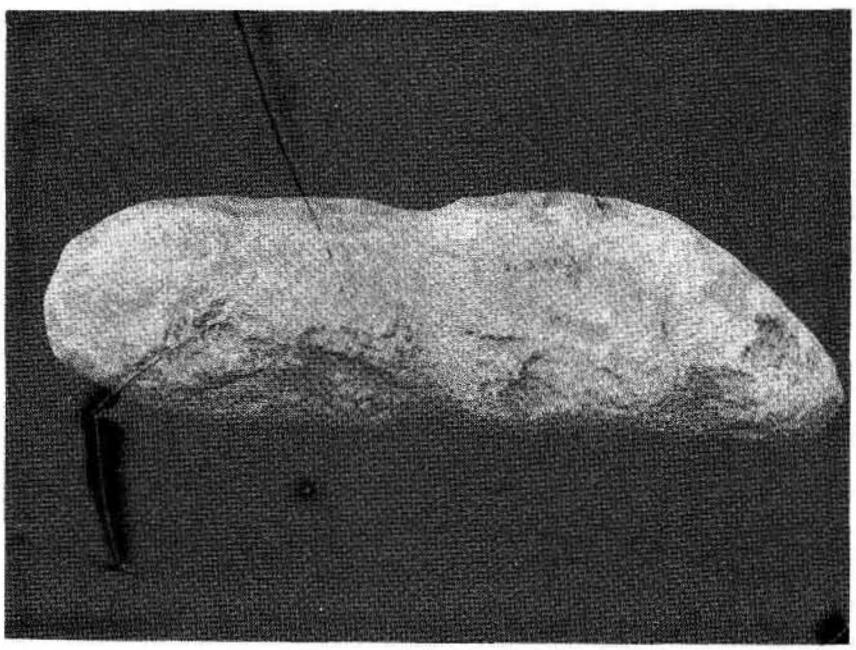

Figure 7.6. *Long pointed maul from the ground stone cache on the floor in the northwest corner of Room 8 at 29SJ 627, FS 138. (NPS Chaco Archive Negative No. 31644).*

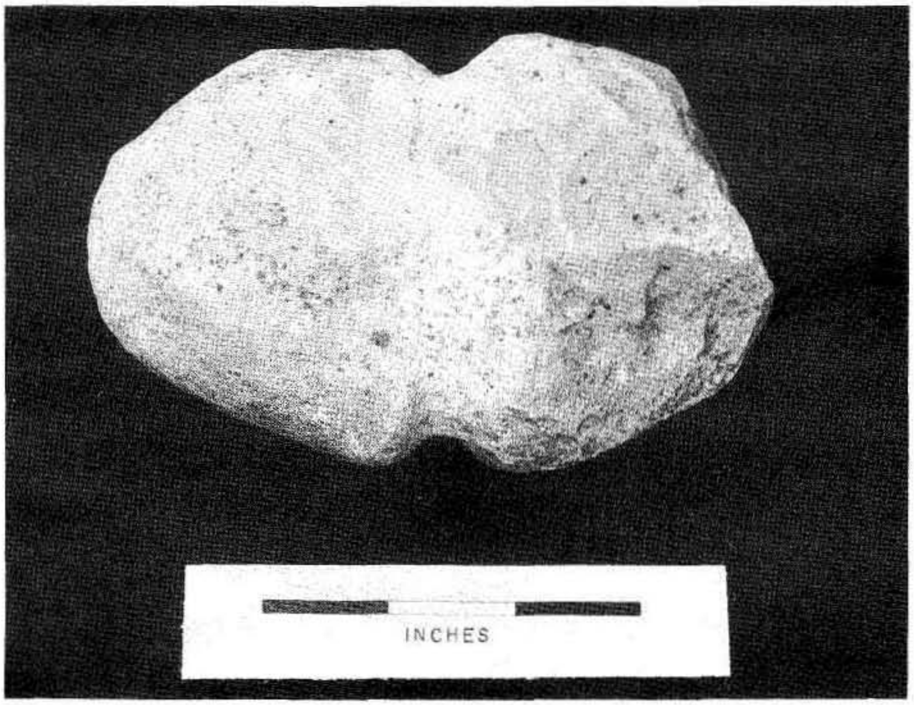

Figure 7.7. *Battered maul with full medial groove from 29SJ 627, FS 1139. (NPS Chaco Archive Negative No. 31642).*

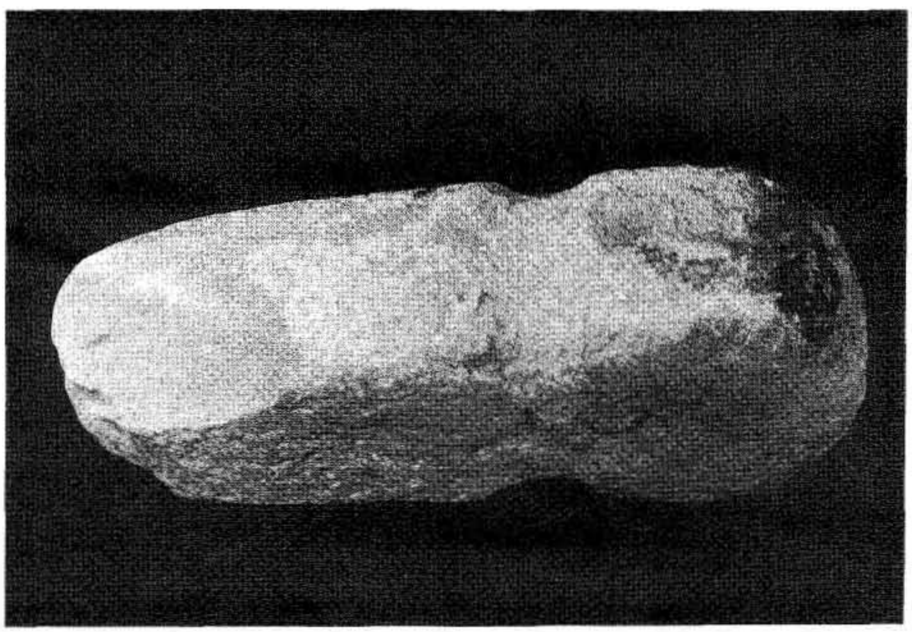

Figure 7.8. *Example of a large grooved Cliff House sandstone maul, shaped by pecking and grinding and regrooved from 29SJ 627, FS 5133. (NPS Chaco Archive Negative No. 31641).*

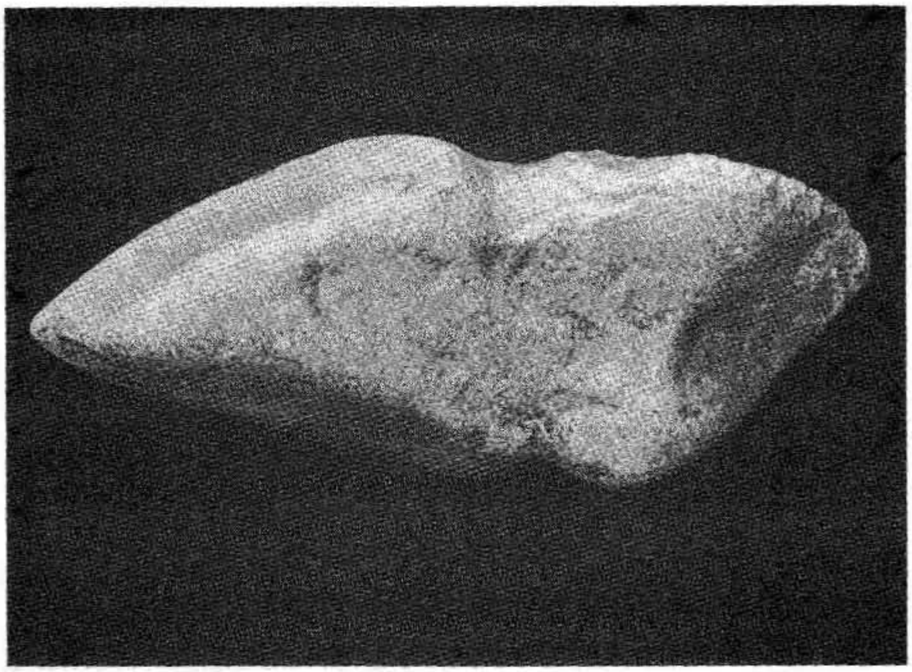

Figure 7.9. *Example of an irregularly shaped maul from 29SJ 627, FS 776, manufactured out of a notched hornblende-diorite river cobble. (NPS Chaco Archive Negative No. 31640).*

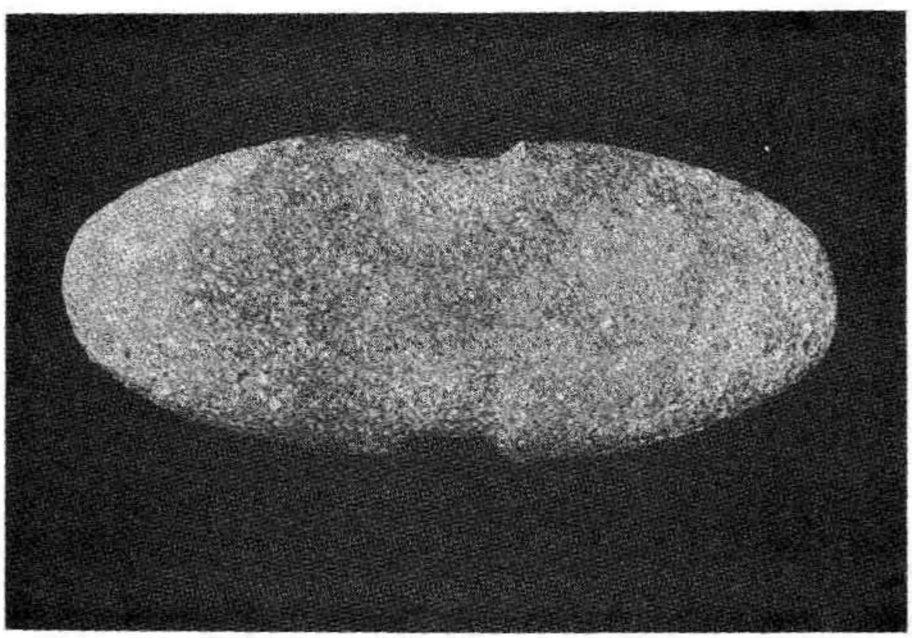

Figure 7.10. *Hornblende-diorite maul with sharpened bit and poll and medial grooves, from the ground stone cache in Room 8, 29SJ 627, FS 138. (NPS Chaco Archive Negative No. 31644).*

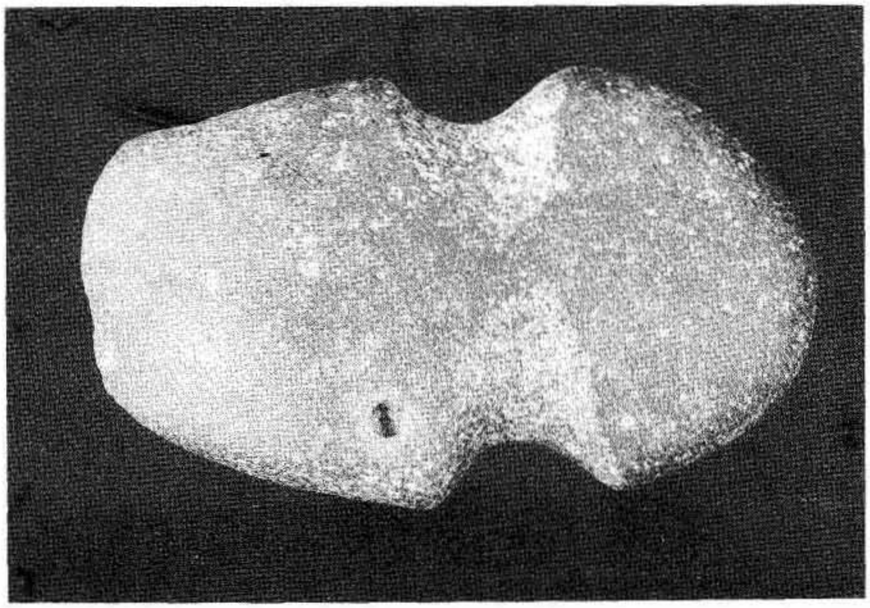

Figure 7.11 Gabbro-greenstone axe, from 29SJ 628, FS 310. Bit shows signs of having been resharpened many times. (NPS Chaco Archive Negative No. 31649).

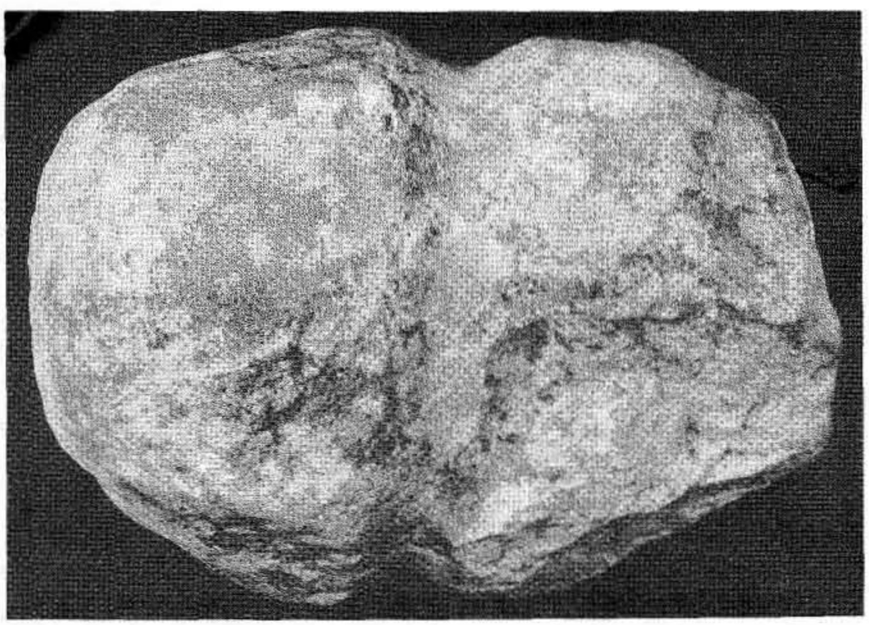

Figure 7.12. Crudely shaped Cliff House sandstone maul from 29SJ 628, FS 401. (NPS Chaco Archive Negative No. 31647).

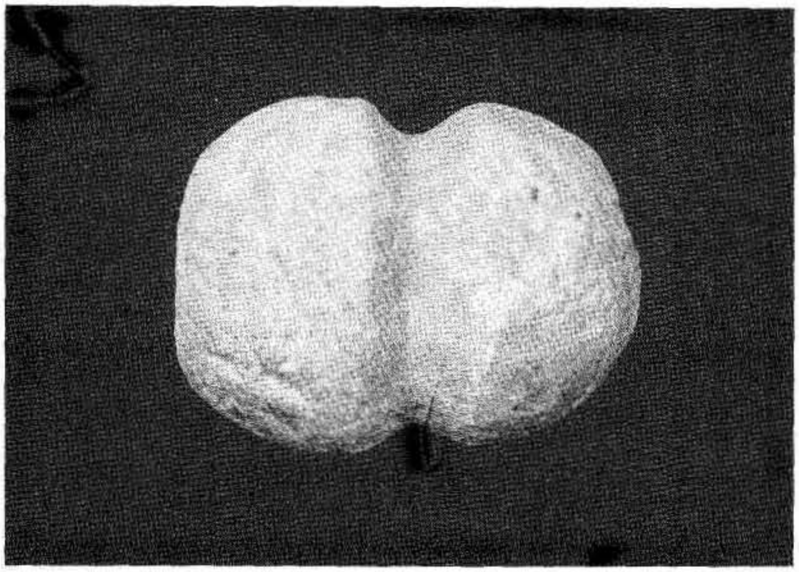

Figure 7.13. *Small grooved hammer of Cliff House sandstone from 29SJ 629, FS 3327. (NPS Chaco Archive Negative No. 31650B).*

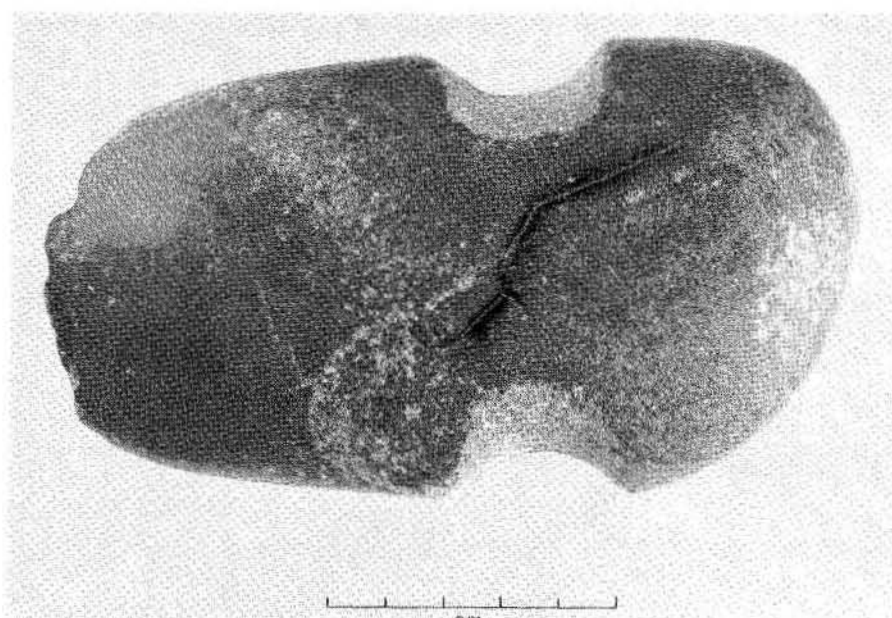

Figure 7.14. *Notched axe of hornblende-gneiss from 29SJ 1360, FS 381. (NPS Chaco Archive Negative No. 19384).*

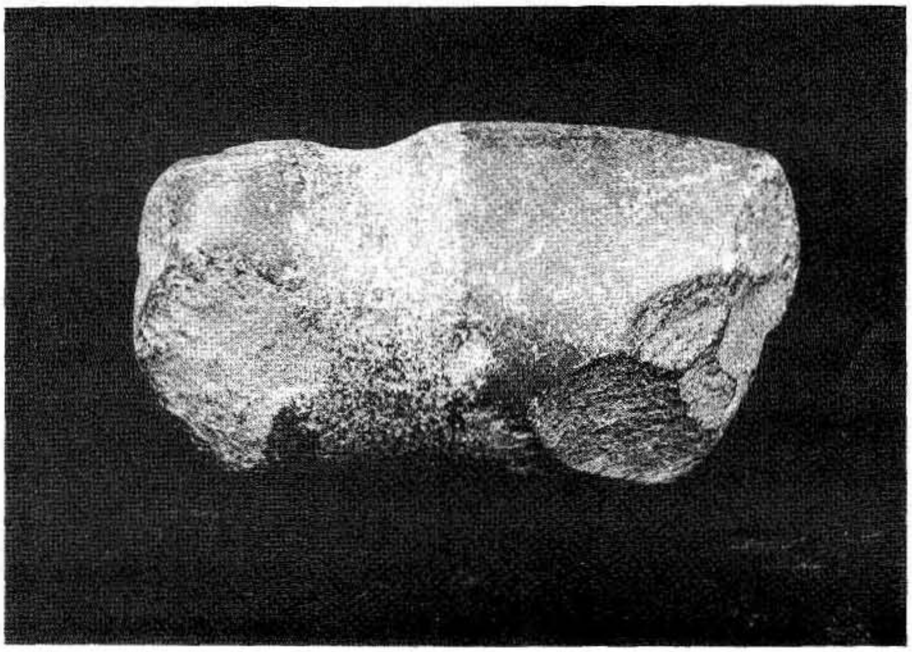

Figure 7.15. Very battered, full-grooved greenstone axe from 29SJ 390, FS 12. (NPS Chaco Archive Negative No. 31639).

that retains its sharp cutting edge and shows signs of resharpening. The edge angle is no longer symmetrical; the angle of the blade along one face to the bit is much steeper on one side than the other. The inner edge is roughly perpendicular to the haft, whereas the outer edge slopes up at a 25-30 degree angle due to extensive use. There are some fine striations that extend diagonally from the bit towards the outer edge and the haft and are probably the result of use. Sets of parallel striations extend in all directions and overlap, testifying to many resharpenings. The poll is formed by the natural contour of the stone and exhibits only light battering. These wear patterns suggest a single use as a woodworking tool.

The axe fragment has been slightly ground, but due to the extreme hardness of the material, this grinding did not shape the stone to any extent. The microscopic striations present are very irregular, possibly indicating the use of an abrader in many different directions to sharpen or polish the axe. The bit is broken off and bifacially flaked leaving an uneven cutting edge, which is slightly abraded and step-fractured.

The one maul from 29SJ 628 is a complete specimen made of Cliff House sandstone and exhibits a full groove pecked around its circumference (Figure 7.12). The bit is semirounded and shows signs of battering.

This site consists architecturally of five pithouses and a few storage cists dated to late Basketmaker III and early Pueblo I periods (Truell 1975). Both axes come from the floor of the antechamber of Pithouse D. It is significant that these two specialized artifacts can both be directly associated with this structure. The maul is from Level 2 in the fill of Pithouse C and cannot be positively associated with a specific feature.

The two greenstone axes are important in that there are relatively few axes of this material from sites in Chaco Canyon. The closest probable source for this material is the Brazos Uplift in north central New Mexico, east of the San Juan Drainage. The only greenstone axes recovered from sites in Chaco Canyon are associated with early sites (except for one from 29SJ 390), most of which are late Basketmaker III and Pueblo I in age.

29SJ 629

The grooved stone artifacts from this site consist of one axe, one maul, and an artifact that has been called a hammer, for lack of a better term. The axe is a fragment and was found on the surface in Room 9. The hammer was found in the backdirt of fill removed from Pithouse 3 by the backhoe. The maul is from the upper fill of Pithouse 1.

The axe fragment is a portion of the face and is made of a greenstone river cobble. One face and both sides are highly polished by abrasion; these surfaces are covered with numerous irregular striations. Several large flakes have been removed from one face and the bit is missing. Apparently, the axe fractured at the groove at the same time or soon after the bit was broken. The edge is not battered or abraded and does not appear to have been used as a hafted hammer after the bit was removed. Some slight abrasion noticeable on the bit indicates that it may have been used as a hammerstone before being discarded.

The hammer (Figure 7.13) is made from Cliff House sandstone and is ovid in shape and in cross-section with a full groove bisecting the artifact almost exactly in half. Both ends of the hammer are battered.

The maul from the fill of Pithouse 1 is Cliff House sandstone and has a notch pecked into each corner of its triangular-shaped body. An abraded area on the face appears to be a result of the shaping process; however, some of it could be from wear.

The poor provenience control of these artifacts make exact temporal correlations impossible. The site appears to have been occupied during late Pueblo I and early Pueblo II periods (Windes 1993). The presence of a greenstone axe fragment is significant and ties in culturally, if not temporally, with the two found at 29SJ 628 in the same rincon.

29SJ 1360

Site 29SJ 1360 produced two axes, both from House II; a complete specimen from Kiva A, Level 3 and a fragment from the kiva trench overburden. The complete artifact (Figure 7.14) is manufactured from a hornblende-gneiss river cobble and has two opposing notches pecked into its sides for hafting purposes. The face is polished and, as a result, covered with many irregular striations. There are also several striations that can be attributed to use wear. Several small flakes have been removed from the bit, resulting in a jagged but sharp cutting edge which shows little sign of battering or abrading.

The fragmented specimen also has two opposing notches pecked into its sides for hafting. The bit and most of the face are missing, leaving the poll and the notches. The material is an intermediate igneous river cobble probably brought in from the San Juan River. The edge of the poll is abraded as though it had been used for grooving or engraving.

It is interesting that both specimens come from the same provenience in the site and ultimately from the same source area. This site contains both Pueblo I and Pueblo II materials (McKenna 1984).

29SJ 721

The one specimen from this site is a large maul fragment made from a notched hornblende-diorite river cobble. The artifact retains its natural shape except for two opposing notches pecked into the stone for hafting purposes. The bit is dulled by battering and the poll is broken off at the notches. The artifact is from an isolated Pueblo III kiva, but the main portion of the site consists of two Basketmaker III pithouses and some cists (Windes 1976a).

29SJ 724

The single grooved artifact from this Pueblo I site was a crudely shaped, but complete Cliff House sandstone maul. It comes from Roomblock 1 where a test trench made contact with the wall of Pithouse A. Three notches are pecked into the natural corners of the unshaped rock; the artifact remains very angular and irregular (Windes 1976b).

29SJ 389 (Pueblo Alto)

The only grooved stone artifact recovered from Pueblo Alto during the first season of excavation was a large miscellaneous grooved sandstone implement too large to have been a maul. It is made from Cliff House sandstone, shaped mainly by flaking and pecking, and has two opposing notches pecked into the sides. Both ends are battered, although it was probably never hafted. It was recovered from this

Classic Bonito Phase pueblo while clearing the walls of Other Structure 6 (Windes 1987). Windes (1987 (3):297) indicates there were few hafted tools recovered from Pueblo Alto during the entire excavation period. He described one found in Kiva 15; it was made from hornblende-diorite. Forty-nine hafted hammers were also found (Windes 1987(3):296) and are better classified as hammerstone abraders.

29SJ 390 (Rabbit Ruin)

At this site, a full-grooved greenstone axe (Figure 7.15) was recovered during wall clearing procedures along the east wall of Room 11. The bit is broken and several large flakes have been battered and abraded. The face is finely polished and covered with hundreds of irregular striations, which are a product of polishing. There is some yellow hematite present in the groove on one face of the axe (Windes 1987).

Discussion

Although this sample is small, it is informative. There appears to be a slightly higher percentage of mauls represented at most sites. Axes account for only ten of the 25 specimens analyzed, or 40 percent of the total sample. The mauls account for 52 percent, and the one hammer and one miscellaneous grooved sandstone implement each account for four percent of the sample. Temporally, there appears to be a higher percentage of axes occurring early; i.e., Basketmaker III to Pueblo II periods, with the frequency dropping off after Pueblo II times. This sample is biased in this respect because most of the sites excavated by the Chaco Project in the past three years (1973-1976) have been early sites; i.e., Basketmaker III, Pueblo I.

The four greenstone axes account for 40 percent of the total axe sample, indicating a definite preference for this material. The preference for these axes in Basketmaker III and Pueblo I times is indicated at both 29SJ 628 and 29SJ 629 where three of the four axes were recovered. Forty percent of the ten axes are manufactured of greenstone, 20 percent of Cliff House sandstone, and all other materials represent (hornblende-diorite, hornblende-gneiss, claystone, intermediate igneous) 10 percent each. The mauls are manufactured of two materials, 66 percent are Cliff House sandstone and the remaining 34 percent are hornblende-diorite.

When axes and mauls are combined, Cliff House sandstone occurs most abundantly, accounting for 48 percent of the total. The other materials occur in the following frequencies: hornblende-diorite—24 percent; greenstone—16 percent; claystone, hornblende gneiss and intermediate igneous—four percent each. The Cliff House sandstone occurs abundantly in the canyon, making half of the raw materials used for the manufacture of grooved artifacts locally exploitable by the inhabitants of the canyon. The closest source for the rest of the materials, which occur primarily as river cobbles, is the San Juan River and its associated gravel beds. There is a source of greenstone in the Brazos Uplift in north central New Mexico, east of the San Juan Drainage. The claystone comes from Mancos shale outcrops near Crownpoint, south of Chaco Canyon. The San Juan River is ca. 75 kilometers to the north. There are several prehistoric roads that lead out of Chaco Canyon to the San Juan area; however, the earliest date for the road system is not known.

Summary of All Axes and Mauls Reported from Chaco Canyon

A search through the existing literature on excavated sites in Chaco Canyon was undertaken to obtain information on other grooved stone artifacts. The sample of 25 axes and mauls analyzed in the first portion of this chapter was combined with those from previously excavated sites (Table 7.2). It was hoped that by looking at all the sites in Chaco Canyon where grooved stone artifacts have been recovered that each time period would be equally represented and some substantial conclusions could be drawn. Only 24 sites, including the eight previously mentioned, have records of grooved stone implements (Bradley 1971; Brand et al. 1937; Judd 1954, 1959; Kluckhohn and Reiter 1939; Pepper 1920; Roberts 1929, Vivian and Mathews 1965). Many sites, such as Chetro Ketl, cannot be included in this study because references to grooved stone artifacts could not be located, although some were undoubtedly recovered.

When all the sites are examined, the lowest frequency of both axes and sites reported occurs during Basketmaker III and Pueblo I times. The highest frequency occurs during the Pueblo II period of the Hosta Butte Phase. The largest number of sites investigated also occurs during this period. This is due mainly to the excavation of many of the small

Table 7.2. Sites with grooved stone implements (axes and mauls).

Basketmaker III	Pueblo I	Pueblo I/ Pueblo II	Pueblo II	Pueblo III
Shabik'eshchee	29SJ 724[a]	29SJ 627[a]	House Site	Pueblo del Arroyo
29SJ 628[a]	Bc 236	29SJ 629[a]	Wetherill Mesa Site	Pueblo Bonito
		29SJ 1360[a]	Bc 50	Kin Nahasbas
			Bc 51	Pueblo Alto[a]
			Bc 53	Una Vida
			Bc 59	29SJ 390[a]
			Bc 362	29SJ 721[a]
				Kin Kletso

[a] Sites investigated by the Chaco Center.

sites (Bc sites) by the University of New Mexico Field School in the late 1930s and early 1940s. The Classic Bonito Phase greathouses and the smaller Pueblo III sites occur in the next highest frequency as do the number of grooved stone artifacts. One axe that is included in this count was found on the surface of an undisclosed site in Mockingbird Canyon.

There is a total of 132 grooved stone artifacts from 24 sites in the canyon. Eighty stone axes represented in the collection account for 60 percent of the total. These 80 axes come from 18 sites ranging in time from late Basketmaker III through the Classic Bonito Phase greathouses, averaging 4.4 axes per site. The actual distribution, however, is not quite that even. Only two axes come from Basketmaker III and Pueblo I horizons. Both are greenstone and both come from 29SJ 628. There are seven mauls from four different sites of this period. All but one of these mauls is made from Cliff House sandstone. The one exception comes from Bc 236 and is manufactured out of silicified wood (Bradley 1971). The sandstone mauls come from Shabik'eshchee Village (29SJ 1659, Roberts 1929), which had four; 29SJ 724 and 29SJ 628 produced one each. It is interesting to note that all but the two greenstone axes are made of local materials, making the occurrence of these two axes even more significant.

The period from late Pueblo I/early Pueblo II through the end of the Hosta Butte Phase is represented by 48 axes from 11 sites. The materials become more diversified during this period, with nonlocal materials accounting for a higher percentage. Locally obtainable Cliff House sandstone accounts for 18 percent of the materials used in the manufacture of axes. The nonlocal materials (82 percent) are mostly diorite (21 percent), basalt, granite, and serpentine river cobbles and various others referred to only as miscellaneous river cobbles; 27 percent of the materials are listed as unknown. There is a decline in the frequency of mauls during this period with 26 represented from eight sites. These are mostly made from local material with Cliff House sandstone accounting for 19, or 61 percent of the total. The remaining 39 percent are made from various diorite and granite river cobbles.

The Classic Bonito Phase greathouses and the McElmo Phase sites of Kin Kletso (Vivian and Mathews 1965) and 29SJ 390 (Windes 1987) yielded a total of 30 axes, the majority of which came from Pueblo Bonito (Judd 1954) and Pueblo del Arroyo (Judd 1959). It is interesting that of these 30 axes, none are manufactured out of local materials. All are materials that come from the San Juan River Valley and the Brazos Uplift to the north, except the claystone, which comes from near Crownpoint. All of the axes from Pueblo Bonito (15) and Pueblo del Arroyo (8) have been called miscellaneous river cobbles; these account for 76 percent of the axes from this group. The remaining seven axes are diorite (3), basalt (2), and greenstone (1), all of which probably originated as river cobbles. One axe from Kin Nahasbas is of unidentified material (Luhrs 1935, Mathien and Windes 1988).

The 18 mauls from this group follow the pattern observed for the Hosta Butte Phase sites, with 57 percent of them manufactured out of Cliff House sandstone, 15 percent from river cobbles, and 28 percent of unidentified materials. Eight of these mauls come from Kin Nahasbas (Luhrs 1935; Mathien and Windes 1988). The information on these artifacts is sketchy at best. Four of the eight can be called miscellaneous grooved implements, the largest one weighing almost 6 kg. Six of the eight come from Subfloor Pit 2, a large masonry floor vault in the great kiva. They were used as wedges around a large sandstone disc in the bottom of a posthole for one of the main roof supports.

Discussion

Several interesting patterns emerge from the analyses of the grooved stone implements in this collection. There is an increase in the number of axes between Basketmaker III and Pueblo I and the Hosta Butte Phase of Pueblo II, then the number drops off slightly during Pueblo III. This pattern can be explained, in part, by the fact that the number of sites investigated also follow this pattern. Four Basketmaker III and Pueblo I sites are included in the study, with only 2.5 percent of the axes coming from these sites. The Pueblo II period yielded 61 percent of the axes studied from 11 sites. The later Classic Bonito Phase sites of the Pueblo III period produced 36.5 percent of the total number of axes from only eight sites. This last period probably involves a higher percentage of axes during the Pueblo II period.

The ratio of axes to mauls also changes through time. During the earliest periods, Basketmaker III and Pueblo I, the ratio of axes to mauls is 1:3.5. During Pueblo II, the axes become more numerous than the mauls, with a ratio of 1.9:1, and during the last period, Pueblo III, the ratio of axes to mauls becomes 1.5:1.

This pattern, which approximates a normal bell curve with its apex occurring during Pueblo II, is further supported when the ratio of artifacts to room count is examined. During Basketmaker III, the ratio of axes to pithouses is 1:11.5 and the ratio of mauls to pithouses is 1:4.6. No axes were recovered from the two Pueblo I sites investigated, 29SJ 724 and Bc 236. The maul frequency was 1:10 for the rooms and 1:1 for the pithouses. In the sites containing both Pueblo I and Pueblo II components, the ratio becomes much larger, with the ratio of axes to rooms becoming 1:4 and the ratio of mauls to rooms, 1:2.7. The axe ratio remains at 1:4 for the Pueblo II sites and the maul to room ratio becomes lower at 1:20.7. For the Pueblo III sites, including the McElmo and Classic Bonito Phases, only ground floor rooms are included in the room count because total room counts have not been estimated for some of the sites. It should also be noted that almost 50 percent of these ground floor rooms remain unexcavated, which might alter any observable patterns. The ratio of axes to ground floor rooms is 1:25 and the ratio of mauls to ground floor rooms is 1:38. Because the ratio does not include total room counts, the ratio of axes and mauls to rooms is actually lower than the figures indicate.

It is evident then that there is a definite change through time in the frequency and the materials of stone axes in Chaco Canyon. In the beginning of the Anasazi occupation, local materials were being used for the manufacture of most of the grooved stone artifacts, except for two highly specialized axes made from greenstone. The frequency of axes increases during Pueblo II and the materials become more diverse, incorporating mostly river cobbles from the San Juan River Valley. Then, at the height of the Bonito Phase, the frequency of stone axes drops off and all the materials used in their manufacture come primarily from the San Juan River Valley.

Several factors can be suggested to explain these results. Probably the most important one to consider is that the sample is somewhat skewed. It is noticeably biased towards the later sites, even though much of the pertinent data was unrecorded from early excavations at these sites. For example, Chetro Ketl, the second largest site in the canyon in terms of size and excavation completed, had to be left out of this study because of unobtainable data.

One possible explanation is that as the trade networks grew, so did the abundance of exotic items such as stone axes. An increase in the population would place an increase on the demand for specialized and rare tools. During the height of the occupation when the road systems were operative, treks to the San Juan River and back would be more frequent, explaining the fact that all the axes during this period were imported.

Regardless of which theory is used to explain the frequency and utilization of these axes, there is a noticeable lack of stone axes in Chaco Canyon when it is compared to sites elsewhere in the Southwest. When sites from other areas in the Southwest are examined, the axe frequencies per site become much higher (Table 7.3). The materials from these other sites, however, are as diversified as those in Chaco

Canyon and river cobbles remain the preferred sources for materials used in the manufacture of stone axes.

Table 7.3. Ratio of axes to total ground floor rooms.

Sites	Total Axes	Total Ground Floor Rooms	Ratio
Chaco PIII[a]	29	734	1:25
Mesa Verde[b]	126	124	1:1.01
Aztec[c]	100	225	1:2.5
Village of the Great Kivas[d]	6	80	1:13
Lowry Ruin[e]	2	37	1:18.5

[a] Pueblo Del Arroyo (Judd 1959), Pueblo Bonito (Judd 1954), Pueblo Alto (Chaco Center Archives), Una Vida (Chaco Center Archives), 29SJ 390 (Chaco Center Archives), 29SJ 721 (Chaco Center Archives), Kin Kletso (Vivian and Mathews 1965).
[b] Badger House (Hayes and Lancaster 1975), Big Juniper House (Swannack 1969) Mug House (Rohn 1971).
[c] Aztec (Morris 1928).
[d] Village of the Great Kivas (Roberts 1932).
[e] Lowry Ruin (Martin 1936).

Two reasons come to mind for the high frequency of axes occurring in areas such as Mesa Verde. First of all, timber resources are much more accessible than in Chaco Canyon. Second, the Mancos River provides a much closer source of river cobbles for the manufacture of axes. This situation also exists at the two large outlying Chacoan sites of Aztec, where 100 axes were recovered, and the Salmon Ruin, which also produced a large number of axes. Both sites are located in areas with more prolific timber resources than Chaco Canyon and both are within one kilometer of an unlimited source of river cobbles from the Animas and San Juan Rivers, respectively.

The information about the types (i.e., notched, 3/4, or full-grooved), frequencies, and material of those axes from sites outside Chaco Canyon is just as limited as the information within Chaco Canyon. Despite the paucity of information, the same general patterns, as far as types of axes and the material type, emerges. The preference for full-grooved or notched axes is indicated and remains constant from Basketmaker III through Pueblo III. The preference switches over to 3/4 and multiple-grooved axes during Pueblo IV, but this has no bearing on the Chaco Canyon study. The material types also remain constant through time, with igneous and metamorphic river cobbles the preferred parent material, mainly because of their hardness and shape, which required minimal modification. This pattern changes rapidly during Pueblo IV, with a strong preference for sillimanite axes indicated at Pecos Pueblo (Kidder 1932) and most of the large Pueblo IV sites along the Rio Grande.

The ratios of axes to mauls is much higher on the sites outside of Chaco Canyon. I believe that this is due largely to differences in terminology. The grooved-stone artifacts from these sites that would have been defined as mauls in this chapter are listed under such categories as hammers, picks, hoes, weights, or clubs. The ratio of axes to rooms decreases through time, as it does in Chaco Canyon. In some sites, especially on the Mesa Verde, ratios reach close to 1:1 (Table 7.3). The decline in the frequency, however, does not occur geometrically and in many sites the increase in frequency from Pueblo II to Pueblo III is hardly noticeable. The frequency may even decline slightly; however, it is not nearly as sharp a decline as observed in Chaco Canyon.

Undoubtedly, the availability of timber resources had some impact on the number of axes utilized in Chaco Canyon; however, 52 stone axes were recovered from the large Hohokam site of Snaketown in south central Arizona (Haury 1976). Snaketown is situated in an environment which is equally void of abundant timber resources; therefore, it should have experienced little need for stone axes. Even more interesting is the fact that the timber required for construction at Snaketown, which is a large pithouse village, is a fraction of that required by most of the larger sites in Chaco Canyon. The occurrence of so many axes at Snaketown, in contrast to the relative lack of these tools in Chaco Canyon, is puzzling.

One possible explanation for the increase in frequency of axes from Basketmaker III through Pueblo II, and then the decline during Pueblo III, is presented below.

During the early Anasazi occupation, the canyon was lightly populated. The timber resources required by this population were minimal due to the small size of the group and their style of architecture. The house types were pitstructures that required large beams only for their main supports. The rest of the roof structure consisted of short beams, branches, and brush closing material. These requirements could easily be met by the presence of small relic stands of Ponderosa pine and Douglas fir, with scattered piñon and juniper occurring in the canyon or on the mesas such as occur on Chacra Mesa today. The occurrence of both Ponderosa pine and Douglas fir macrobotanical remains from early sites such as 29SJ 627 and 29SJ 628 support this theory. These two species occurred in higher frequencies than would be expected if they had been imported from another area. There is evidence that these two species were being used as firewood at these sites, another argument for their occurring locally.

As the population increased during Pueblo II, so did construction and the need for increased timber resources. The technique of cribbing logs to roof kivas requires more beams than if they were roofed flat. When multiple story dwellings became more popular, larger beams were required to roof the ground floor rooms in order to support the weight of the upper rooms.

With the timber resources in the canyon limited, this resource could conceivably disappear with increased population and construction occurring during Pueblo II, as indicated by the frequency of both sites and axes. Therefore, at the height of the Chacoan occupation, an easily accessible timber resource would be nonexistent. The Chacoans would be required to import most of the beams for the construction of the later sites. This behavior could be one cause for the establishment of the elaborate road system that existed at this time. If indeed many of the large beams were brought in from the Chuska, Jemez, La Plata, and San Juan mountains, most of the labor requiring stone axes would be completed at these locations. There is some evidence that many of the large beams were cut to predetermined lengths (Judd 1964:26-27; Hudson 1972). If this is true, the beams could be felled, cut to predetermined lengths, debarked, and limb trimmed before transportation to Chaco Canyon, thereby eliminating the need for many stone axes at sites in the canyon.

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Chapter Eight

An Analysis of Manos from Chaco Canyon, New Mexico

Catherine M. Cameron

Introduction

Manos (n=1,244) from twelve sites in Chaco Canyon were analyzed. The collection included samples of manos recovered from two sites and all manos recovered from the other sites (see Sample below). Analysis examined material, technology of manufacture, form and characteristics of use, and reuse. Appendix 8A describes the attributes used in mano analysis.

The analysis began in 1975 with a sample of 100 manos from five sites in Chaco Canyon (Cameron 1976). Analytic attributes were selected based on a literature search and an examination of the mano sample. Analysis of this sample was used to refine the attributes selected and to eliminate attributes that were not useful. The revised analytic form (Appendix 8A) was applied to a much larger sample of manos (n=911) between 1975 and 1977 and variability in attributes was examined (Cameron 1977). Manos excavated from sites in Chaco Canyon after 1977 were analyzed using the revised form.

In 1978, a group of unprovenienced manos from Site 29SJ 627 (see Sample below) was briefly examined and only those attributes considered most useful in assessing mano variability were recorded. These data were not included in the computerized mano database and are not used in this analysis.

Due to a great delay in the publication schedule for Chaco manuscripts, neither of the previous reports on manos (Cameron 1976, 1977) were ever published. The present report was written in 1985. It includes data used in both of the previous reports, as well as data collected on manos between 1977 and 1979.

The Sample

Selection of Manos for Analysis

Excavations in Chaco Canyon spanned the period from 1973 to 1979. Prior to 1975, manos and other ground stone were not routinely returned to the laboratory for analysis. They were described briefly (length, width, thickness, type) and then discarded. Unfortunately, most of these descriptions have since been lost. Some ground stone was retained; however, there were no consistent criteria for selection (Peter McKenna, personal communication; Thomas C. Windes, personal communication). Sites excavated prior to 1975, from which some manos were discarded, are:

29SJ 299
29SJ 423
29SJ 627 (first year of excavation)
29SJ 628
29SJ 721
29SJ 724
29SJ 1360
29SJ 1659

All manos that were retained were analyzed except for those from sites 29SJ 627 and 29SJ 1360. Manos from these two sites were sampled because of time limitations. Almost 60 percent of the manos from 29SJ 627 were analyzed (354 of 597). Those selected for analysis included all manos from floor contact, floor fill, and wall-fall contexts; 50 percent of manos from trash contexts; and 10 percent of manos from alluvial fill contexts. Over 70 percent of the manos from 29SJ 1360 were analyzed (107 of 145). Manos at this site were selected by major provenience unit: all manos from rooms and kivas;

66 percent of the manos from the plaza; and 10 percent of the manos from the surface and from a trash area which may not have been associated with the rest of the site.

Association of Manos with Other Ground Stone Types

Mano analysis was part of a larger program of ground stone analysis. Field identifications were used to sort ground stone into four categories (manos, metates, abraders, and other ground stone). When an artifact showed evidence of multiple use, it was included in more than one analysis (i.e., manos reused as abraders, metate fragments reused as manos, etc). Less than one-fifth of the manos showed evidence of secondary use which could be associated with another artifact type (see Reuse below).

The Analysis

Mano Types

Two mano types are typically identified in the Southwest: one-hand manos and two-hand manos (Bartlett 1933, Chapman 1983, Lancaster 1983, Woodbury 1954). One-hand manos are oval in plan and shorter in length than two-hand manos, which are generally rectangular in plan. One-hand manos have a width/length ratio greater than 0.75, while two-hand manos have a ratio of less than 0.75 (Chapman 1983:522).

One-hand manos have been associated with basin metates and the grinding of wild plants during Archaic and Basketmaker time periods (Bartlett 1933:20-21), while two-hand manos were used on trough or slab metates primarily for grinding corn during Pueblo periods (Lancaster 1983:17). There is evidence, however, that one-hand manos continued to be used occasionally throughout the Pueblo period (Chapman 1983) and may have been used for a variety of purposes (Lancaster 1983:34, Woodbury 1954:78-79).

For this analysis, one- and two-hand manos are subdivided by differences in cross-section. Differences in cross-section are usually explained as being the result of degree of use and/or variation in type of stroke used with the mano (Bartlett 1933; Chapman 1983; Lancaster 1983). Manos from Chaco Canyon showed seven cross-section types: rectangular, beveled, wedge, triangular, ovoid, bi-triangular, and discoidal (Figure 8.1, Table 8.1).

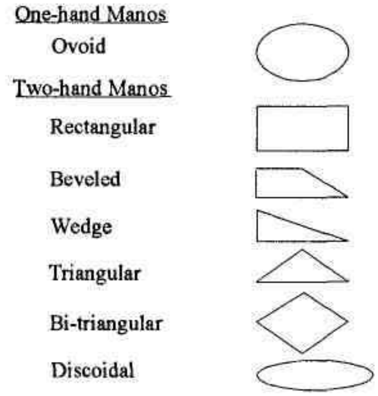

Figure 8.1. Manos cross-section types.

All one-hand manos from Chaco had ovoid cross-sections (see Material Types below). Two-hand manos never had ovid cross-sections; all other cross-section types were present in two-hand manos. Therefore, while the terms one- and two-hand manos will be used in this discussion for the remainder of this report, mano type will refer only to the seven cross-section types; ovoid cross-section equals one-hand manos while the other six cross-section types (rectangular, beveled, wedge, triangular, bi-triangular, and discoidal) will identify subdivisions of two-hand manos.

Table 8.1. Frequency of mano cross-section types.

Cross-section Type	Number	Percent
One-hand Manos		
Ovoid	26	2.09
Two-hand Manos		
Rectangular	202	16.24
Beveled	125	10.05
Wedge	456	36.66
Triangular	74	5.95
Bi-triangular	2	0.16
Discoidal	256	20.58
Cross-section unknown	103	8.28
Total	1,244	100.00

Material Type

Almost all manos were made of sandstone. Only five were another material, all quartzite. The sandstone presumably came from the local Cliff House sandstone formation, which forms the walls of Chaco Canyon. The initial analysis of a sample of 100 manos recorded several characteristics of the sandstone (including hardness, color, grain size, grain shape, and grain sorting). Little variability was found among these attributes (Cameron 1976), and only the first three were retained during the analysis of the remainder of the manos (Appendix 8A).

Sandstone from which manos were made was hard (84 percent) and fine-grained or very fine-grained (92 percent). A chi-square test of hardness and grain size, contrasting hard and soft materials with very fine-grained material and all other grain sizes was not significant ($\chi^2=0.056$, df=1, $0.90 < p < 0.95$).

Almost half of the manos were gray, one-fifth were tan, and one-fourth were mixed tan/gray. Two varieties of the Cliff House sandstone have been described in Chaco Canyon: a softer buff-colored sandstone and a light brown, harder sandstone (Vivian and Mathews 1965:34). Differential use of these two materials in wall construction has been noted (Lekson 1984:10). In another study, Garrett (1988) has differentiated between a well-cemented, very fine-grained, gray sandstone used as building material at a site in Chaco Canyon and less well-cemented, medium-grained, light brown sandstone found in outcrops near the site. In spite of the differences in color found in Chaco manos, the uniformity in hardness and grain size suggests selection for specific varieties of the local sandstone.

Four of the five quartzite manos are one-hand (ovoid cross-section) manos indicating selection of quartzite for this artifact type. A chi-square test of one-hand and two-hand manos by material type (sandstone versus quartzite) was significant at the .001 level ($\chi^2=155.8$, df=1).

Technology of Manufacture

Most manos were made by shaping a block of sandstone. Less than 6 percent could be identified as having been made from cobbles, concretions, or reused manos or metates. Easily available local material probably reduced the need to recycle other artifacts. Shaping was achieved through chipping and pecking, which was often visible on edges and ends of manos. Initial forms were generally rectangular and as described below (see Form below), some "new" manos may have been relatively thin, perhaps manufactured of tabular sandstone.

Form

Dimensions

Manos with an ovoid cross-section are smallest in average weight, length, width, and grinding area (Table 8.2). They were the only cross-sectional type for which a width/length ratio was greater than 0.75. As noted above, manos with an ovoid cross-section can be identified as one-hand manos.

Length and width for other cross-section types (two-hand manos) were very similar, averaging 18.7 cm in length and 11.0 cm in width. These dimensions are similar to those for manos used on trough metates from other areas of the Southwest (Bartlett 1933:13; Morris 1939:133; Woodbury 1954). Low variation in length and width of manos correlates with a similar lack of variation in the width of metate troughs and to the average grip size of grinders (Lancaster 1983:84). Trough widths for Chaco metates average about 19.7 cm (John Schelberg, personal communication, 1985).

Weight, Thickness and Grinding Surface Area

Weight, thickness, and grinding surface area vary among cross-sectional types and indicate that for two-hand manos, cross-section type reflects stages in the use-life of a mano. Weight is greatest for rectangular manos (Table 8.2); discoidal manos form an intermediate weight group; beveled, wedge and triangular manos weigh the least. (As noted above, one-hand manos weigh less than any of the two-hand mano types.) Maximum and minimum thickness were also greatest for rectangular manos; however, maximum and minimum thickness varied for other two-hand mano types. Discoidal manos have a higher minimum thickness than other types, but a lower maximum thickness than do wedge-shaped and beveled manos.

The association of thickness and weight with cross-section supports the suggestion that cross-

Table 8.2. Size of manos by cross-section.

Measurements	Two-hand Manos: Rectangular	Beveled	Wedge	Triangular	Bi-triangular	Discoidal	One-hand Manos: Ovoid
Weight	1819.8	868.3	942.2	890.5	1114.3	1129.5	572.8
s.d.	546.2	267.8	331.0	278.4	545.7	343.8	161.7
Length	19.4	18.6	18.2	19.0	19.3	18.7	10.6
s.d.	2.0	2.1	2.5	2.1	1.2	2.5	1.5
Width	11.6	10.3	10.5	11.2	12.2	11.6	8.3
s.d.	1.3	1.2	1.2	1.1	0.1	0.9	1.0
Maximum thick.	4.1	2.7	3.0	2.0	1.8	2.5	3.4
s.d.	0.9	0.6	1.0	0.7	1.1	0.6	0.9
Minimum thick.	3.3	0.9	1.2	1.1	1.3	2.0	2.6
s.d.	1.0	0.7	0.7	0.7	1.1	0.6	0.6
Area grinding	180.0	165.0	162.8	178.6	202.0	180.0	57.2
Surface A	39.3	30.2	32.9	43.2	15.6	38.5	21.5
Area grinding	167.9	141.8	127.5	147.3	185.5	169.5	44.6
Surface B	37.9	49.4	50.2	43.2	16.3	35.6	12.4

section types relate to progressive stages in the use-life of manos (see Mano Use-life below). Rectangular manos, often considered an early use stage, would have lost the least material and thus be heaviest and thickest. Beveled, wedge, and triangular manos presumably represent well-used stages; they should be thinnest and weigh the least. Discoidal manos may also represent early stages in mano use, but may have been made of a tabular sandstone which was initially thinner than the sandstone from which rectangular manos were made (Chapman 1983). This would account for their intermediate weight and thickness.

Grinding surface area was greatest for rectangular manos, discoidal manos, bi-triangular, and triangular manos (Table 8.2). Smaller grinding areas on wedge and beveled types suggest that grinding surface area decreases with use, but that the grinding stroke described by Bartlett (1933:15-16) for modern Hopi grinders, which resulted in a triangular cross-section, may have been developed to increase grinding surface area.

Shape

Plan view was rectangular for more than 85 percent of the manos for which this variable could be recorded. Other shapes were primarily oval (10 percent) or irregular (3 percent). Longitudinal cross-section was either square or convex for more than 95 percent of the manos for which this variable could be recorded. Rectangular and discoidal mano types had a higher relative frequency of square longitudinal sections, while beveled, wedge, and triangular manos had a higher relative frequency of convex longitudinal sections. This suggests that a convex longitudinal section may be related to later stages in mano use-life. A chi-square test of "new" manos (rectangular, discoidal) and "used" manos (beveled, wedge, triangular) by longitudinal section (using only square and convex longitudinal sections) was significant at the .001 level ($\chi^2=30.8$, df=1).

Finger Grooves

Only 10 percent of the manos showed evidence of prepared finger grooves (Table 8.3). These were shallow, circular holes pecked into the edge of the mano to provide a better grip. They occurred on one-hand and two-hand manos of all cross-section types except bi-triangular. Many rectangular and discoidal manos ("new" mano types) had two finger grooves. Other mano types had only one groove, indicating that a second groove may have been worn away and was no longer visible. Two manos (both wedge cross-section) had a long groove for multiple digits.

Table 8.3. Number of finger grooves by mano type.

Type	One Groove	Two Grooves	Groove for Multiple Digits	Total
One-hand manos				
Ovoid	2	1	-	3
Two-hand manos				
Rectangular	25	19	-	44
Beveled	3	-	-	3
Wedge	52	3	2	57
Triangular	5	-	-	5
Bi-triangular	-	-	-	-
Discoidal	14	8	-	22
Unknown	4	-	-	4
Total	105	31	2	138

Mano Use

Evidence for Use on Trough Metates

Virtually all metates from sites excavated by the Chaco Project were the trough variety (John Schelberg, personal communication 1985). Corresponding evidence that manos recovered from these sites were used on trough metates is indicated by size and shape of two-hand manos. Almost 70 percent of the manos had canted ends, indicating contact with the walls of a trough metate (Figure 8.2). Of the 24 percent of manos with straight edges, most were found on manos with rectangular and discoidal cross-sections (Table 8.4), suggesting again that these are "new" manos with little distinctive wear on their ends. Manos with curved ends (Table 8.4) were primarily one-hand manos (ovoid cross-section). As these manos are small, their use on a trough metate might not be apparent from an examination of mano ends.

Average length of Chaco manos (18.7 cm, see Form above, Table 8.2) is similar to the length of manos used on trough metates from other areas. Manos used on trough metates in northern Arizona average 18.0 cm in length, while manos used on slab metates from that area average 25 cm in length (Woodbury 1954). In southwestern Colorado and northwestern New Mexico, manos used on trough metates average 17.4 cm in length, while manos used on slab metates average 22.5 to 33.0 cm in length (Morris 1939:133). These comparisons provide further evidence that Chaco manos were used on trough metates.

Characteristics of Grinding Surface

Almost 90 percent of the manos showed evidence of grinding use on only one surface. As with metate surfaces, manos were frequently pecked

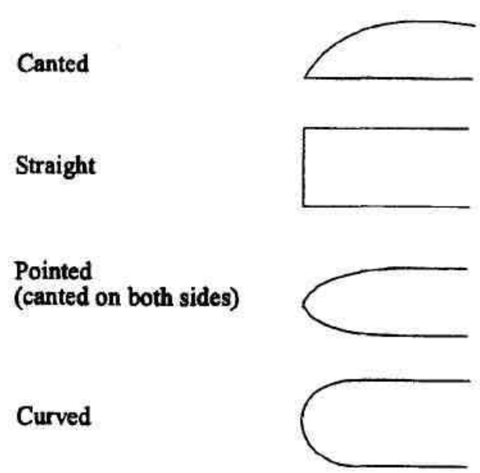

Figure 8.2. Configuration of ends.

Table 8.4. Shape of mano ends by cross-section.

	Canted		Square		Pointed		Curved		Other			
Type	No.	%	No.	%	No.	%	No.	%	No.	%	Total No.	% of Total
One-hand Ovoid	3	11.54	4	15.38	2	7.69	17	65.38	-	-	26	2.09
Two-hand Rectangular	99	49.01	82	40.59	5	2.48	4	1.98	12	5.94	202	16.24
Beveled	89	71.20	22	17.60	5	4.00	1	0.80	8	0.06	125	10.05
Wedge	345	75.66	69	15.13	13	2.85	4	0.88	25	5.5	456	36.66
Triangular	59	79.73	9	12.16	2	2.70	-	-	4	5.40	74	5.95
Bi-triangular	-	-	-	-	2	100.00	-	-	-	-	2	0.16
Discoidal	145	56.64	90	35.16	9	3.52	-	-	12	4.68	256	20.58
Unknown	56	54.37	12	11.65	3	2.91	-	-	32	31.07	103	8.28
Total	796		288		41		26		93		1,244	
% of Total		63.99		23.15		3.30		2.09		7.48		100.00

Table 8.5. Cross-section by grinding surface preparation.

	Very Pecked		Pecked/ Moderate Pecking		Heavy Abrasion		No Pecking		Little Pecking/Little Abrasion		Other		Total	% of
Type	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	Total
One-hand Ovoid	-	-	8	30.8	5	19.2	12	46.2	1	3.9	-	-	26	2.1
Two-hand Rectangular	28	13.9	95	47.0	65	32.2	10	5.0	4	2.0	-	-	202	16.25
Beveled	1	0.8	20	16.0	57	45.6	47	37.6	-	-	-	-	125	10.1
Wedge	12	2.63	119	26.1	213	46.7	110	24.1	-	-	2	0.4	456	36.69
Triangular	-	-	14	18.9	38	51.4	22	29.7	-	-	-	-	74	6.0
Bi-triangular	-	-	-	-	1	50.0	1	50.0	-	-	-	-	2	0.2
Discoidal	15	5.88	96	37.65	118	46.27	25	9.8	1	0.4	1	0.4	256	20.6
Unknown	5	4.9	45	43.7	41	39.9	11	10.7	1	1.0	-	-	103	8.3
Total	61		397		538		238		7		3		1,244	
% of Total		5.0		31.9		43.3		19.2		0.6		0.2		100.0

to provide a coarser and more effective grinding surface. Mano surfaces varied from pecked to completely abraded and smooth; however, rectangular and discoidal types ("new" manos) were more likely to be very pecked. Beveled, wedge-shaped, triangular, and bi-triangular types ("well-used") were more likely to be heavily abraded (Table 8.5). A chi-square test of "new" manos (rectangular, discoidal) and "used" manos (beveled, wedge, triangular, bi-triangular) by grinding surface preparation (very pecked and moderate abrasion versus heavy abrasion and no pecking evident) was significant at the .001 level ($\chi^2=139.0$, df=1). Ovoid (one-hand) manos showed less pecking than other types (Table 8.5).

Striations were visible on most (93 percent) of the manos and were almost all oriented perpendicularly to the long axis of the artifact (89 percent of those visible). This indicates that manos were held perpendicularly to the metate and moved with a reciprocal motion. Ten percent of the manos had striae both perpendicular and parallel to the long axis of the artifact (cross-hatched), possibly as a result of secondary use. Only one mano showed rotary striae (with a wedge-shaped cross-section).

Handedness in the Mano User

Most manos (78 percent) had edges that were parallel to each other, probably indicating equal pressure on the trailing edge of the mano by the mano user. Of the manos for which edges were not parallel (n=96), a slightly greater frequency expanded left (59 percent), indicating greater pressure on the right side of the trailing edge of the mano. This might suggest a slightly greater number of right-handed mano users in Chaco Canyon.

Reuse

Almost 75 percent of manos showed use-wear not associated with the grinding process, but more than half of this secondary use consisted of slight grinding and polishing or striation/grinding (Table 8.6) and could not be identified with a particular artifact type. As almost all of this type of use-wear occurred on the surface of the mano which had not been used for grinding, slight grinding, or polishing may not, in fact, indicate reuse, but may be the result of continued contact with the hand of the grinder.

Of the manos for which reuse could be identified (n=220, 18 percent of the total), more than one-third were reused as abraders, another one-fourth were reused as anvils, while the remainder were hammerstones, palettes, choppers, and polishers. Some manos were reused more than once as different artifact types.

Temporal Variability in Cross-section Types

Table 8.7 shows mano cross-sections through time. (Only those manos which could be confidently assigned to 100-year periods are included.) One-hand (ovoid cross-section) manos appear in all time periods with highest relative frequency of this type during the period from A.D. 500 to 600. This may indicate one-hand mano use during this period, or it may be the result of small sample size. Rectangular, discoidal, and wedge-shaped manos generally form a relatively high percentage of all manos in all time periods. Beveled manos occur primarily after A.D. 920 and triangular and bi-triangular manos occur exclusively after A.D. 920.

Table 8.8 shows mano types for the pre-A.D. 920 and post-A.D. 920 periods. It is clear that typical patterns of mano use in Chaco Canyon generally produced wedge-shaped manos, but that after A.D. 920, a new grinding stroke was developed that resulted in beveled and/or triangular manos. Bartlett (1933:18-19) suggests that the grinding stroke which produced triangular manos was developed between A.D. 1100 and 1300. The transition from trough to slab metates has been dated to the late Pueblo II to the early Pueblo III period (Woodbury 1954). This suggests that the development of the stroke that produced triangular manos may have been associated with the development of slab metates.

The vast majority of the beveled and triangular manos from Chaco Canyon, however, have canted ends, indicative of use with a trough metate (Table 8.4). They are also the same average length as those used with trough metates (see Form above, Table 8.2). An intermediate stage in the progression from trough to slab metates involved enclosing trough metates in bins (which are a usual component of the use of slab metates). The use of the metate bin in Chaco Canyon began in late A.D. 900s along with the first evidence of communal grinding areas (Truell 1983). These changes in grinding patterns may be

Table 8.6. Type of secondary use by associated artifact type.

Type	Hammerstone Pounder	Palette	Anvil	Abrader	Other	Chopper	Polisher	Unknown	Total	% of Total
Battering	8	-	-	-	4	1	-	1	14	1.51
Polishing/Grinding	-	-	3	20	2	-	7	13	45	4.8
Chipping	-	-	-	-	1	2	-	12	15	1.61
Chipping/Battering	6	-	-	-	-	6	-	1	13	1.40
Pigment	1	4	-	1	3	-	-	19	28	3.01
Striation/Grinding	-	-	-	55	-	-	-	99	154	16.56
Grinding/Pecking	-	-	45	1	-	-	-	5	51	5.48
Grinding/Pigment	-	9	-	-	-	-	-	5	14	1.51
Slight grinding/ polishing on unused surface	-	-	-	-	3	-	-	546	549	59.03
Other wear types	7	6	11	5	7	-	2	9	47	5.05
Total	22	19	59	82	20	9	9	710	930	
% of Total	2.37	2.04	6.34	8.82	2.15	0.97	0.97	76.34	100.0	

Table 8.7. Distribution of mano cross-section types by time.

	Time Period (A.D.)													
	500-600		600-700		700-820		820-920		920-1020		1020-1120		1120-1220	
Type	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
One-hand														
Ovoid	2	40.0	3	9.1	2	5.7	-	-	5	1.4	3	0.9	1	3.3
Two-hand														
Rectangular	1	20.0	8	24.2	5	14.3	6	22.2	67	19.0	46	15.0	3	10.0
Beveled	-	-	1	3.0	1	2.9	-	-	27	7.6	45	14.7	7	23.3
Wedge	-	-	11	33.3	17	48.6	11	40.7	130	36.9	104	33.9	9	30.0
Triangular	-	-	-	-	-	-	-	-	20	5.7	22	7.1	4	13.3
Bi-triangular	-	-	-	-	-	-	-	-	2	0.6	-	-	-	-
Discoidal	2	40.0	9	27.3	6	17.1	8	29.6	71	20.2	63	20.5	2	6.7
Total	5		33		31		25		322		283		26	

Table 8.8. Mano cross-section types by time.

	Pre A.D. 920		Post A.D. 920	
Type	No.	%	No.	%
One-hand				
Ovoid	11	8.8	11	1.2
Two-hand				
New mano types (Rectangular, Discoidal)	58	46.4	367	39.1
Beveled	3	2.4	120	12.8
Wedge	53	42.4	366	39.0
Triangular and Bi-triangular	-	-	74	7.8
Total	125		938	

associated with the development of the grinding stroke that produced triangular manos.

Mano Use-life

As noted above, differences in cross-section for two-hand manos are generally explained as the result of degree of use and/or variation in type of stroke used with the mano. As indicated by this study and as noted by others (Bartlett 1933; Chapman 1983), manos with a rectangular or discoidal cross-section are "new" mano types, while other cross-sections are the result of varying degrees of use. There are, however, different ideas on the processes which produce "used" mano cross-sections, especially for beveled and triangular manos. Bartlett (1933:15-16) suggests that triangular manos are the result of a new grinding technique, but does not mention beveled manos. Eidenbach (1980:37) placed beveled manos as an intermediate stage in a use-life that results in triangular manos. Chapman (1983:531-532), however, suggests that beveled manos are the end result of continued use, with wedge-shaped manos as an intermediate stage.

The occurrence of beveled manos at sites in Chaco Canyon during the same periods when triangular manos begin to occur (A.D. 920 to 1020) suggests association between these two types; beveled manos might be less worn than triangular manos. This process is described by Bartlett as follows:

> As a woman grinds she exerts the most pressure with the palm of her hand on the back of the mano and on the down stroke of the mano she pulls up on the front of it, so that only a small part of it touches the metate. On the up stroke she holds the mano flat on the metate. Because the back part of the mano receives the most pressure and gets the most wear, it becomes worn down more rapidly than the front portion. Very gradually the mano takes on a slightly triangular form, being flat on top with one long side resting on the metate and one short side. Then the mano is turned around and the short side is used for grinding until it in turn becomes long, when the process is repeated (Bartlett 1933:15-16).

It might follow that beveled manos may have been used in the manner described above, but not turned around. This does not, however, seem to be supported by manos from sites in Chaco Canyon. If beveled manos are an intermediate stage between new manos and triangular manos, they should be thicker and weigh more than triangular manos. As Table 8.3 shows, average weight for beveled manos is less than triangular manos; average minimum thickness is also less. Apparently, attributes of beveled and triangular manos at Chaco Canyon cannot be used to confirm the place in a use-life of these types.

Greathouse and Small-house Sites: Consumption and Distribution of Manos

Ceramics and chipped stone have been used to examine average artifact consumption rates for large and small sites in Chaco Canyon (Cameron 1984; Toll 1984). This is more difficult with manos because of the large number which were discarded or not analyzed. Comparisons can be made, however, between the Gallup phase at Pueblo Alto and 29SJ 629, a village site where no manos were discarded in the field.

Table 8.9 shows the number of households (defined architecturally), the duration of occupation, the percent of the site excavated (Toll 1984) and the projected total number of manos from the site. Mano use rates (per household per year) at Pueblo Alto during the Gallup Phase are more than three times as great as those at 29SJ 629. Ceramic and chipped stone use rates showed similar high frequencies at Pueblo Alto (Cameron 1984, Toll 1984). Because manos are a domestic artifact, the differences in use rate at Pueblo Alto and 29SJ 629 suggest that population at Pueblo Alto is larger than would be indicated by architectural households alone.

The new grinding technique proposed for the post-A.D. 920 period (see Mano Use-life above) may be examined at greathouse and small-house sites. While it would be most instructive to examine manos only from the period from A.D. 920 to 1020, the sample of manos from greathouses during this period is very small (n=8).

Comparing manos from greathouse (Pueblo Alto and Una Vida) and small-house sites (29SJ 627 and 29SJ 629), including all periods after A.D. 920 (Table 8.10), shows that while the frequency of beveled manos is lower at small-house sites than at

Table 8.9 Projected use-rate of manos at greathouse and small-house sites.

	Pueblo Alto	29SJ 629
% of site excavated:		
Rooms, etc.	10.0	100.0
Midden	2.2	70.0
Number of manos:		
Rooms, etc.	114	170
Midden	26	7
Projected total number of manos	2,322	180
Years of use	50	130[a]
Number of households	20	2
Manos per household per year	2.3	0.69

[a] This figure represents the span during which the site was occupied and may include one or more gaps in site occupation (Windes 1993).

Table 8.10. Frequency of beveled and triangular manos at greathouse and small-house sites.

	Greathouses (Pueblo Alto Una Vida)		Small-house Sites (29SJ 627 29SJ 629)	
Type	No.	%	No.	%
Beveled	75	17.3	39	7.3
Triangular	40	9.2	32	6.0
Other	318	73.4	460	86.6
Total	433		531	

greathouse sites, the frequency of triangular manos is similar for both types of sites. This suggests that use of the new grinding stroke extended to both greathouse and small-house sites.

Conclusions

Manos from Chaco Canyon showed little variability that could not be related to manner or duration of use. Almost all were made of sandstone. Length and width were very similar and were similar to other manos from comparable time periods in the Southwest. Manos from sites excavated by the Chaco Project seem to have been used almost exclusively on trough metates.

The greatest variability was found in mano cross-section, thickness, weight, and grinding surface area. Variability in these attributes could be related to different stages in the use-life of a mano. Temporal variability was found in the occurrence of triangular and beveled manos which may be related to the development of a new grinding stroke. This new grinding stroke apparently was used in Chaco Canyon after A.D. 920, earlier than the A.D. 1100 date proposed by Bartlett (1933), and may have been associated with the development of mealing bins and communal grinding areas in Chaco Canyon.

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Appendix 8A

Mano Analysis Form

Attributes and recording methods are described below. Standard orientation is widest edge away from the observer, grinding surface face down. Edges are parallel to the long axis of the artifact, ends are perpendicular to the long axis of the artifact.

Weight: Weight was measured to the nearest 0.1 gram.

Length: The maximum dimension of the longest axis of the artifact was measured to the nearest 1 millimeter.

Width: The maximum dimension perpendicular to the length was measured to the nearest 1 millimeter.

Maximum thickness: The maximum dimension perpendicular to the plane of the length and width measurements measured was to the nearest 1 millimeter.

Minimum thickness: The minimum dimension perpendicular to the plane of the length and width measurements was measured to the nearest 1 millimeter.

Burning: Burning was determined by color (black, red) or friability of the material.

0) None.
1) Partially.
2) Completely.
3) Utilized surface only.

Material hardness:

1) Very soft—material can be rubbed off with fingers.
2) Soft—material scratches with fingernail.
3) Medium soft—penny scratches material.
4) Medium hard—penny scratches material slightly, leaves sparse copper.
5) Hard—penny scratch barely evident, copper streak clearly evident.
6) Very hard—penny leaves copper mark only.

Color of material: A fresh break was always used to determine color.

1) Tan.
2) Gray.
3) Mixed (tan/gray).
4) Other.

Exfoliation: Exfoliation or weathering was most frequently evident as the shedding of thin layers of material.

1) Absent.
2) Present.

Previous form: The original form of the artifact prior to use as a mano was recorded as:

1) Metate.
2) Mano.
3) Cobble.
4) Concretion.
9) Unknown.

Grain size: Grain sizes were compared with the Grain Size and Shape Chart (Geological Specialty Company). A fragment of the material was crushed and examined with a 10X hand lens.

1) Very fine 1/16-1/8 mm.
2) Fine 1/8-1/4 mm.
3) Medium fine 1/4-3/8 mm.
4) Medium 3/8-1/2 mm.
5) Medium coarse 1/2-6/8 mm.
6) Coarse 6/8-1.0 mm.

Portion of artifact represented:

1) Whole.
2) Greater than half.
3) Less than half.
4) Fragment—neither whole length nor whole width can be measured.
5) One face missing—generally the result of exfoliation causing one face to lift off.

Plan view: The shape of the artifact, in standard orientation, in plan view.

1) Oval.
2) Rectangular.
3) Trapezoid.
4) Irregular.
5) Broken/indeterminate.

Cross-section: For observation of cross-section, the artifact is placed in standard orientation and then the left side is turned toward the observer.

1) Rectangular.
2) Beveled.
3) Wedge.
4) Triangular.
5) Ovoid.
6) Bi-triangular.
7) Discoidal.
9) Unknown.

Longitudinal section: The longitudinal section was observed with the mano in standard orientation.

1) Square.
2) Convex.
3) Bi-convex.
4) Oval.
9) Unknown.

Relationship of edges: This observation was taken only on whole manos in standard orientation. The relationship between the two edges parallel to the long axis (length) was recorded.

0) N/A.
1) Parallel—edges equidistant from each other.
2) Expanding right—the left portion of the near edge has been worn away.
3) Expanding left—the right portion of the near edge has been worn away.
4) Other.
9) Unknown.

Configuration of ends: The ends of the artifact were defined as the portions of the perimeter that are parallel to the direction of the grinding stroke.

1) Canted.
2) Straight.
3) Pointed.
4) Curved.
5) Curved/slanted.
6) Straight/slanted.
7) Slanted/pointed.
8) Other.
9) Unknown.

Technology of manufacture: All signs of the manufacture process that had not been obliterated by use were recorded. These were usually visible on edges.

1) Chipped.
2) Pecked.
3) Smoothed, ground.
4) 1, 2
5) 1, 3
6) 2, 3
7) 1, 2, 3

Number of finger grooves:

0) 0
1) 1
2) 2
3) 3
4) 4
5) Groove for multiple digits.

Number of primary use surfaces: The number of surfaces on which evidence of grinding was found (when the grinding was not related to the secondary use of the item). Artifacts with beveled faces (cross-sections 2, 4, 6) were recorded as two use surfaces.

0) 0 (for mano blanks)
1) 1
2) 2
3) 3
4) 4

The remainder of the analysis examined mano use. Face A was defined as the most heavily used face. If both sides were equally worn, then Face A was arbitrarily assigned to one.

Area of grinding surface, Face A: The area of the grinding surface was measured to the nearest square centimeter using a centimeter grid on clear film.

Grinding surface preparation, Face A: The amount of pecking or roughening present on the grinding surface of the mano.

1) Very pecked—little or no abrasion.
2) Pecking evident—moderate abrasion (polish only on ends).
3) Pecking evident—heavy abrasion (polish in the center of the mano face as well as on ends).
4) No pecking visible—surface totally abraded.
5) Little pecking/little abrasion.

Orientation of striations, Face A:

0) Not visible.
1) Reciprocal, perpendicular to the long axis.

2) Rotary.
3) Reciprocal, parallel to the long axis.
4) 1, 3 (cross-hatched).

Area of grinding surface, Face B: Same as Face A.

Grinding surface preparation, Face B: Same as Face A.

Orientation of striations, Face B: Same as Face A.

The next set of variables examines reuse of the artifact.

Number of secondary utilized surfaces: The number of areas on the artifact with evidence of utilization not relating to use as a mano.
1) 1
2) 2
3) 3
4) 4

Location of secondary use:
0) Other than those described below.
1) Utilized face (mano use).
2) Unutilized face.
3) Edge.
4) End.
5) 3, 4
6) 1, 2
7) 2, 3
8) 2, 4

Characteristics of secondary use: Up to two wear types were recorded.
1) Battering.
2) Spalling/fire-cracking.
3) Polish.
4) Chipping.
5) Pecking, cutting, gouging (other than resurfacing).
6) Archeological evidence of reuse (post shim, building stone, etc.).
7) Pigment.
8) Striation/grinding.
9) Slight grinding, polishing on unused surface.

Other artifact type associated with mano:
1) Hammerstone/pounder.
2) Palette.
3) Anvil.
4) Abrader.
5) Other.
6) Chopper.
7) Polisher.
8) Post shim.
9) Unknown.

Number of tertiary utilized surfaces: The number of surfaces which exhibit a third kind of use (not associated with use as a mano and different from the secondary use described above).

Location of tertiary use: Same as those for secondary use.

Characteristics of tertiary use: Same as those for secondary use.

Other artifact type associated with mano: Same as those for secondary use.

Amount of use: A subjective assessment of amount of use as a mano, based on size, shape and surface characteristics.
0) None—for mano blanks.
1) Light.
2) Moderate.
3) Heavy.
4) Worn out.

Chapter Nine

The Metates of Chaco Canyon, New Mexico

John D. Schelberg

> Because all Bonitian metates are troughed, I did not recognize soon enough the possibility of a cultural lag. (Judd 1954:135)

Background

Katherine Bartlett (1933) was the first to systematically consider the subject of Pueblo or Anasazi milling stones; she included manos, metates, mealing bins and their location within houses in both ethnographic and archeological settings. On the basis of her observations of the Hopi, she evaluated the archeological record of the Anasazi grinding complex in northern Arizona, and the subtitle of her 1933 article, "A Study in Progressive Efficiency," set the tone for virtually all subsequent discussions of the changes in metate morphology. Simply stated, this view is that there has been an increase in the efficiency of the grinding surface of the manos and metates; this is a cause of the transition from trough to slab metates. Archeologists have not only generally accepted this conclusion but also Bartlett's notion that the change from trough metate to slab metate was a pan-Anasazi phenomenon which began during Pueblo II and ended by Early Pueblo III (Bartlett 1933:23).

Woodbury (1939) generally concurred with Bartlett when he analyzed the ground stone artifacts from site Bc 51 in Chaco Canyon. In his 1954 monograph concerning the stone tools from northeastern Arizona, he discussed the reasons for and the value of analyzing stone tools as they relate to greater archeological problems. His epistemological concerns are perhaps too conservative by today's standards and diffusion is not as attractive a mechanism as it once was; nevertheless, he recognized the necessity of making generalizations about social systems and cultures as a whole. He considered two of the principal goals of archeology—the construction of chronological sequences and the determining of the geographic boundaries of cultures—to be the first steps which were necessary prior to the reconstruction of culture history. Choosing appropriate "index fossils" to serve as diagnostic criteria for successive cultural periods would accomplish these goals. Among the characteristics necessary for index fossils, Woodbury listed abundance, successive variation, and geographic variation. Because he thought, on occasion, too much reliance was placed on pottery for the definition of a "culture," he suggested that stone artifacts would help in the choice of criteria with which to define the time and space framework. He considered archeology to be a method which assisted in the reconstruction of culture history rather than as a means for testing hypotheses (Woodbury 1954:16-17).

Three of the more recent general Southwestern textbooks have continued these themes. McGregor's (1965) attributes the change in metate morphology to the processes of diffusion. The other two tacitly imply that diffusion was involved; however, they are more concerned with the argument of increasingly efficient grinding surfaces. Their data is from northern Arizona and they unfortunately extend the implications to the Southwest, with the suggestion that they have uncovered systematic regularities (Martin and Plog 1973, and especially Plog 1974). While the facts of a transition from trough to slab metate between Pueblo II and Pueblo III may be true in certain areas of the Southwest, one of the major points of this chapter will be to demonstrate that neither diffusion nor a change in morphology took place in the Chaco Anasazi region. If Bartlett, Martin, and Plog are correct that this is one area where this transition should have taken place, we can demonstrate that, by their own criteria, their implied systemic regularities are not pan-Southwestern. I will suggest several additional variables which are relevant to this problem and which were not previously considered.

Carter (1977) pointed out that metates were not necessarily only associated with agriculture and were in fact in use in the Great Basin between 10,000 and 2,000 B.P. They had a worldwide distribution. The major emphasis of his article is to demonstrate not only the association of metates with Paleo-Indians, but also that they go back as much as 80,000 years in the New World. Fortunately, we are concerned with agricultural societies only a few thousand years old and it will not be necessary to critically consider his evidence for extreme antiquity.

Metates, from the Aztec metatl (Judd 1954: 132), were used for grinding corn and other items in the Southwest and throughout Mexico and Central America. Early explorers and later ethnologists recorded their use and occasionally the context of that use; modern researchers frequently cite specific cases to warrant archeological assumptions by indicating that a proposition has some basis in fact. From Hawikuh, Coronado wrote in 1540 that, "They have the very best arrangement and machinery for grinding corn that was ever seen. One of these Indian women here will grind as much as four of the Mexicans" (Judd 1954:133). Ethnologists observed the Pueblos grinding both domestic and wild foodstuffs for everyday consumption, clay for pottery, pigments for paint, pollen for ceremonies (often with some shell and/or turquoise ground in), various plants and herbs for medicinal purposes, etc. A more esoteric observation was Titiev's (1972:142-143), who recorded that the Hopi women collect stones for metates between March and the first appearance of peach blossoms because the stones are "cold" and would cause frost if gathered out of season. They may be installed at any time, however. Every Hopi woman spent at least three hours per day over her metate in 1899 (Dorsey in Woodbury 1954:64) and Bartlett was told by the Hopi that each family used one large bowl (about three quarts) of cornmeal every day. Usually 10 to 20 bowls were kept on hand (Bartlett 1933:3).

It was frequently recorded that metates and/or manos were graded in degrees of coarseness (coarse, medium, and fine) and archeologists are delighted when they find a prehistoric example of a modern observation. Other recorded facts include the construction and location of metate bins, the number per house, and the number of houses with them. Roughly one-half of the homes at Cochiti had mealing bins (Lange 1959:68); every Hopi house had at least two mealing bins in 1932 (Bartlett 1933:14). The number of manos per metate (six at Cochiti) is frequently noted and this ratio is usually calculated by archeologists (Lange 1959:117).

Lange (1959:117) explicitly noted that many anthropologists assumed that hammerstones were used exclusively for chipping and flaking stone artifacts; however, his observations at Cochiti were that they were used much more frequently for "sharpening up" the grinding stones, especially the manos. "Grinding sessions were inevitably preceeded by sharpening or roughing the grinding surfaces of the implements." This was also recorded by Bandelier in 1880 (in Lange 1959) and a number of Chaco archeologists, including Roberts (1929:133) and Judd (1954:135), were careful to point this out. Bartlett (1933:4) was told that the Hopi of the 1880s used to sharpen the metates once every five days.

I did not conduct an intensive review of the Southwestern ethnographic literature in the hopes of ferreting out all the references to metates. Given the general absence of quantification (i.e., for rates, or time, or distance, etc.) in this literature, the most that would be achieved would be a relatively complete list of specific items that were ground. It is clear that metates were utilized for grinding anything that had to be ground.

Appendix 9A provides a review of the archeological literature for Chaco Canyon sites, a select few Chacoan outliers (but includes most for which any printed material was available), and several sites from Mesa Verde (for comparison). The review focused on the numbers and forms of metates, the numbers of manos and hammerstones, and mealing bins, primarily because the ethnographic literature frequently discussed these items.

Research Orientations

In very early reports—when all objects discovered were new in the experience of the finders—fairly detailed descriptions were given of metates and manos. After that milling stones were no novelty, and moreover, they were too cumbersome to be taken back to a laboratory for study, and so we have the beginning of the long period when metates were described as being "of the usual type." (Bartlett 1933:3)

For many decades, the context in which research occurred in the Southwest was to clarify time periods and the origin and subsequent spread of cultural traits across the landscape. As far as the cumbersome metate was concerned, the general outline of its history was considered to be sufficiently understood by the 1930s—as Bartlett's lament indicates. She was particularly distressed because she felt that manos and metates were the most important aspect of the Anasazi tool kit—they were an agricultural people heavily dependent on maize for their subsistence (Bartlett 1933, 1936). She also recognized their dependence on wild products.

Bartlett studied the change in metate morphology from basin to trough to slab metates. Because of increasing grinding surface area, she considered the sequence representative of increasing efficiency. The final transition to slab metates was thought to represent the peak of the efficiency response (in conjunction with a number of factors including increased numbers of rooms per house, the advantage of having to deal with the smaller rocks that slab metates required, and the social advantages and interaction created by specified grinding areas which contained multiple metates so that several women could grind simultaneously, etc.). The transition from trough to slab metate began in Late Pueblo II times and ended by Early Pueblo III (ca. A.D. 1100s).

These conclusions were accepted by succeeding generations of archeologists as being essentially true—of course, there were the expected variations in the details of the sequence or the time of the transition from region to region. In an effort to find dated references to the appearance of items of material culture, subsequent researchers concerned with more than a single site devoted a great deal of energy to exhaustive reviews of the literature. These references were then arranged by type and date, and the diffusion process and pathways were delineated. Maps with numerous arrows indicated the progress from the earliest to the latest appearances (e.g., Woodbury 1939, 1954). The fact that the race of maize depended on by the Anasazi has changed through time was pointed out; however, only recently has this factor been examined with respect to metates.

With the advent of the New Archeology in the 1960s, it was only natural that manos and metates were evaluated. Martin and Plog (1973) and Plog (1974) did not actually propose any radically new interpretations for metates. In fact they reiterated Bartlett's notion of increasingly efficient grinding surfaces through time. The context of the argument, however, was quite different; they were very concerned with an ecological approach and the concomitant consequences of sedentism and increasing reliance on agricultural products. In the long run, this would require an increasingly efficient adaptation in order for a larger population to survive in a generally marginal environment. Because of an underlying (but unstated) assumption that the Anasazi everywhere were basically the same through all time, they implied that their findings were applicable to all Anasazi, as did Bartlett, Woodbury, and everyone else. This is one of the unfortunate results of too heavy a reliance on arguments of ethnographic analogy, derived from a time when there were similarities in the lifestyle of the Anasazi and a result of not critically assessing the specific characteristics of the area under investigation.

In an attempt to transcend simple descriptive statistics, relatively general arguments of increased efficiency, and to better understand Southwestern adaptation—both synchronically and diachronically—two long-term proposals have recently been advanced. Both incorporate metates into their respective arguments. While the arguments are plausible in theory, they are not realistic because of insufficient appreciation for the realities of the archeological record. One investigator (Hill 1976) proposed to monitor changes in dependence on agriculture for inhabitants of the Pajarito Plateau, monitored (in part) by metate frequency as recorded by survey (and supplemented by excavation). The other investigator (Hard, personal communication 1981, 1986) was more concerned with focusing on metates in an ethnographic setting to gain a better understanding of the activities associated with metates. He then hoped to be able to calculate the volume of metates and develop an index that determined the amount of ground corn and faunal material. Other factors were the site population and the use-life of metates. Because it was necessary to look at metates from a series of sites, he proposed that additional information could be gathered from survey and a review of the literature.

Problems associated with data from either survey or the literature include such observations as Bandelier's (in Lange 1959:117), in which he stated that the Mexicans ransacked the ruins looking for metates. Woodbury (1954:54) noted that they (i.e., The Peabody Museum Awatovi Expedition) regularly gave good Anasazi metates to Hopi women; tourists and pot hunters who collected them were another problem. Many site reports do not record the total number of metates or manos recovered. Others report the results without specifying the sample size and it is impossible to discern if the total or some fraction thereof is being discussed. Others discuss those from fill and floor contexts and note that many (or some) were used in construction. These problems must be considered before making specific quantified statements of the kinds proposed.

Another issue relevant to this problem is more directly concerned with the archeology of complex societies. Such factors as the modification of rooms by the addition of subsequent floors, partition walls, or a major change in room function, such as the insertion of a kiva into a living room, causes major reorganization of the room's facilities. Stone tools need maintenance during their use-life and replacement after wearing out; the worn-out items are recycled into other contexts—often more than once. Clean-up activities disrupt the primary context of the archeological record.

There seems to be an inherent failure to appreciate the amount of prehistoric metate movement within and even between sites and the degree of reuse in post-grinding contexts. A good example of the problems which could result from uncritically relying on the distribution of metates, as recorded by site survey, occurred in Marcia's Rincon in Chaco Canyon. There was a cluster of 15 sites in a 1-km-radius; one, 29SJ 633, had over 150 metate fragments on the surface while the other sites in the area had few. The sites spanned several hundred years and at least portions of most were occupied at the same time. It was semi-seriously suggested that 29SJ 633 was a specialized corn grinding site for others in the rincon or even for some of the inhabitants of the greathouses (given Hill's programmatic statements, he would likely concur). It is clear from the test excavations, however, that the final inhabitants of 29SJ 633 (possibly "Mesa Verde" immigrants moving into a generally deserted canyon) were scrounging metates from the other sites in the rincon and using them in wall construction. Of the over 150 fragments recovered from the surface, after testing, not one was clearly used as a grinding tool at this site.

Examples of within site movement away from the primary context of grinding are easier to document; the obvious examples of metates used in the construction of walls, firepits, plugs, and post shims occurred at most Chacoan sites. Of the more than 30 possible metate "bins" (including grist troughs, catchment basins, etc.) excavated by the Chaco Project, none contained a metate. From all excavated sites in the Canyon there are few <u>in situ</u> metates. One four-compartment mealing bin with four metates was found in Chetro Ketl, Room 35 (Unnumbered photo, Chaco Archives; Woodbury 1939:65). Roberts (1929) found several in Shabik'eshchee Village (including several leaning against a wall in the "normal" storage position for the time period). Adams (1951) found two similar metates in Half House, and Bradley (1971) found several at Bc 236—a very late ("Mesa Verde") site. Pepper (1920) found several huge examples at Pueblo Bonito, including a boulder with five troughs. Of those in which context can be determined, less than 10 percent of the total metates recovered were in their primary context. Such a situation is not unusual for other Southwestern sites.

The local Chacoan archeological record became increasingly complex as the number of sites, population, and site and material reuse increased. When dealing with the archeology of complex societies, there is no guarantee that the material recovered, especially from the surface, was in its primary context at that location or even at that site. Chacoan metates provided an attractive target for reuse in construction because they were frequently thin and already shaped. Simply breaking them prepared them for use. Less than 12 metates were clearly worn out or "killed," and most appeared to have a substantial use-life remaining. Why someone who is dependent on grinding seeds and grain on a daily basis would break up a perfectly good metate for reuse in construction is rather enigmatic.

The process of metate matching was used to document within-site movement at 29SJ 389, 29SJ 391, and 29SJ 629. Matches were made between fragments found on the surface, from wall clearing, and from proveniences within and between rooms, pithouses, and kivas. A match is simply the rejoining of two or more separate fragments into the original piece. As noted in Appendix 9B, pieces from any one metate ended up in a diverse number of proveniences. These matches were as varied as a single metate that was broken up to construct a single slab-lined hearth in Room 147 at 29SJ 389, to pieces of an individual metate being used as architectural elements of the ventilator shaft of Pithouse 2, where a matching fragment was used as a post shim in Room 9 at 29SJ 629 (see also Windes 1993).

Of the many matches from Pueblo Alto, one was between a fragment from the construction of the south wall of Room 143 and a fragment from the west wall of Room 3, Plaza Feature 1—a distance of 50 m. This has obvious implications for investigations predicated on quantifying the total number of metates from a site. An average of 12 percent of the total number of fragments was matched at 29SJ 629 and Pueblo Alto; within-provenience matches were sometimes much higher. Matching reduces the total possible number of individual metates represented at any site and precludes using a simple count of individual fragments on the surface as an index for, among other things, agricultural intensification or specialization. Pot hunters, reconstruction, recycling, and prehistoric scrounging are all factors which complicate the archeological record; pristine sites, especially in an area that was occupied for so long, are very rare in Chaco Canyon.

There is yet another kind of problem which has to do with the archeologist rather than the archeology. Because of a prevalent attitude that metates are "of the usual type" or "seen one, you've seen them all," the literature and field notes indicate an uncritical approach to the analysis or classification of metates. As a result, abraders and other miscellaneous objects are analyzed as metates. Some are only unworked fortuitously shaped rocks. This complicates any study which is based on a review of the literature (Appendix 9A) because one can never be certain of the veracity of the reporting. Such errors range from the very obvious—such as artifact No. 173 from Bc 288, the Gallo Cliff Dwelling (29SJ 540), which was labeled a trough metate when it was actually a passive abrader of soft sandstone—to the less obvious, such as several abraders found at Long House (Wheeler in Cattanach 1980:261, Figure 303c-d), which were identified in an illustration as slab metates. They may have originally been slab metates, but their final use was probably as abraders. Rather than having been a trough metate which was later used as a slab metate on the opposite side, as was suggested (Hayes and Lancaster 1975:152, Figure 191b), this was probably a multifunctonal tool which was simultaneously used as a passive abrader on the reverse side. Even the generally experienced Chaco Center staff submitted 19 abraders and fortuitously shaped rocks (0.05 percent of the metate fragments) for analysis as metates. Loose (1979) reported a number of slab metates from 29SJ 299; however, they were all abraders. The section concerning terminology has additional classificatory problems.

What then is the use of analyzing metates? There are a number of issues that will be examined—some are descriptive and a few are more theoretically oriented. It will be pointed out that

1) metates, in addition to being used for grinding a variety of materials (which is clearly already known), were multifunctional tools during their life as a metate (which seems to be less generally recognized and much less quantified),

2) metates were extensively reused after they ceased being metates and certain aspects of this may be indicative of general levels of social organization,

3) the amount of energy invested in the metate (in terms of procurement, shaping, finishing, and its reuse) varied through time and is, in part, a reflection of the social organization of the system of which it was a component, and

4) the argument of an increasingly efficient grinding surface, as represented by the sequence of basin to trough to slab metate, is clearly <u>not</u> as general a trend as Bartlett (1933), Woodbury (1954), Martin and Plog (1973), and Plog (1974) indicate. This is an important point because Martin and Plog (1973:216-217) imply that this "fact" is a cultural universal in the Southwest. If ever there were a portion of the Anasazi world which necessitated efficiency, it was the world of the Chacoans.

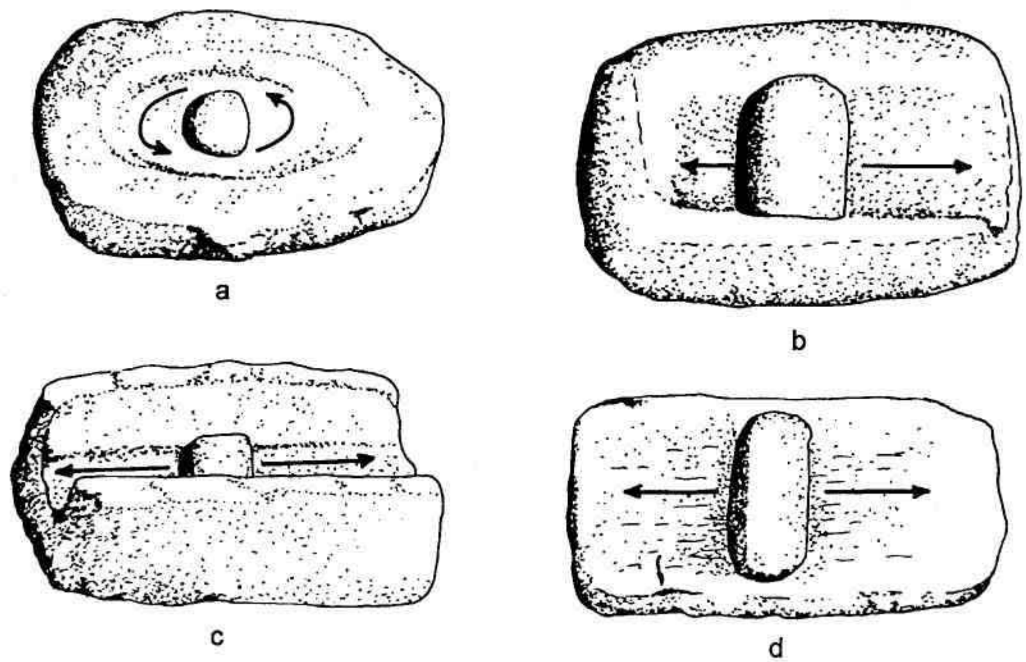


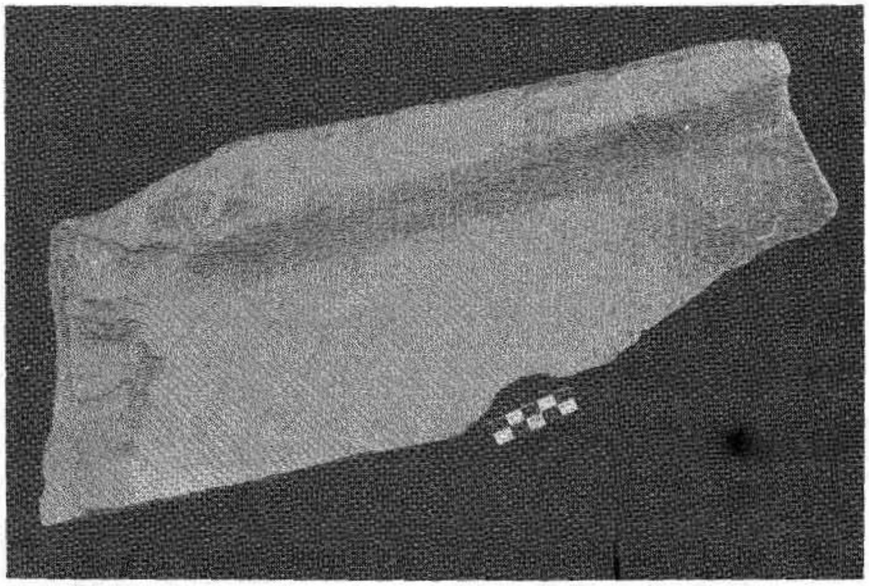
Figure 9.1. *Types of metates. A) Basin metate with one-hand mano. B) Trough metate (one end closed) and two-hand mano. C) Trough metate (both ends open) and two-hand mano. D) Slab metate with two-hand mano. (Adapted from Eddy [1964].)*

Terminology

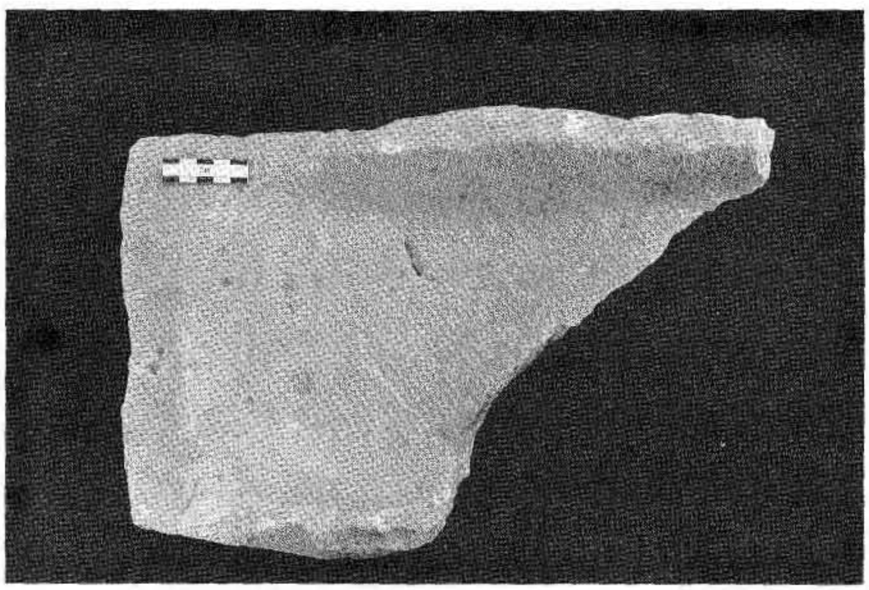
There is a certain amount of confusion in the literature which stems from the general nature of the English language and the subsequent citation of only a portion of a previously published statement. For example, Morris (1939) described thick and thin trough metates and sometimes referred to the latter as slablike or slabs because the thin pieces of stone resembled slabs and not because they were slab (i.e., flat surface/troughless) metates. Judd (1954) was careful to point this out because Bartlett and others subsequently misrepresented the metates at Pueblo Bonito because they assumed Pepper was talking about flat surface metates.

For the purposes of this report, the terminology will generally follow Bartlett (1933). She discussed basin, trough, and slab metates. Basin metates are often associated with Archaic sites in the Southwest and are the result of a rotary grinding motion with a small, one-hand mano (Figure 9.1A). No basin metates were analyzed for this report (none were recovered). Trough metates are those which resulted from grinding in a reciprocal motion with a two-hand mano which was smaller than the surface of the metate; the result was the creation of lateral edges and frequently, a shelf at the near-end (the end closest to the miller). Eventually, the shelf at the near-end was eliminated and the trough went completely through the stone, leaving only the two lateral edges remaining. Thus, the length of the trough determines two types of metates. A closed-end metate has a trough which is less than the length of the stone, with a shelf at the near-end (Figure 9.1B). A metate is open at both ends if the trough traverses the full length of the stone (Figure 9.1C). Slab metates (Figure 9.1D) resulted from use of a mano which was as wide as the metate surface; no edges or shelves exist.

Unfortunately, two semantic problems exist concerning trough metates, which hopelessly complicate many previously published analyses. There are some trough metates which essentially do not have a shelf at the near-end but which are still clearly closed at the near end (Figure 9.1B, Figure 9.2A and B, and Appendix B). The only real



A



B

Figure 9.2. Trough metate fragments without shelf, but clearly closed at one end: A) FS 1132 from Pueblo Alto (29SJ389), Room 103, Test Pit 5, Layer 1. B) FS 120 from Pueblo Alto, Circular Structure 1. (5 cm scales) (NPS Chaco Archive Negative Nos. 14220 and 14198.)

difference is the fact that the length of the near-end "shelf" is variable, and in the Chaco collection, it varies from less than 1 cm to over 18 cm in length (Figures 9.3, 9.4, 9.5, and 9.6). The upper surface, however, is the same height as the lateral shelves, and there is a continuous, non-undulating upper surface across the lateral shelves and the near-end. Unfortunately, many investigators classify a metate with a very narrow near-end shelf as open at both ends (e.g., Hayes for 29SJ 627 and 29SJ 1360; see also Hayes and Lancaster 1975:151, Figures 189, 190; or Swannack 1969:109, Figure 97c-e). This is clearly not the case.

One problem that results from this curious and incorrect labeling is that trough metates which are actually open at both ends are, in certain archeological sequences, intermediate between closed-at-one-end metates and slab metates. Both of the Mesa Verde sites noted above, Badger House and Big Juniper House, span this entire sequence; however, neither the number nor the context of those which are open at both ends can be determined from the published reports. This cavalier description led at least one Chaco Project archeologist to label a portion of a Chacoan site as late because of the supposed existence of a number of metates which were open at both ends. In fact, not only were there none at this site, but the entire canyon has yielded less than 35 such metates, representing only 0.5 percent of the total recovered from all sites. For this report, only those metates that are actually open at both ends will be so classified (Figure 9.1C).

The second semantic problem is perhaps less serious. A type of trough metate, referred to as "The Utah Type," is based on examples from southeastern Utah. One of the primary defining criteria of this type is a rectangular "box" pecked into the shelf at the near-end. Because metates with and without the box co-occurred in the sites in Utah, the name "Utah Type" was often casually associated with both. Any given Southwestern archeological site report is likely to refer to "the so-called Utah type metate," sometimes noting that the box was absent. When describing several sites in Chaco Canyon, Hayes referred to some metates with shelves at the near-end as "Utah." He does not, however, mention the "box," so there were probably no Utah metates, as originally defined, found in the canyon. None were recovered by the Chaco Project.

For the purposes of this report, the term, "Utah" metate, will refer only to those which have a box ground into the shelf at the near-end. Those metates without a box but with a shelf at the near-end are "closed-at-one-end"—no matter how short the shelf. Given the restricted distribution of the Utah type and its comparatively small surface area, it is necessary to maintain this distinction.

There are only several possible Utah-type metates from Chaco Canyon, and these are all from Pueblo Bonito. Pepper (1920:60, Figure 18b) illustrated one, as did Judd (1954:140, Plate 26.A). Judd (1954:139) indicated that this was a local type because they found fragments of several others. Because of the care with which the metate was constructed and its context, Pepper thought its function was ceremonial and Judd concurred. Judd (1954) indicated that the rectangular depression was in its upper end (i.e., at the near-end). It is difficult to determine from the photograph; however, I would suggest, based on the apparent morphology of the trough, that the depression is actually at the far end. Therefore, it is very probable that these were a local type and not a Utah type. Given that the grinding surface area of Judd's is approximately 336 cm^2 and that his and Pepper's were apparently recovered in the vicinity of kivas, it is a reasonable assumption that these were for ceremonial purposes only. It is likely that no true Utah metates have been recovered in Chaco Canyon.

Finally, the third major type of metate is the slab metate. This resulted from use of a mano which was as wide as the metate surface and, therefore, no lateral edges or near-end shelf were created by the grinding process. The majority of these metates were permanently fixed in mealing bins with upright stone, or occasionally wooden sides, which functioned to contain the ground meal. Usually the stone that was used was smaller than that needed for a trough metate. In this report, slab metates are those with a flat surface.

Change in Morphology

There are several aspects to the frequently discussed transition from basin to slab metate. The first concerns the morphology of the metate and its grinding surface. Another aspect is the location and/or degree of permanency of the metate in a bin.

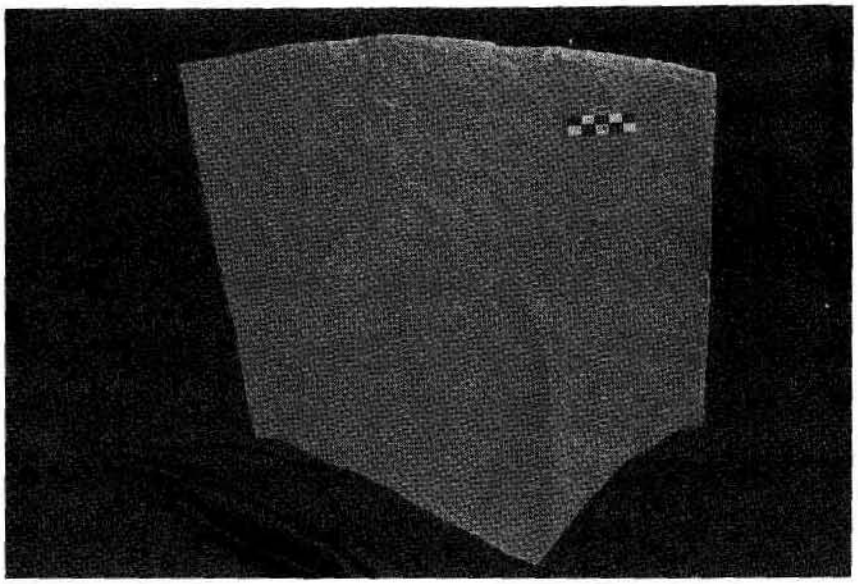


Figure 9.3. Trough metate fragment (FS 1133) with 19 cm near-end shelf. From Pueblo Alto (29SJ 389), Room 103, Test Pit 5, Layer 2. (5 cm scale) (NPS Chaco Archive Negative No. 14224.)

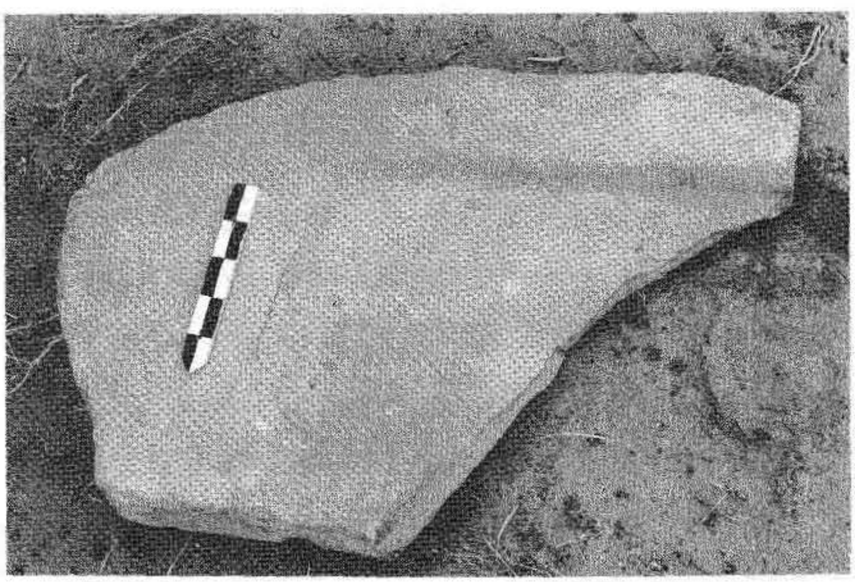


Figure 9.4. Trough metate fragment with irregular, wide, near-end shelf. From wall clearing of Kiva 2 at Pueblo Bonito (29SJ 389). (15 cm scale) (NPS Chaco Archive Negative No. 17954.)

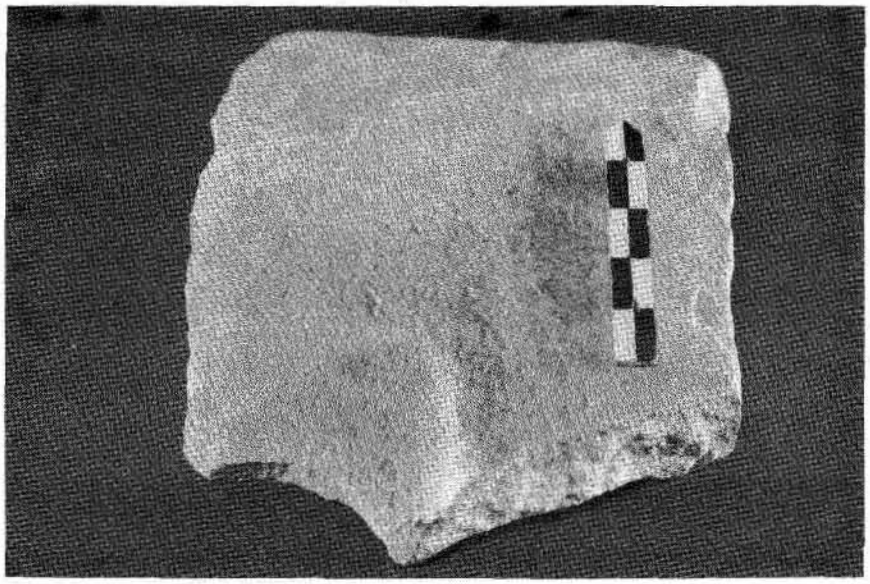


Figure 9.5. *Trough metate fragment (FS 922) with rectangular near-end shelf. From Pueblo Alto (29SJ 389), Plaza Feature 1, Test Pit 5, Layer 2. (15 cm scale) (NPS Chaco Archive Negative No. 23625.)*

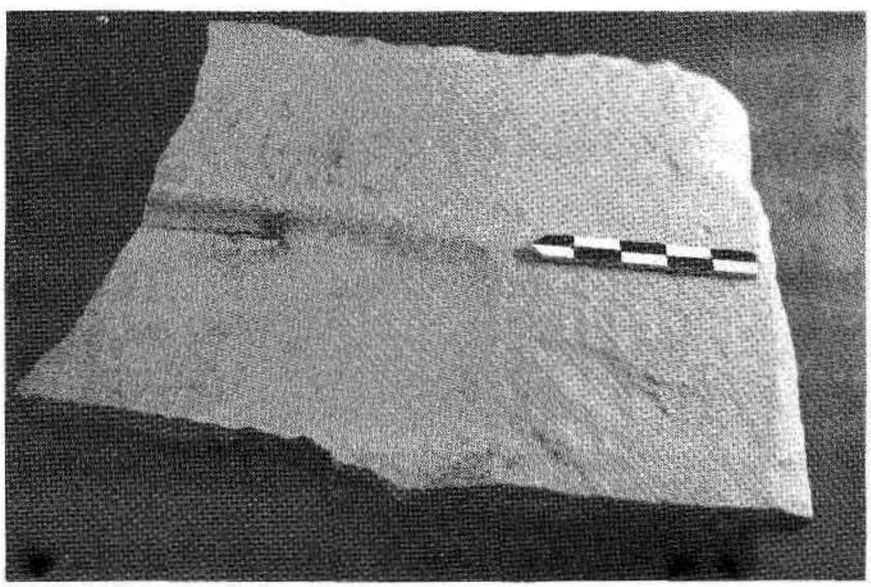


Figure 9.6. *Trough metate fragment (FS 2715) with rectangular near-end shelf. From Pueblo Alto (29SJ 389), Room 142, Test Trench 1, Level 11. (15 cm scale) (NPS Chaco Archive Negative No. 23604.)*

The generalized statements from the literature indicate that the earliest Anasazi metates (Basketmaker and Pueblo I) were troughs in generally unshaped, relatively thick, flat slabs that were not permanently fixed into a bin; they were fully portable and were leaned against the wall when not needed (e.g., Roberts 1929:133).

Later (nominally Early Pueblo II), as houses became larger, with more rooms and more substantial investment in the construction of the walls, work areas were more formalized and metates were moved to bins. The arguments vary, but the general trend is that trough metates were initially put in the bins, then as the Anasazi "learned" or "discovered" that the function of a bin was similar to the shelves surrounding the trough, they began to eliminate the shelves. The first to go was the near-end shelf; the resultant metate was open at both ends but retained the lateral shelves. The argument that the idea "arrived" was bolstered by finding occasional metates that had been made by battering the near-end off and then using it in the open-at-both-end style. Judd (1954:140, Plate 30B) illustrated one example which he thought fit this pattern. Finally, the lateral shelves were perceived as unnecessary and were eliminated by using a mano which covered the upper surface. Sometime during this sequence the metates were permanently fixed in the bin by setting it into an adobe bed (e.g., Bartlett 1933).

Progressive advancement of the Anasazi intellect is a frequently implied or stated reason underlying this sequence of metate morphology (Bartlett 1933, 1936; Woodbury 1939, 1954; etc.). Bartlett (1933:29), however, did point out that with each change in metate morphology (and assumed increase in grinding surface area), the permanent location in a grinding bin, and the creation of specific grinding areas, the task of grinding corn became "easier or quicker or more sociable." This idea was subsequently formalized by Martin and Plog (1973), who indicated that the grinding surface grew more efficient through time. Plog (1974:139-141) expanded on this theme ("less efficient surfaces were replaced by more efficient ones"), using evidence from Arizona sites. This sequence is considered completed by A.D. 1000. Even though only data from a portion of Arizona was examined, Plog implies that this was a pan-Southwestern event. This generalization, however, is based simply on the change from basin to slab metate, and in this broad a conceptualization, it is generally true.

Bartlett (1933:26) noted that during Pueblo II (A.D. 1050 to 1300) both trough and slab metates co-occurred in bins. Slab metates are usually listed as a Pueblo III trait. Unfortunately, this sequence has been perpetuated for Chaco Canyon. In his listing of traits by time period, Hayes (1981:30, 32) apparently uncritically accepted it and noted that metates, open-at-both-ends and set in a bin, replaced those open-at-one-end during Early Pueblo III. During Late Pueblo III, he said that slab metates in bins were used (along with "heirloom" trough metates). The less than 35 slab metates (less than 0.5 percent) from all excavated sites in Chaco Canyon represent almost nothing; therefore, either the Chacoans never made it to Pueblo III or they were not concerned with increasing efficiency in their marginal environment (see Schelberg 1982 for discussion of environmental parameters). It is necessary to consider other factors than time or increasing "efficiency" as the only causes of grinding surface variation.

Plog's formulation of the efficiency argument is curious because it promotes increasing the effectiveness and efficiency of the grinding surface. He noted that the surface of the manos grew to 50 percent larger, but he said nothing about the metates. That the surface area increased in a general sequence from basin to slab metate is true; the crucial difference is between the trough and slab surfaces. It is not technically correct to say that "less efficient surfaces were replaced by more efficient ones" (Plog 1974:139) because efficiency is usually measured by some form of input-output equation. Something is more efficient if the same job can be done in less time or if a higher output can be achieved during the same time; therefore, if there were more efficiency in anything, it was the grinding process whereby more meal was obtained in the same time period or the same amount of meal was obtained in less time.

From Plog's presentation, we must assume that with each morphological change in metates, the grinding surface area increased in portions of Arizona. This is not, however, the case in the Chaco region, when comparing the areas of trough and slab metates. The area of the Chaco Canyon slab metate from 29SJ 629 is 777 cm^2 (N=1), compared to 1,024 cm^2 for the 44 trough metates whose area could be calculated from Pueblo Alto (Appendix 9E). The slab metate area represents a net loss of 247 cm². On the average, the Chacoan open-at-two-end trough metates were smaller than the open-at-one-end forms (Appendix 9E). This was also the case at the Salmon Ruin, a Chacoan outlier, where the area for the slab metates was 935 cm², compared to 1,187 cm² for the trough metates (Shelley 1980:110). The latter example represents a net loss of 252 cm² and is exactly the opposite situation as that predicted by Plog. Similar net losses occur if the averages of trough metate and slab metate grinding surfaces are compared from Pueblo Bonito, Una Vida, or Rabbit Ruin (Appendix 9E). Also in Appendix 9E is an additional discussion of the problems associated with the determination of grinding surface area.

As with any archeological situation, a number of factors were causally related to the overall form and location of metates. Two which were generally not considered by the researchers discussed above include the properties of the corn being ground and the utilization of space within a site. The latter will be discussed later. One of the underlying causal factors cited in the change from basin to trough metates is that a relatively high yield domestic crop was increasingly relied on and that a greater amount of meal could be ground more effectively because of the larger grinding area and the reciprocal grinding motion associated with trough metates. Yet the argument concerning the transition from trough to slab metates centers around increased learning capacities of the Anasazi. There is no reason to exclude another, though less dramatic, shift in the nature of the material (in this case maize) being ground. There are several aspects to this argument including the hardness of the kernels and the race or strain of corn in the area.

Cutler suggested (Mollie Toll, personal communication 1996) that a number of races of maize with differing requirements and productivities were introduced into the Southwest through time. With respect to these factors, it is not unreasonable to consider the grinding surface morphology. Bartlett (1933) suggested as much when she noted that the function of the edge of a trough metate was to keep the kernels within the grinding surface and that once metates were placed in bins, this function was replaced by the sides of the bin. I attempted to consider the relationship of the kind of corn and metate from the literature; however, the problems of preservation and/or very general presentation precluded many useful observations.

Unfortunately, the archeological record of the canyon will be of little utility for this problem because of the nature of the preservation, general lack of association, and the difficulty with identifying the very small diameter corn cobs recovered during our excavation. Because we have so few slab metates, if the generalizations from the literature are accurate, I would expect that the corn from the Chaco Canyon sites (except perhaps for the late Mesa Verde affiliated sites) would be the earlier varieties (Chapalote related) with about 12 rows of kernels per ear rather than the late hybrid varieties of Chapalote and Maize de Ocho. It would be interesting to know the moisture and growing season requirements of these varieties of corn; perhaps Chaco Canyon was climatically unfavorable for certain varieties.

Related to this problem is the hardness of the maize kernels which varies from the earlier flint corn (named for the hardness of the kernels) to the later softer flour corn. One of the postulated functions of the large, often featureless and usually empty rooms at the Chacoan greathouses is food storage, perhaps used as a buffering mechanism for local and regional problems and populations (Judge et al. 1981; Schelberg 1979). Even kernels of the softer flour corn dry out and become harder after storage; therefore, a continuing function existed for the shelves of the trough metate. It is interesting that one of the latest sites in the canyon to be occupied had a preponderance of slab metates (Bradley 1971). This site was occupied after the demise of the extensive Chacoan regional system and at a time when the more restricted social organization was based on local family or extended family ties. The amount of corn stored would only have to suffice for this relatively small number of persons for one winter season at a time—the kernels would be less dried out and the race of corn may have been different. There is some evidence for this because all of the six charred corn cobs recovered were the eight-row variety (Bradley 1971:51).

Experimentation by the staff of the Salmon Ruin indicates that flour corn is much easier to grind than flint corn. The flour corn kernels are easily crushed by pressing on them prior to grinding, whereas the flint kernels must be impacted with a mano; this tends to shatter the kernels and sends pieces flying (Shelley 1980:112).

Additional evidence comes from the excavation at the Salmon Ruin where, during the Primary (that is, Chacoan) occupation, 75 percent of the metates were trough and 22 percent were slab. During the Chacoan occupation, the predominant corn variety was flint. During the Secondary Occupation (that is, Mesa Verde) the trough metates comprised 21 percent of the total and the slab metates were 77 percent of the total. A "significant admixture" of flour corn was associated with the Mesa Verde occupation (Shelley 1980:107 and 112).

As with any event, many causal factors are involved. It is clear that in this case the variety of corn and perhaps the hardness of the kernels that were being ground were more influential in determining the morphology of the grinding surface of the metate than was an attempt at maximizing some sort of efficiency per se—especially in light of the decrease in the surface area suffered by the slab metates.

The Analysis

Metates are one of the many tools relied upon by prehistoric Southwestern groups and are ubiquitous in Anasazi archeological sites. Since metates were not easily transported prehistorically and were generally procured from the immediate vicinity, archeologists have spent a greater research effort on small portable tools made from silicious rocks whose quarry sources may be discovered. The procurement, production, and movement of raw materials and finished tools across space is central to arguments of population movement, trade, exchange, and production. Meanwhile, metates and other ground stone tools are usually treated in a perfunctory set of tables.

Unlike projectile points and other silicious tools, metates were used daily and provided the means for the greatest portion of the daily meals. Undoubtedly, the makers and users of ground stone followed a selection process similar to that surrounding silicious tools. Stones cannot be too soft or their use-life will be too short; cracks or fissures may cause them to break prematurely during use and maintenance. Early anthropologists in the Southwest reported sets of three or four metates or manos of increasingly fine-grain material which permitted the grinding of very fine meal; they also mentioned numbers of associated manos and hammerstones (e.g., Bartlett 1933; Lange 1959).

For this analysis, metates were treated as another tool in the overall Chacoan tool kit. Variables were recorded to characterize the rock being used, to permit discussion of the manufacture and varied use of the metates, and to follow their journey into the archeological record. The selection of variables was guided by those used by other analysts and by the observations of the early ethnologists. No variables were recorded that have not been employed by other researchers; however, unlike many site reports, an attempt was made to systematically document metates rather than to provide only overall measurements and several comments.

The Chacoan metates proved to be quite interesting. They were multipurpose, multifunctional tools which did not occur in graded series. They did not follow the purported general Southwestern sequence of trough metates open-at-one-end being replaced by trough metates open-at-two-ends, and finally being replaced by slab metates. Statistically, slab metates were irrelevant and were, in fact, numerically almost nonexistent; the open-at-two-end trough form was almost as rare. The slab metates which were found had smaller grinding areas than many trough forms, contrary to the expectation of the arguments for increasing grinding efficiency through time as the forms of the metates change (Appendix 9E). Trough metates were used in bins amd most were closed at one end. The vast majority of the metates were broken up prehistorically long before they were worn out. One-third of the broken pieces were recycled into other tools and several types of architectural elements before finally entering the archeological record.

The archeology of complex societies frustrated the best efforts of the analysts to consider the observations of the early Southwestern ethnologists and other archeologists. Initially, the intent was to determine the proportions of manos, hammerstones, and metates as an interrelated tool kit necessary for the daily grind. It was hoped that the numbers of metates, manos, and hammerstones, their use-life, and the volume of meal ground per some unit could be determined. The continuous occupation and use of

Chacoan sites by subsequent generations and the reuse following a period of abandonment resulted in changes in room function, the addition and removal of structures, and disruptions to the artifact assemblages. Not only were metates broken up, recycled into other tools and used in construction within a site, but pieces were also collected and taken to different sites for use in new construction.

Changes wrought by the prehistoric Chacoans were sufficient to render the delineation of culturally meaningful tool ratios or other indices essentially meaningless. If any hope remained after several summers of excavation, following a survey of excavated sites in Chaco that too was dashed. The remaining metates' locations were dictated by the National Park Service goals of interpretation to the visitor and keeping the area cleaned up. Any vestiges of hope vanished during archival research replete with references to unspecified numbers of ground stone from Bc 50 (for example), or specific numbers from a few miles south of Pueblo Bonito, or ground stone referenced in a 1904 letter from Richard Wetherill to the Field Museum of Natural History in Chicago, or an unlabeled photo of trough metates in a group of mealing bins. While some of the goals of the study were not realized, many others were—including several directly relevant to the archeology of complex societies.

The analysis of metates was undertaken by two people. In 1975 and 1976, Jean Hooten analyzed those from 29SJ 423, 29SJ 1659 (Shabik'eshchee Village), 29SJ 628, 29SJ 299, 29SJ 724, 29SJ 1360, and 29SJ 627. Between 1976 and 1979, I analyzed those from 29SJ 629 (The Spadefoot Toad Site), 29SJ 389 (Pueblo Alto), 29SJ 390 (Rabbit Ruin), 29SJ 391 (Una Vida), 29SJ 827 (Bc 362), and 29SJ 633 (The Eleventh Hour Site). The initial form was developed by Hooton (see Appendix 9C) and tested on a random sample of metates available at that time; during this process it was modified as conditions warranted. Her analysis of 29SJ 629 included only a portion of those that were ultimately recovered. Because I knew that more would be found from this site, I reanalyzed the ones she had done to become familiar with the process and to determine if any comparability existed between the two investigators. A comparison of the results was better than I had anticipated and discrepancies were often those of minor subjective interpretation. During this process, I modified the form to reflect other interests and to accommodate additional observations (see Appendix 9D). The differences in the forms will be presented in the Variables section. In 1981, the entire computer file was permanently modified to reflect the final form. Naturally, my observations are not recorded for Hooton's sites.

Depending on how complete each artifact was, forty-five variables could be recorded in computer format. When warranted, other observations were recorded separately (e.g., metate matches in Appendix 9B). Pieces that were too small to merit computer coding were weighed and measured and any other characteristics were noted (Appendix 9F). Every whole metate or fragment recovered was analyzed except for those from 29SJ 627, where Hooten analyzed a 50 percent sample due to the large number of mostly fragmentary pieces.

Variables Recorded

Variables 01 through 08 are provenience information and include the site number, the major provenience type and number, major location within the provenience, the type and number of the feature and its fill designation and layer number. This coding was identical to that used for the artifact inventory of each site.

Variable 09, weight, was recorded in grams. Variables 10 through 12 recorded the length, width, and thickness to the nearest whole centimeter. If a fragment was sufficient for computer coding, it was weighed and measured, regardless of its completeness.

Variable 13, burning, was recorded as none, partial, utilized surface, or complete. The latter variable was recorded only for sites 29SJ 629, 29SJ 389, 29SJ 390, 29SJ 391, 29SJ 827, and 29SJ 633.

Variable 14 was recorded differently by the two analysts. Hooton (Appendix 9C) used it for encrustation and recorded insignificantly, completely, or utilized surface. She was monitoring deposition of calcium carbonate in an attempt to differentiate between rocks picked up from the surface as opposed to rocks which may have been quarried. Based on her analysis of the random sample, however, she believed that it was not a useful variable to record and so I did not. When I began to analyze metates, a previously unrecorded attribute—floor wear—was monitored as light, medium, and heavy on the bottom, edge, or both.

Variable 15, hardness, was devised by the ground stone analysts because the Mohs hardness scale was insufficient. A 1972 penny from the Denver mint was used to scratch the stone. Soft sandstone could be crumbled by hand; medium could be scratched with a fingernail. Hard sandstone scratched by a penny would leave some copper on the rock's surface. Very hard sandstone was not scratched, but a streak of copper remained. The hardness of the use surface was recorded and this was usually, although not always, the same as the other portions of the rock.

Variable 16, color, was tan, gray, or interbedded, a combination of the two, or rarely, a combination of red and gray. Normally, the tan sandstone is the more massive of the two and makes up the bulk of the cliffs; the gray is thinner, harder, and occurs in discrete beds.

Variable 17, geological structure, was an attempt to monitor two variables—based on a dichotomy of the thickness and the overall shape of the rock. The two variables were the stone (thinner and gray, much of which was quarried from the surrounding benches, and thicker and tan, much of which was available at the base of the cliffs) and the amount of effort (time and/or energy) that went into shaping the stone. Both of these variables (shape and effort) were assessed at several junctures of the analysis because variable 16 was too vague. Tabular metates were 8 cm and less in thickness and rectangular in shape. Tabular irregular were those that exhibited some attempt to make them more rectangular but they remained partially irregular. Massive irregular rectangular metates were less than rectangular. Massive fragments were greater than 8 cm thick and those whose overall shape could not be determined. Eight centimeters was chosen as the demarcator following Judd's analysis (1954:135), which indicated that of the two principal groups of metates that he observed in Chaco, the second was at least three inches thick.

Variable 18, grain size, was derived from the Mounted Sand Grain Folders made by the Geological Specialty Company. Fine: 0.125-0.25 mm; medium: 0.25-0.5 mm; very fine: 0.0625-0.125; medium fine: used to designate occasional pieces with less uniformly sorted grains; this is a mix of medium and fine.

Variable 19, manufacture, was concerned with the specific kinds of modification to the rock prior to its use as a metate. These were most easily seen on the edges and bottom. Additionally, there were cases in which it was difficult or, occasionally, impossible to differentiate between manufacture and additional (simultaneous or post-metate) use. In such cases, a subjective assessment was made or it was recorded as unknown. The options were unmodified, chipped/flaked, abraded, pecked, and combinations thereof.

Variables 20-24 noted the dimensions of the utilized surface (the trough) and the near-end to the nearest whole centimeter. Only those which were complete were measured. The length was measured down the center—the distance the material being ground would have traveled along the stone. Unfortunately, Hooton (Appendix 9C) measured the width of the trough at the top and I measured it at the bottom, resulting in noncomparability between her sites and mine for this dimension. The maximum trough depth was generally in the center, approximately two-thirds of the length from the near-end. The measurement for the thinnest part of the trough was an actual measurement taken at whatever location was appropriate. Due to irregularities in the bottom of the rock, the thinnest part of the trough cannot be directly calculated by subtracting the depth of the trough from the thickness of the stone. The irregularities are not reflected in the measurement of the overall thickness of the stone as the latter is concerned with the maxium. The near-end shelf width was measured in the center.

Variable 25, assessment of amount of use, was rated as light if the trough depth was up to one-third of the thickness of the rock; medium if it was between one-third and two-thirds; and heavy for greater than two-thirds. Pecked outline was reserved for those occasional metates which were essentially brand new and unground.

Variable 26, grinding surface preparation, considered the relationship between the pecking of the surface (to sharpen or refurbish it) and the degree of grinding since the last sharpening episode. The depth of the pits and their frequency were observed. The sequence of heavy pecking/light abrasion, moderate pecking/moderate abrasion, light pecking/heavy abrasion, and no pecking/heavy abrasion, progressed from a freshly pecked relatively unground surface to a heavily ground surface. The final option, i.e., no pecking and heavy abrasion, required a judgment between attributing the grinding to use during its life as a metate or to secondary (that is, post-metate) use as a passive abrader. The surface normally would not be ground completely smooth while it was being used as a metate.

Variables 27 and 28 were characteristics associated with a metate's use as a grinding implement. Undulant trough walls reflect the replacement of a worn or broken mano by a new, but shorter, mano. Battering/crushing was a variable used by Hooton (Appendix 9C) to record small concentrations of intensive hammerstone pounding in the trough. Striations are a series of very fine and frequently difficult-to-see sets of parallel lines on the surface of the trough—a result of grinding either with a rock harder than the metate or a rock of comparable hardness in direct contact with the metate (i.e., there was little meal being ground between the two rocks). Lateral shelf was recorded by Hooton (Appendix 9C); I did not record this as it is a concomitant of the definition of a trough metate and would be associated with every one. Asymmetrical wear to the left or right at the near-end was recorded for those metates which had a rectangular near-end (see Variable 29). This was an attempt to monitor the right or left handedness of the grinder.

Variable 29 was recorded differently by the two analysts. Hooton (Appendix 9C) recorded latitudinal cross-section as trough, double-sided trough, and stepped trough. Since these are concomitants of the definition of a trough metate and/or monitored by other variables in the analysis, I did not record them. Instead, I looked at the shape of the near-end of the trough: rectangular, U-shaped, or irregular.

Variable 30, plan view, was a simple overview of the shape of any nearly complete metates. This generally overlapped other variables. The options included rectangular, angular-irregular, rounded-irregular, and round. The latter was added for one metate from 29SJ 391, Una Vida, recovered by Gordon Vivian and left at Chaco Canyon.

Variable 31, major type, was recorded as trough one-end-open, trough two-ends-open, two-sided trough (for those which were turned upside down and used again as a trough metate), other trough (for fragments which were trough but which did not have the diagnostic ends), slab, basin, ceremonial beautiful (for those with a tremendous amount of energy invested in the construction or having decorative scrolls along the border), and Utah (see above for discussion of the Utah problem).

Variable 32, number of major secondary utilized surfaces, was the number of surfaces which were used for activities other than the primary job of grinding while the metate was still being used as a metate.

Variable 33 recorded the location of the surfaces noted in Variable 32. Options were trough, adjacent/contiguous (to the trough, that is the lateral shelves and near-end), opposite (the bottom), and any of the combinations.

Variable 34 was the type of wear recorded by Variable 32. Those recorded were ground/abraded (use as a passive abrader); pecked, gouged/battered/hacked (use as a passive abrader); pigment (use as a paint palette); incised groove; ground/gouged (similar to anvil wear, see Akins this volume); wide, deep, parallel grooves in the trough (these differ from striations in the greater size and depth, and general ease of visibility); passive abrader (see Akins, this volume); and concentration of pecks on the bottom (added for metates exhibiting areas of 5-to-15 cm in diameter which were essentially solid peck marks). It is not completely clear that such a concentration was the result of secondary use. An argument could be made that it was the result of manufacturing the stone into a metate, e.g., the removal of a bulbous projection.

Variable 35, number of other utilized areas, was also secondary wear contemporary with the use as a metate but less intense or extensive than that recorded by Variable 32.

Variables 36 and 37 recorded the kind of wear noted by Variable 35. Options included pigment, ground/abraded, gouged/pecked, striations, battered/crushed, and burned. Hooton (Appendix 9C) recorded kill hole, but I did not record it here because that is not the result of using the metate as a secondary tool.

Variable 38, other artifact type, denoted artifacts that were made from a metate after it ceased to be used as one and usually after it was broken up. Artifacts recorded included palette, anvil, fire dog, crusher/chopper, hammerstone, active abrader, mano, vent shaft collar, post shim, passive abrader, saw edge, drill base, passive abrader with undulations in the trough, base for a mealing bin, mealing bin construction, shaped slab cover, notch, step, and building stone.

A category of wear was recorded under this variable because there were no other columns available on the form. Referred to as bin wear, it was recorded on the near-end, far end, lateral edge, the center trough, and the various combinations.

Variable 39, condition, was a description of the piece being analyzed. Included were whole and usable, analytically complete but unusable (referred to those broken up prehistorically but the pieces recovered during the excavation could be reassembled), and fragment. The latter condition yielded no whole measurement; instead, length, width, thickness, or combinations of these were recorded.

Variables 40 and 41 were for the dimensions of the nonutilized surface, that is, the width of the left and right lateral shelves to the nearest whole centimenter.

Variable 42, characteristic of the trough, could only be recorded for relatively complete trough widths in that it was an attempt to look at the cross-section profile of the use surface. Flat, slightly concave (less than 1 cm) or very concave (greater than 1 cm) were the options.

Variable 43, amount of work invested in an artifact, indicated the effort expended in shaping the stone into a metate. Regularity of the stone in all dimensions—symmetry, flaking, grinding, pecking—were considered. The options were none/unmodified, slight, moderate, extensive, or superior.

Variable 44, disposition, was a somewhat over-elaborated category which attempted to record what happened to the metate: killed and broken, worn out (with a hole in the bottom), killed, reused in construction, reused in construction with a hole, reused in construction with a kill hole, no obvious reason (a perfectly good, whole, and usable metate), broken, and has become another artifact (used for those pieces which were subsequently fashioned into another artifact as recorded in Variable 38). To be recorded as reused in construction, the piece had to be in place, or in wall-fall, at the time of excavation. In those cases where more than one event transpired in the life of the metate (usually a fragment which had been made into another artifact and subsequently reused as an architectural element), the final use was recorded in this space.

Variable 45 was the field specimen (FS) number assigned to the artifact in the field.

Variable 46, angle of the trough, was only recorded for a small portion of the sample and noted the angle created by the slope of the trough. It will not be discussed.

The results of the analyses are presented in the following section. Rather than following the sequence of variables as listed above and on the recording forms, the variables are grouped into related categories which more closely correspond to the sequence of events associated with tool procurement and use.

Metates—The Beginning

The first set of variables to be discussed concern the rock itself. Sandstone is the single most ubiquitous feature of Chaco Canyon, but it is not univariate; harder, more tabular layers were heavily used during construction episodes at many Bonito Phase greathouses. All of the Chacoan metates were sandstone—there was not a single exception. The best determination is that they were all made from the locally available sandstones. Geological structure, color, grain size, hardness, manufacturing techniques, and plan view were monitored and are discussed below.

<u>Geological Structure</u>

When the original analyst looked at two properties of the rock—thickness and overall shape—the geological structure was divided into five not mutually exclusive categories. Thickness is directly related to the layer of sandstone being utilized; certain layers produce thin pieces and others produce thick pieces. The overall shape of the stone can be modified by the manufacturer, if desired. Fortunately, the variables can be combined into exclusive categories.

The five values are 1) tabular rectangular and 8 cm or less thick, 2) tabular irregularly shaped and 8 cm or less thick, 3) massive rectangular and greater than 8 cm thick, 4) massive irregularly shaped and greater than 8 cm thick, and 5) massive greater than 8 cm thick but too fragmentary to depict the regularity of the original stone (Figures 9.7, 9.8, 9.9, and 9.10).

Table 9.1 indicates that the tabular, less than 8 cm thick stone was the most frequently selected for metate manufacture at all sites except one (discussed below). Included are sites from all temporal periods located throughout the canyon, including the valley floor and the surrounding plains. No attempt was made to locate the exact quarry from which any given stone originated, but tabular stone of this type occurred on the benches of the canyon above the valley floor. After procurement, a stone would have to be taken down the cliffs to the pueblo. It was also from these locations that building stones for the greathouses were quarried. The sandstone at the base of the cliffs and closest to many of the sites in this sample is the more massive variety. While it was closest to the location of metate use, it was the least selected.

The massive, greater-than-8-cm-thick sandstone represented 31.9 percent of the sample at 29SJ 629 and 26.8 percent at 29SJ 389. At all other sites with larger sample sizes, the comparable percentage is low. The single site with less than 50 percent thin metates, 29SJ 827, is one of the two temporally latest sites analyzed; this site has the largest number of trough metates with both ends open and two slab metates. At the other late site, 29SJ 633, 50 percent of the pieces were 8 cm or less; 40 percent were greater, and 10 percent were unknown. But many of the metates from this site were used in wall construction and had been taken from other nearby sites in and around Marcia's Rincon. At best, only a few of those analyzed from 29SJ 633 were actually used as metates at this location; therefore, the information is more relevant in the context of a site cluster than for this specific single location.

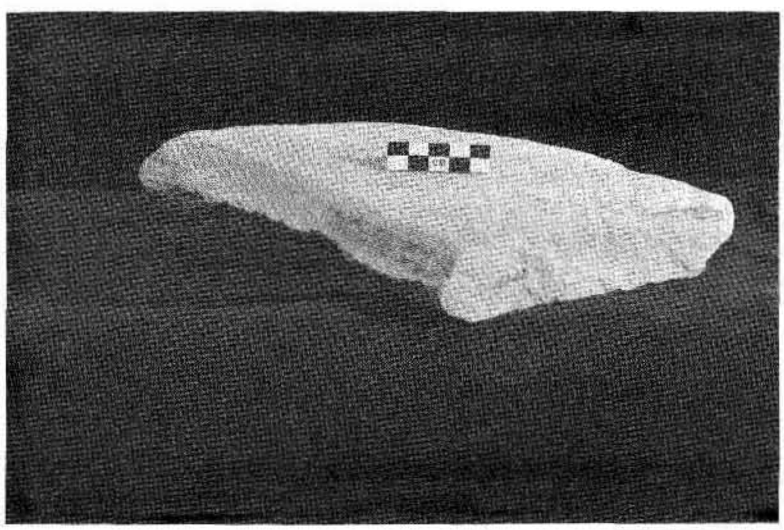
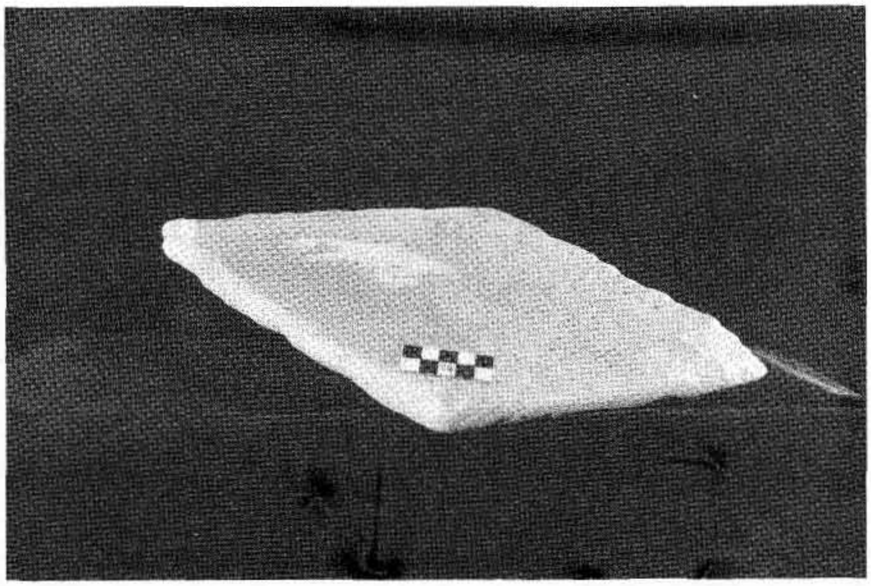


Figure 9.7. *Example of geological structure: Trough metate fragment (FS 152-02) from Pueblo Alto (29SJ 389), Room 110. (5 cm scale) (NPS Chaco Archive Negative No. 14056.)*



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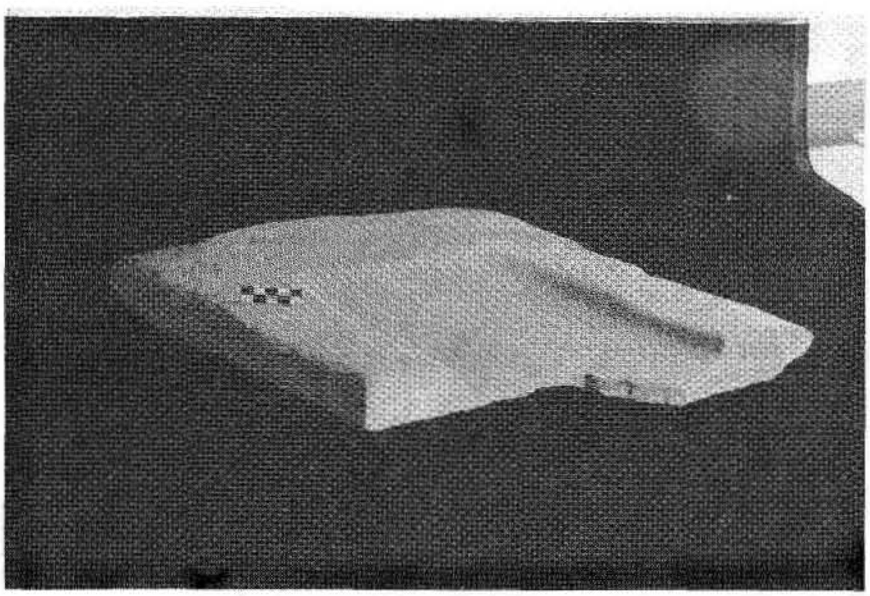


B

Figure 9.8. *Example of geological structure: A) Trough metate fragment (FS 434) from Pueblo Alto (29SJ 389), Other Structure 6. B) Trough metate fragment (FS 900-05) from Pueblo Alto, Plaza Feature 1, Test Trench 1. (5 cm scales) (NPS Chaco Archive Negative Nos. 14057 and 14047.)*

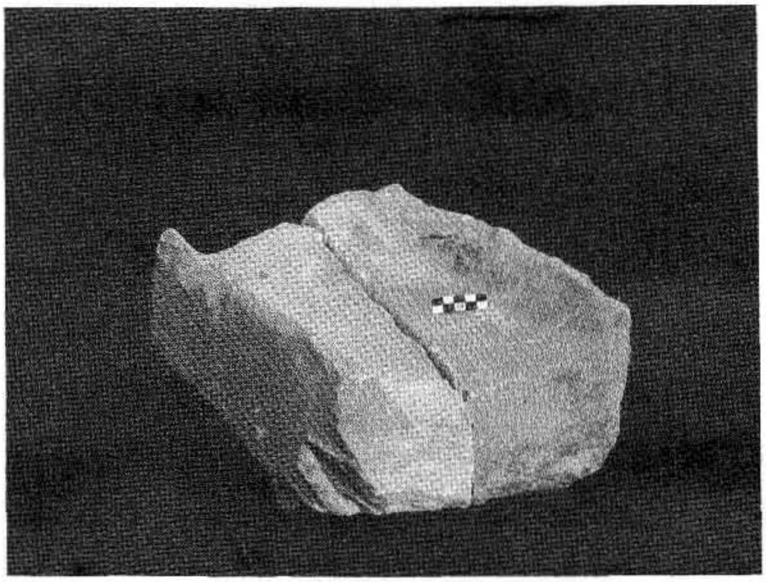


Figure 9.9. *Example of geological structure: Trough metate fragments (FS 566, 463-03) from Pueblo Alto (29SJ 389), kiva complex at southwestern corner of plaza and Other Structure 9, north of Room 209. (5 cm scale) (NPS Chaco Archive Negative No. 14049.)*

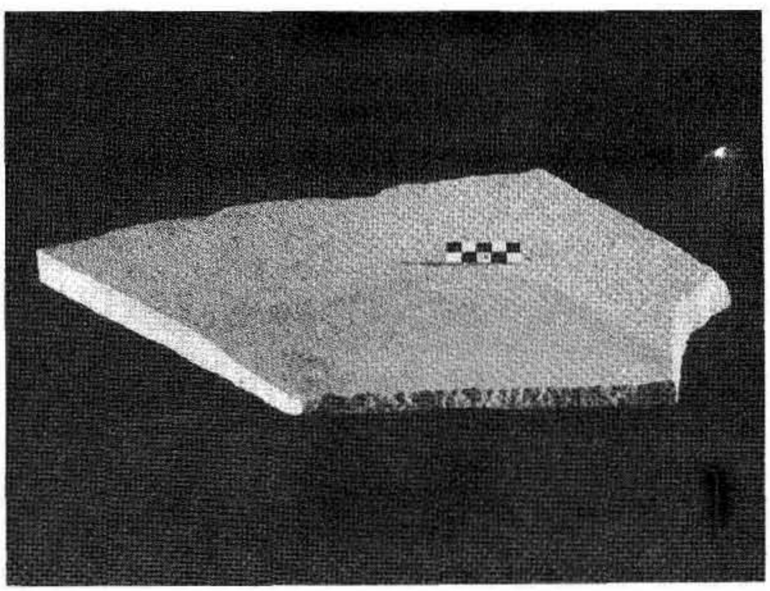


Figure 9.10. *Example of geological structure: Trough metate fragment (FS 1133-1) from Pueblo Alto (29SJ 389), Room 103, Test Pit 5, Layer 2. (5 cm scale) (NPS Chaco Archive Negative No. 14043.)*

Table 9.1. Geological structure.

	Structure												
	Tabular		Irregular Tabular		Tabular Massive		Irregular Massive		Massive		Unknown		
Site No.	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	Total
29SJ 423	1	20.0	1	20.0	-	-	-	-	-	-	3	60.0	5
29SJ 1659	2	66.7	-	-	1	33.3	-	-	-	-	-	-	3
29SJ 628	19	63.3	4	13.3	4	13.3	-	-	-	-	3	10.0	30
29SJ 299	22	61.1	9	25.0	4	11.1	-	-	-	-	1	2.8	36
29SJ 724	15	68.2	6	27.3	1	4.5	-	-	-	-	-	-	22
29SJ 1360	7	41.2	8	47.1	1	5.9	-	-	-	-	1	5.9	17
29SSJ 629	61	54.0	2	1.8	13	11.5	3	2.7	20	17.7	14	12.4	113
29SJ 627	106	51.0	47	22.6	25	12.0	-	-	-	-	30	14.4	208
29SJ 389	232	65.9	1	0.3	13	3.7	9	2.6	72	20.5	25	7.1	352
29SJ 390	4	66.7	-	-	-	-	1	16.7	1	16.7	-	-	6
29SJ 391	14	87.5	-	-	1	6.3	-	-	-	-	1	6.3	16
29SJ 827	28	43.1	-	-	2	3.1	5	7.7	29	44.6	1	1.5	65
29SJ 633	22	50.0	-	-	1	2.3	-	-	17	38.6	4	9.1	44
Totals	533		78		66		18		139		83		917

The second characteristic monitored in the classification sequence is the overall shape of the stone. At almost all of the sites, the regular, rectangular shape is overwhelmingly preferred for stones both less than and greater than 8 cm thick. For example, at 29SJ 389, 65.9 percent (n=232) belonged to the regular class and 0.3 percent (n=1) were irregular. The single exception was 29SJ 1360, where seven regular metates (41.2 per cent) contrasted with the eight irregulars (47.1 percent). While the numbers are much lower, the results are the same for those greater than 8 cm thick, except at the late 29SJ 827; here, there were more than twice as many irregular stones as regular ones (n=5 and 2, respectively).

The preferred stone for metate manufacture was sandstone, which was 8 cm or less in thickness and rectangular in overall shape. It came from the benches above the canyon floor where it was quarried and carried down the cliffs to the sites in the bottom or up the cliffs and slopes to the sites along the rim. Irregularly shaped stones were used in both classes of thickness but this was the exception. All of the metates were sandstone.

Color

There is little overall color variation in the sandstone at Chaco. Localized discolorations occur due to impurities, fossils, or desert varnish staining. Usually, however, there are only two colors—tan and gray. As might be expected, these colors generally, but not exclusively, coincide with the two major categories of sandstone. The massive cliff-forming material from which the stone greater than 8 cm thick was procured is generally tan; the thinner, 8 cm or less, sandstone is generally gray. At all sites and in almost all cases, the gray color occurred in significantly larger numbers and percentages than did the tan. The difference varied from two to almost eight times more gray than tan, except at 29SJ 724 where gray predominated by only 4.6 percent (Table 9.2).

Other categories of color were also recognized. The most common (Class 3) was not different, but rather was both gray and tan in interbedded layers in a single stone. Clearly, the source for this material was one or more contact zones between the two. The highest percentage in this category was found at the temporally late site 29SJ 827, where 38.5 percent of

Table 9.2. Color.

	Color										
	Tan		Gray		Interbedded		Other		Unknown		
Site No.	No.	%	No.	%	No.	%	No.	%	No.	%	Total
29SJ 423	-	-	2	40.0	-	-	-	-	3	60.0	5
29SJ 1659	1	33.3	2	66.7	-	-	-	-	-	-	3
29SJ 628	6	20.0	12	40.0	3	10.0	-	-	9	30.0	30
29SJ 299	7	19.4	23	63.9	3	8.3	-	-	3	8.3	36
29SJ 724	7	31.8	8	36.4	4	18.2	-	-	3	13.6	22
29SJ 1360	5	29.4	10	58.8	-	-	-	-	2	11.8	17
29SJ 629	18	15.9	75	66.4	1	0.9	18[a]	15.9	1	0.9	113
29SJ 627	32	15.4	136	65.4	21	10.1	-	-	19	9.1	208
29SJ 389	36	10.2	280	79.5	18	5.1	7	2.0	11	3.1	352
29SJ 390	2	33.3	4	66.7	-	-	-	-	-	-	6
29SJ 391	4	25.0	10	62.5	1	6.3	-	-	1	6.3	16
29SJ 827	9	13.8	30	46.2	25	38.5	-	-	1	1.5	65
29SJ 633	10	22.7	25	56.8	8	18.2	1	2.3	-	-	44
Totals	137		617		84		26		53		917

[a] Burned.

the sample was this interbedded material. The next highest frequency was 18.2 percent at both 29SJ 633 and 29SJ 724. The "other" color category included a greenish piece of sandstone and burned pieces which ranged from pink to red.

By itself, the color of the rock was not significant in the selection of the stone for manufacture. The gray color occurred in much greater percentages because the thinner sandstone was preferred to the more massive tan rock.

Grain Size

Grain size was analyzed using the criteria of the Wentworth Geological Scale. It was included in the analysis because of numerous examples in the archeological and ethnographic literature of metates and manos, which were made from rocks of differing grain sizes and textures. According to the ethnologists, this was necessary in order to grind grain into a very fine meal. Soldiers accompanying Coronado's 1540 expedition through the New Mexico territory commented that grinding done by the Pueblo Indians was superior to that of the Mexican Indians (Judd 1954:133). To break up the kernels, the initial grinding occurred on the roughest metate. The meal was then ground across two or three increasingly finer textured metates.

Once again, the Chacoan metates did not encompass the reported variation from elsewhere in the Southwest; the majority of the metates were made from material with only one grain size. The overwhelming majority of the grain size was Wentworth's fine (0.125 to 0.25 mm). At eight of the sites, the percentage was between 91 and 100 percent fine, and two sites, 29SJ 389 and 29SJ 1360, were 86 and 88 percent, respectively. Lower percentages can be related to sample sizes, except at 29SJ 629; here, 59 pieces (52.2 percent) were in the fine range and 51 pieces (45.1 percent) were in the very fine range (0.0625 to 0.125 mm). At 29SJ 389, an additional 10 percent was in this very fine range (Table 9.3).

The grain size of a few metates fell into the medium category (0.25 to 0.5 mm). From one to 12 metates—a total of 25 out of 917 pieces or 2.7 percent analyzed at eight sites—occurred in the medium range. In effect, the medium-fine category was a residual classification for slightly different pieces exhibiting less uniformly sorted grains. A total of 20 such fragments were recorded.

The Chacoans were using the material provided by their surroundings and in the case of stone for manos and metates, it was relatively uniform. The lack of coarseness in the granular structure could be

Table 9.3. Grain size.

	Grain Size								
	Fine		Medium		Very Fine		Medium Fine		
Site No.	No.	%	No.	%	No.	%	No.	%	Total
29SJ 423	2	40.0	-	-	-	-	3	60.0	5
29SJ 1659	3	100.0	-	-	-	-	-	-	3
29SJ 628	29	96.7	1	3.3	-	-	-	-	30
29SJ 299	34	94.4	2	5.6	-	-	-	-	36
29SJ 724	20	90.9	2	9.1	-	-	-	-	22
29SJ 1360	15	88.2	2	11.8	-	-	-	-	17
29SJ 629	59	52.2	3	2.7	51	45.1	-	-	113
29SJ 627	196	94.2	12	5.8	-	-	-	-	208
29SJ 389	302	85.8	2	0.6	36	10.2	12	3.4	352
29SJ 390	3	50.0	-	-	2	33.3	1	16.7	6
29SJ 391	15	93.8	-	-	-	-	1	6.3	16
29SJ 827	63	96.9	1	1.5	1	1.5	-	-	65
29SJ 633	41	93.2	-	-	-	-	3	6.8	44
Totals	782		25		90		20		917

somewhat compensated for by keeping the grinding surface rough. Fine-grain surfaces clog easily, however, and as they clog they lose their seed or kernel cutting and grinding abilities. To grind an equal volume of meal, more maintenance would be required on metates of this material than would be required on coarser surfaces.

Hardness

The hardness of the stone was monitored to assess the rate of wear and to determine if it were playing a role in the selection of the stone by the metate manufacturer. A somewhat subjective but consistent scale was devised. Soft stone was easily gouged by a penny and could be marked with a fingernail. The penny would leave a fine scratch on a metate made from a medium-hard stone. A hard metate would not be marked by the penny, but some copper would be left on the stone. The penny would leave a clear trail of copper on the surface of a very hard metate (Table 9.4).

As expected, soft stone was rarely used for metates; only three were recorded during the entire analysis, one for each of three sites. The medium-hard stone was used, but not in large numbers or percentages. The hard sandstone was easily the most frequently used for grinding, with six sites higher than 80 percent. The percentages of hard stones at 29SJ 389 and 29SJ 391 appear low at 67 and 37.5 percent respectively; however, the differences are to be found in the very hard category. Fully 32 percent (n=113) of those recovered from 29SJ 389 were very hard, as were 62 percent (n=10) from 29SJ 391. Most of these were the tabular gray material.

Several analysts (Schelberg, Hooten, Akins, and Cameron) had the impression that, in general, the tabular gray material was harder than the tan, more massive stone. This is not clearly reflected in the results and is likely due to the relatively unsophisticated nature of the test. The very hard stone was almost always gray, but variation occurred in both colors. The metate manufacturers clearly were not selecting soft stone; the differences between the tan and gray colors did not appear to be significant to them. The very hardest is gray but there is no indication that metates of this material were being used in any manner different from the other grinding stones.

Manufacturing Technique

The amount of effort expended on the metate manufacture was analyzed, in part to assess changes

Table 9.4. Hardness.

	Hardness										
	Soft		Medium		Hard		Very Hard		Unknown		
Site No.	No.	%	No.	%	No.	%	No.	%	No.	%	Total
29SJ 423	-	-	1	20.0	1	20.0	-	-	3	60.0	5
29SJ 1659		-	1	33.3	2	66.7	-	-	-	-	3
29SJ 628	1	3.3	4	13.3	25	83.3	-	-	-	-	30
29SJ 299	1	2.8	-	-	35	97.2	-	-	-	-	36
29SJ 724	-	-	8	36.4	14	63.6	-	-	-	-	22
29SJ 1360	-	-	2	11.8	15	88.2	-	-	-	-	17
29SJ 629	-	-	10	8.8	76	67.3	27	23.9	-	-	113
29SJ 627	1	0.5	15	7.2	191	91.8	-	-	1	0.5	208
29SJ 389	-	-	2	0.6	236	67.0	113	32.1	1	0.3	352
29SJ 390	-	-	-	-	3	50.0	3	50.0	-	-	6
29SJ 391	-	-	-	-	6	37.5	10	62.5	-	-	16
29SJ 827	-	-	2	3.1	59	90.8	4	6.2	-	-	65
29SJ 633	-	-	-	-	40	90.9	4	9.1	-	-	44
Totals	3		45		703		161		5		917

Table 9.5. Manufacture by site.

	Percentages by Category								
Site No.	Unmod.	Chipped/ Flaked	Abraded	Pecked	Chipped/ Flaked/ Abraded	Chipped/ Flaked/ Pecked	Abraded/ Flaked	All	Number
29SJ 423	-	100	-	-	-	-	-	-	5
29SJ 1659	33.3	66.7	-	-	-	-	-	-	3
29SJ 628	63.6	36.4	-	-	-	-	-	-	22
29SJ 299	53.1	46.9	-	-	-	-	-	-	32
29SJ 724	86.7	13.3	-	-	-	-	-	-	15
29SJ 1360	73.3	26.7	-	-	-	-	-	-	15
29SJ 629	43.9	19.5	-	25.6	-	11.0	-	-	82
29SJ 627	76.2	23.8	-	-	-	-	-	-	147
29SJ 389	13.9	46.9	1.5	7.0	9.3	13.6	2.7	5.0	258
29SJ 390	-	20.0	-	40.0	-	40.0	-	-	15
29SJ 391	36.4	9.1	-	-	18.2	9.1	27.3	-	11
29SJ 827	-	57.1	-	1.6	1.6	36.5	-	3.2	63
29SJ 633	12.8	59.0	-	10.3	7.7	10.3	-	-	39

through time and to facilitate discussions of differential work investment at contemporaneous sites such as the small-house sites and the greathouses. Vivian's 1950s stabilization work in the small-house site of Bc 51 indicated that a jewelry manufacturing workshop existed and that perhaps a part-time specialist was involved (Mathien 1984:179; Vivian 1970). Issues of work expenditure, craft specialization, and differential distribution of artifacts are central to arguments of social complexity and interaction.

Table 9.5 lists the results of the manufacturing in percentages; the unknown category is omitted. In general, manufacturing involved bashing or grinding. Bashing was subdivided into chipping, flaking (removal of smaller pieces than occurred by chipping), and pecking (indicated by peck marks similar to those made by a hammerstone when roughening a trough which is too smooth to grind effectively). Usually, the majority of the manufacturing effort tended to occur at both the near and far ends. The ends were made more even and rounded off by various combinations of chipping, flaking, pecking, and occasional abrading (Figures 9.11 and 9.12). A common shaping technique on the ends of the thinnest stones was bifacial flaking; whereas, the thicker ones tended to be pecked more often than flaked. The sides or long edges were usually vertical with square corners and looked as if they had little modification. This regularity resulted from the even breaking of the sandstone bedding planes.

While some grinding (abrading) occurred during the manufacturing process, it was rare and was recorded only at the greathouses (29SJ 389 and 29SJ 391) and the two late small sites (29SJ 827 and 29SJ 633). In only four cases, all at Pueblo Alto, was abrading the single manufacturing technique. It occurred in various combinations with the percussive techniques at the four sites. The occurrence of all four methods on a single metate was found only at two sites, one large, 29SJ 389, and the late small-house site of 29SJ 827. The three percussive methods were the most common and, considering sample sizes, were represented at all sites in usually high frequencies.

No obvious metate manufacturing was recorded at 10 sites representing all temporal periods, locations, and sizes. The variation from 13 to 87 percent is partly due to sample sizes. At five sites, more than 50 percent were unmodified. The fact that all of the metates at 29SJ 423 were modified is as likely due to the sample size as to any other factor. Sample size is less of a consideration at 29SJ 391 and especially at 29SJ 827, where no metate was unmodified but 63 were modified (although some are listed in the unknown category).

Following the procurement of a suitable stone, based on considerations of geological structure and hardness, normally less than 40 percent were modified. When modification occurred, the metate manufacturers used percussive and abrading techniques to shape the stone into its final form. Unwanted projections were removed or reduced, edges and ridges were thinned, bottoms were made more flat for increased stability during use, and rough areas were smoothed. Both upper and lower surfaces and the edges were treated in any combination. No decorations of any kind were observed.

Plan View

This variable (Table 9.6) represented a summation of the overall shape of the stone after manufacture was complete, and was based on commonly used descriptions in the archeological literature. The categories are sufficiently general as to be useful for heuristic purposes only. The predominant shape was rectangular and was derived from the tool's function. The distinction between angular irregular and rounded irregular derives from the angularity of the corners and less-than-straight sides. The only unusually shaped metate was from Una Vida (29SJ 391). It was completely (and very nicely) round. It is possible that the stone had been, or was intended to be, used as a basal support for a wooden roof support timber in a Chaco kiva or even a great kiva.

Work Investment by Site

The work investment by site category (Table 9.7) was a subjective evaluation which took into account the overall regularity, uniformity, and symmetry of the metate, in addition to the amount of work invested in bringing the stone to its final form. Differences between large and small sites were evaluated. At both the large and small sites, most of the metates fell into the slight and moderate

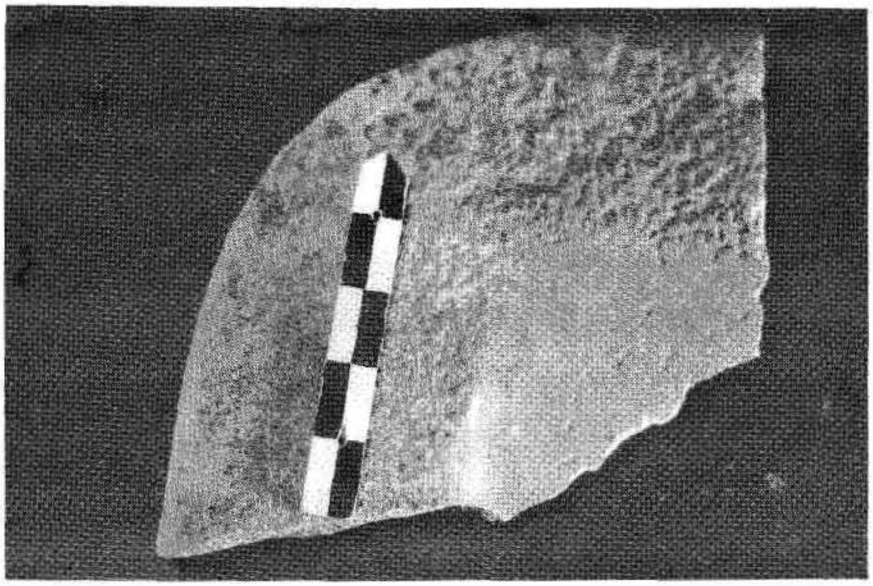


Figure 9.11. *Metate fragment (FS 5347) from Pueblo Alto (29SJ 389), Kiva 15, Test Pit 2, Layer 7, showing rounded ends due to pecking? Note thinness of trough (1.5 cm) in fragment that is 3 cm thick. (15 cm scale) (NPS Chaco Archive Negative No. 23632).*

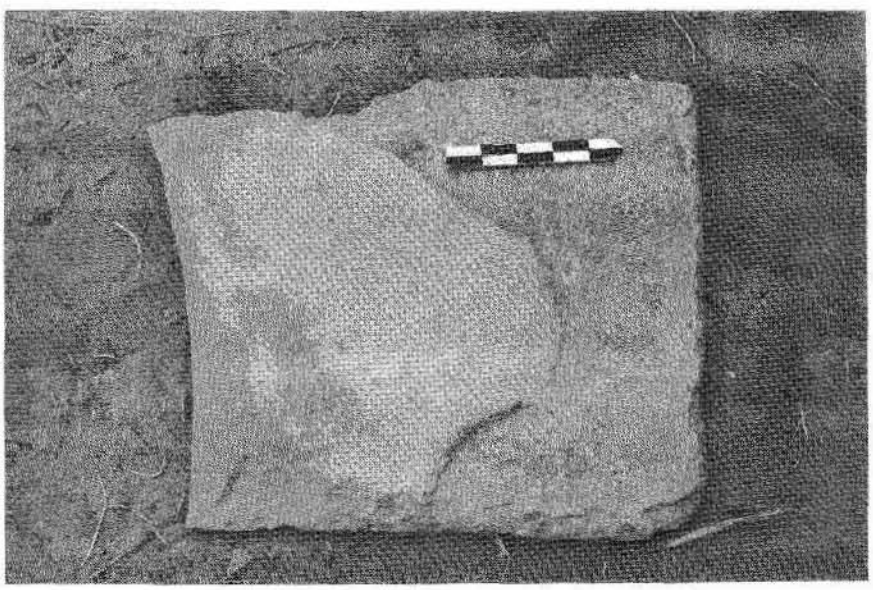


Figure 9.12. *Metate fragment (FS 2715) from Pueblo Alto (29SJ 389), Room 142, Test Trench 1, Level 11, showing bottom that has been pecked. (15 cm scale) (NPS Chaco Archive Negative No. 17959).*

Table 9.6. Plan view by site.

Site No.	Percentages: Rectangular	Angular-irregular	Rounded-irregular	Round	Number
29SJ 423	75.0	25.0	-	-	4
29SJ 1659	33.3	33.3	33.3	-	3
29SJ 628	63.6	22.7	13.6	-	22
29SJ 299	48.6	37.1	14.3	-	35
29SJ 724	71.4	28.6	-	-	7
29SJ 1360	20.0	33.3	46.7	-	15
29SJ 629	67.8	32.1	-	-	28
29SJ 627	46.0	30.9	23.0	-	139
29SJ 389	81.8	16.9	1.3	-	77
29SJ 390	100.0	-	-	-	1
29SJ 391	87.5	-	-	12.5	8
29SJ 827	60.0	6.7	33.3	-	15
29SJ 633	100.0	-	-	-	4

Table 9.7. Work investment by site.

Site No.	Percentage by Site: Unmodified	Slight	Moderate	Extensive	Superior	Number
29SJ 629	20.8	35.4	37.5	8.6	-	48
29SJ 389	13.0	45.0	34.2	7.4	0.4	231
29SJ 390	-	25.0	75.0	-	-	4
29SJ 391	-	33.3	55.6	11.1	-	9
29SJ 827	-	77.0	22.9	-	-	61
29SJ 633	11.4	80.0	8.6	-	-	35

Table 9.8. Major metate type by site.

	Metate Type: Open One End		Open Two Ends		Two Trough Surface		Unknown Trough		Slab		Unknown		
Site No.	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	Total
29SJ 423	3	60.0	-	-	1	20.0	1	20.0	-	-	-	-	5
29SJ 1659	3	100.0	-	-	-	-	-	-	-	-	-	-	3
29SJ 628	19	63.3	-	-	-	-	9	30.0	-	-	2	6.6	30
29SJ 299	30	83.3	-	-	1	2.8	5	13.9	-	-	-	-	36
29SJ 724	12	54.5	1	4.5	-	-	6	27.3	-	-	3	13.6	22
29SJ 1360	14	82.4	2	11.8	-	-	1	5.9	-	-	-	-	17
29SJ 629	52	46.0	2	1.8	-	-	52	46.0	1	0.9	6	5.3	113
29SJ 627	145	69.7	2	1.0	-	-	43	20.7	-	-	18	8.7	208
29SJ 389	135	38.4	2	0.6	-	-	215	61.1	-	-	-	-	352
29SJ 390	1	16.7	1	16.7	-	-	4	66.7	-	-	-	-	6
29SJ 391	5	31.3	-	-	-	-	11	68.8	-	-	-	-	16
29SJ 827	17	26.2	11	16.9	-	-	33	50.8	2	3.1	2	3.1	65
29SJ 633	6	13.6	-	-	-	-	38	86.4	-	-	-	-	44
Totals	442		21		2		418		3		31		917

categories. A total of 21 were given an extensive rating: three at the small-house site of 29SJ 629; 17 at Pueblo Alto (29SJ 389), and one at Una Vida (29SJ 391). Given the differing sample sizes, the percentages are not too different and the differences are not significant. A single metate was listed as superior. This was a portion of a thin, very hard, gray tabular metate with very wide shelves (19 cm), and extensive modification, including flaking of the edges followed by abrasion to smooth them. No decorations of any type were observed on any of the metates.

Major Type

The generalizations in the archeological literature and text books equated the occurrence of slab metates with the Pueblo III period. It was a surprise to learn that slab metates were nearly absent from Chaco Canyon. This fact includes not only the Chaco Project but every excavation ever documented in the canyon. A total of three definite slab metates were included in this analysis. One was recovered by the Chaco Project at 29SJ 629 and the other two were from 29SJ 827. This site had been excavated a decade or more prior to the Chaco Project, and the ground stone was left at the location. These three represent 0.0033 percent of the total metates analyzed (Table 9.8).

Two questionable metates occurred at the late site of 29SJ 633. Most of the metates at this site were the result of prehistoric gathering and subsequent breaking for use in wall construction. One of the two looked similar to an incomplete trough from a trough metate which had been broken away from the surrounding shelves. The other may have been a slab metate but it was too incomplete to be certain.

Based on the available literature for Chaco Canyon, approximately 34 slab metates have been recovered during all of the excavations. If only 1,200 trough metates have been recovered, the slab metates represent 0.03 percent. (See Table 9.9 for a distribution of metate types by site for sites in Chaco Canyon and other Southwestern locations.) This incomplete total is essentially none when compared to over 1,200 trough metates recovered during the same excavations.

All of the remaining metates from the 13 sites in this analysis were trough metates. The vast majority were open-at-one-end. Trough metates open-at-both-ends were somewhat more common than the slab metates but were also underrepresented, according to the archeological literature. Those with both ends open were recovered from seven sites (including 29SJ 827). When those with small sample sizes are excluded, the percentages are generally low. The 12.5 percent at 29SJ 1360 is relatively high for a moderate sample size at an earlier site. Sites with the largest samples, 29SJ 629 and 29SJ 389, had 3.6 and 1.5 percent, respectively. The highest percentage occurred at 29SJ 827. This fact, combined with the slab metates and several open-at-one-end trough metates reminiscent of some from Pueblo Alto, make the metate assemblage at this site very interesting, especially for a small late site.

Trough metates, open-at-one-end, were the dominant grinding tool at all of the sites in all of the temporal periods in Chaco Canyon. This was also the conclusion of Judd (1954) at Pueblo Bonito and Judd (1959) at Pueblo del Arroyo. This fact was not influenced by the presence or absence of bins because trough metates were used in bins at many sites within the canyon. Apparently, they were simply set into some bins in some places and permanently mortared into place in others. It would be interesting to compare sizes and weights to ascertain if these variables determined the need to set a metate in mortar. But such tests cannot take place unless some future excavations discover several situations of metates in primary contexts.

The two, two-surface metates (Table 9.8) were unusual. One was recovered from each of two sites, 29SJ 423 and 29SJ 299. Both were temporally earlier sites. Each metate had an open-at-one-end trough, with the same style trough on the upper and lower surfaces of the stones. Each stone had two troughs. No obvious reason which would lead to the use of the bottom to create a new metate could be determined.

Summary

Following quarry selection, a roughed-out hard piece of sandstone of the approximate final dimension was acquired. Due to the uniformity of the grain

Table 9.9. Metate distribution by type (all numbers approximate).

Site Name/No.	Metate Type: Open at One End	Open at Two Ends	Slab	Basin	Unknown
Shabik'eshchee Village (29SJ 1659)	All[a]	-	-	-	-
Half House (29SJ 1657)	4	-	-	-	-
Three C (29SJ 625)	All[a]	-	-	-	-
Leyit Kin (29SJ 750)	44	-	5	-	1
Bc 50 (29SJ 394)	85	-	-	-	-
Bc 51 (29SJ 395)	14	5	1	3	1
Bc 53 (29SJ 396)	All (> 13)	-	-	-	-
Bc 54 (29SJ 1922)	8	-	1	-	-
Bc 56 (29SJ 753)	1	-	1	-	-
Bc 58 (29SJ 398)	3	-	-	-	-
Bc 59 (29SJ 399)	1+	-	-	-	-
Bc 192 (29SJ 1914)	2	-	-	-	-
Bc 236 (29SJ 589)	4	-	16	-	-
Kin Kletso (29SJ 393)	24	-	8	-	-
Pueblo del Arroyo (29SJ 1947)	44	-	-	-	-
Pueblo Bonito (29SJ 387)	208	-	-	-	-
29SJ 633	135	-	2	-	-
Salmon Ruin: Primary	32	-	10	-	-
Secondary	10	-	37	-	-
Secondary Mix	13	-	42	-	-
Guadalupe Ruin	76%	-	14%	-	-
Village of the Great Kivas	100% (early)	-	100% (late)	-	-
Escalante	1	-	14	2	-
Dominguez	-	-	4	-	-
Mesa Verde No. 499	2	-	15	-	-
Mesa Verde Big Juniper House	3	2+ 24 fragments	8+	-	-
Mesa Verde No. ?	1	-	104	-	-
Mesa Verde Long House	6	-	90	-	-
Mesa Verde: Badger House	200	7+	13	-	-

[a] Numbers not reported.

size, selection was probably guided more by the degree of hardness because no stone was appreciably or inherently rougher than any other. If the roughed-out blank met with approval, no additional modification was required. If not, a variety of percussive and grinding techniques were employed to complete the manufacture. The upper surface was then roughened by pounding so that the grain would be ground rather than simply scattered. The initial pounding was in the general shape of a trough.

To finally prepare a metate for grinding, hammerstones were used to pound the general outline of the trough into the upper surface. The result was a concentration of peck marks whose function it was to create a rough surface which would catch and cut the kernels and seeds. A smooth surface will not function for grinding as the seeds will be pushed off the far end. The actual trough, at best a by-product of the production of meal, was created as the mano ground away at the metate. The goal was to make dinner, not necessarily to make a trough. On slab metates, the entire surface, rather than a portion, was worn away.

One unused trough metate was recovered during the Chaco Project. A blank with an unground but roughed-out-by-hammerstone-pounding trough occurred at 29SJ 389. It was prepared but no evidence of any grinding could be seen. Once the metate is pressed into service, the grinding surface treatment is directly related to the use-portion of the artifact's history and is no longer in the manufacturing component. Grinding surface preparation is discussed in the following section.

Trough metates with one-end-open were essentially the only style used in Chaco Canyon. With the exception of a site excavated in the 1930s (Bc 26; 29SJ 750), and one in the 1950s (Bc 236; 29SJ 589), no other site in the canyon had more than two slab metates; less than 35 have ever been recovered. The open-at-two-end style was slightly more common than slab metates but still insignificant when compared to those with only one-open-end.

Metates—The Use

Once the procurement and manufacturing were completed and the metate was situated at its use locus, its longevity was determined by its physical makeup, the amount of use, and changing societal conditions and organizational requirements. As the use progressed, the trough took on a clear definition and ultimately became the dominant feature of the tool, until in some Southwestern areas, it disappeared completely. Initially, the trough extended only part way through the upper surface and a shelf remained at the end closest to the miller. It has been suggested that this shelf provided a convenient resting place for a mano when not in use. Undoubtedly, a number of factors were involved. Until metates were permanently fixed into bins, they were portable, at least to the extent of being leaned up against a wall when not needed. Then the shelf was inaccessible to the manos, and the latter would also be placed on the floor out of the way. In many Southwestern areas, metates changed through time. The near shelf was cut through by the trough and both ends were opened; this form was subsequently replaced by a completely flat slab metate lacking any trough. As noted above, trough metates with only one-end-open were the clearly dominant type in Chaco Canyon.

Several attributes associated with grinding were monitored primarily for descriptive purposes and, it was assumed, for insight into their use-life and volume of meal which could be produced. Given the arguments in the literature concerning the variously postulated social organization and status differences between and among the greathouse and small-house sites, it was anticipated that interesting differences would be found. While there were differences in dimensions, they were relatively slight and not what one might expect if simply based on untested assertions of major status differentiation between residents of different sites.

Dimensions

It cannot be said which, if any, dimension was the limiting factor from a Chacoan's perspective; in the end, a combination of trade-offs between length, width, and weight were involved. Weight was not the only consideration. Judd (1954:137) reported five trough metates from Room 251 in Pueblo Bonito, each weighing at least 150 pounds (68 kg) and noted that Pepper recovered two which were even larger. I weighed two trough metates left at the Mockingbird Canyon dump in Chaco Canyon that were 105 and 100 pounds (48 and 45 kg, respectively). The former one was from Una Vida. These large ones were even heavier prior to grinding and required several people to transport.

The length of a metate's trough is a function of the effective grinding stroke, which is a function of the volume of meal and the size of the miller's arms and legs. The width of a metate's trough is a function of the mano, which was a function of such factors as the volume of meal to be ground, surface area, weight, and hand size. The overall length and width of the stone could be a function of available space, aesthetic preferences, the need for additional working surfaces (the lateral and near-end shelves), and many other factors.

With respect to the overall dimensions of the stone (i.e., not the trough), the averages of the complete dimensions of the overall length, width, thickness, weight, and surface area of the stone itself are recorded in Table 9.10. This table also includes the depth of the trough. The most striking statistic is the small number of metates which were complete in the five measurements—only 7.5 percent or 69 of the total 917 analyzed items (whole or fragments). This

Table 9.10. Dimensions for metates.[a]

	Dimensions											
	Weight		Length		Width		Thickness		Surface Area		Depth of Trough	
Site No.	No.	g	No.	cm	No.	cm	No.	cm	No.	cm²	No.	cm
29SJ 423	3	10,000	3	57.3	3	38.3	3	5.6	3	2,213.7	3	5.0
29SJ 1659	1	17,010	1	56.0	1	40.0	1	7.0	1	2,240.0	1	4.0
29SJ 628	3	23,546	3	52.3	3	28.0	3	9.7	3	1,539.3	3	2.33
29SJ 299	10	24,272	10	57.7	10	43.7	10	6.6	10	2,544.2	10	4.6
29SJ 724	-	-	-	-	-	-	-	-	-	-	-	-
29SJ 1360	9	21,028	9	51.8	9	35.8	9	12.3	9	1,857.3	9	7.0
29SJ 629	8	19,544	10	47.3	11	33.4	97	7.1	8	1,624.1	8	4.25
29SJ 627	7	20,121	7	52.0	7	35.1	7	10.9	7	1,886.7	7	5.85
29SJ 389	14	21,659	25	50.7	35	34.7	320	6.6	14	1,961.6	14	6.4
29SJ 390	-	-	1	57.0	10	35.5	5	6.9	-	-	-	-
29SJ 391	2	23,750	2	53.0	2	42.0	16	5.8	2	2,214.0	2	5.0
29SJ 827	11	25,136	23	46.4	19	32.6	62	9.1	11	1,702.7	11	3.55
29SJ 633	1	12,500	3	46.7	2	26.2	36	8.0	1	1,325.0	1	5.0
All	69	24,837	69	51.9	69	36.5	69	10.0	69		69	5.1

[a] Complete dimensions only.

Table 9.11. Dimensions for the trough and the near-end shelf.

	Dimensions							
	Length		Width		Area		Average Near-End Shelf Width	
Site No.	No.	cm	No.	cm	No.	cm²	No.	cm
29SJ 423	3	36.0	3	19.3	3	697.0	1	12.0
29SJ 1659	1	36.0	1	19.0	1	684.0	1	18.0
29SJ 628	3	37.7	3	19.0	3	740.0	5	13.4
29SJ 299	10	40.2	10	21.2	10	857.4	16	15.3
29SJ 724	-	-	-	-	-	-	5	8.4
29SJ 1360	9	39.4	9	20.3	9	801.0	6	13.3
29SJ 629	10	40.5	11	18.4	8	786.0	17	11.3
29SJ 627	7	41.4	7	21.4	7	896.8	18	11.4
29SJ 389	19	45.0	35	18.2	14	818.9	68	10.2
29SJ 390	1	50.0	2	22.0	-	-	1	9.0
29SJ 391	2	36.0	2	18.5	2	664.0	5	6.8
29SJ 827	23	44.9	19	19.3	11	820.4	10	6.1
29SJ 633	3	41.0	5	17.2	1	782.0	6	4.8

Table 9.12. Near-end shelf width.

	Near-End Shelf Width										
	<10 cm			> 10 cm			Unknown		< 1 cm		
Site No.	No.	% of Total	Range	No.	% of Total	Range	No.	% of Total	No.	% of Total	Total
29SJ 423	-	-	-	2	33.3	12, 16	4	66.7	-	-	6
29SJ 1659	-	-	-	1	33.3	18	2	66.7	-	-	3
29SJ 628	1	3.4	7	4	13.8	13-18	23	79.3	1	3.4	29
29SJ 299	4	11.1	1-8	14	38.9	12-24	18	50.0	-	-	36
29SJ 724	4	18.2	6-9	1	4.5	12	17	77.3	-	-	22
29SJ 1360	3	17.6	1	6	35.3	10-16	6	35.3	2	11.8	17
29SJ 629	7	6.2	1-9	12	10.6	10-18	89	78.8	5	4.4	113
29SJ 627	17	8.2	1-9	12	5.8	10-18	177	85.1	2	1.0	208
29SJ 389	41	11.6	1-8	39	11.1	10-20	272	77.3	2	0.6	352
29SJ 390	1	16.7	9	-	-	-	4	66.7	1	16.7	6
29SJ 391	3	18.8	2-3	2	12.5	12, 14	11	68.8	-	-	16
29SJ 827	13	19.1	1-8	2	2.9	16, 18	39	57.4	14[a]	20.6	68
29SJ 633	6	13.6	3-6	-	-	-	38	86.4	-	-	44
Totals	100			95			700		27		920/922

[a] 11 open, 2 unknown
1 other
2 slab

Table 9.13. Right and left lateral shelf width.

	Shelf Width							
	<10 cm			> 10 cm			Unknown	
Site No.	No.	% of Total	Range	No.	% of Total	Range	No.	% of Total
29SJ 629	10	9.0	1-9	48	43.6	10-19	52	47.3
29SJ 389	185	52.7	2-9	105	29.9	10-20	61	17.4
29SJ 390	4	66.6	1-9	2	33.3	11-13	-	-
29SJ 391	7	43.8	2-9	7	43.8	10-18	2	12.5
29SJ 633	32	76.2	2-9	2	4.8	10-10	8	19.0
29SJ 827	55	87.3	1-9	5	7.9	10-15	3	4.8

indicates the extent to which the sample was broken up. The small sample sizes and their variability between sites preclude any definitive statements; however, the larger stones (overall area) tend to be earlier and the smaller occur later in time. In general, there is a decrease in the size of the stone from Basketmaker to Pueblo IV-V. One by-product of the smaller slab metates is that they could be easily transported by a single individual.

With the exception of the consistent reporting of the metates from 29SJ 827, few of the tables in this report include metates from previously excavated sites; therefore, the weight category in Table 9.10 is deceptive because, as noted above, the heaviest metates recovered were those from Pueblo Bonito by Pepper and Judd and from Una Vida by Vivian. The heavier stones would tend to move around less during use and the miller could concentrate on grinding and not on adjusting the metate. Based on unnumbered photographs in the Chaco archives, it appears that, in addition to metates used on a floor, even some of the trough metates in bins were not fixed in place by adobe (e.g., the four in a set of contiguous bins at Chetro Ketl).

With respect to the overall dimensions of the utilized surface (that is, the trough), the averages of the complete dimensions for length, width, area, and depth are presented in Table 9.11. While the metates at the later sites tend to have larger surface areas, there are individual differences compounded by sample size variability, and no clear-cut trend is evident. As will be discussed later, the main grinding area difference is that the surface area of the trough metates is larger than the area for the few slab metates recovered in Chaco Canyon.

The near-end shelf, and the right- and left-lateral shelves were important in the daily life of the Chacoans because they provided additional use surfaces upon which other tasks—secondary to grinding quantities of meal but contemporaneous with the primary function of a metate—could be accomplished. As discussed below, they were especially convenient as a base for striking, cutting, and for other uses. Tables 9.12 and 9.13 provide summary measurements and ranges differentiated above and below 10 cm for the shelves surrounding the trough. Overall, the variation for the near-end shelf is from less than one cm long to 24 cm. Generally, there is a decrease in the percentage of metates with near-end shelves greater than 10 cm as one moves from earlier to later sites; this corresponds to the decrease in overall stone size through time. The largest (24 cm in length) occurred at 29SJ 299, and the second largest, 20 cm, occurred at 29SJ 389. Table 9.11 includes the average near-end shelf width by site (those less than 1 cm wide are not included in Table 9.11 due to computer formatting).

The largest lateral shelf, 20 cm, occurred at 29SJ 389, but the second largest, 19 cm, was from 29SJ 629. Again, there is no clear trend in increases or decreases through time. Given the sample size variation, 29SJ 629 had the greatest percentage of metates with shelves greater than 10 cm. These measurements were not taken at the sites analyzed earlier in the project. The metates with shelves greater than 15 cm were quite impressive, especially as they tended to be only 5-to-7-cm-thick; it is unfortunate that none were complete and unbroken.

Grinding Surface Preparation

As noted above, a single metate with a prepared but unused surface was found at 29SJ 389. The outline of the trough was roughed-in but no grinding had occurred. Once grinding was initiated, any metate's surface was gradually worn away. The pits created by pounding with hammerstones and/or the ends of manos decrease in depth and cease to catch the grain fragments. Grinding becomes progressively more difficult; for a while, additional force applied to the mano or a longer grinding session would still reduce the meal into a finer consistency. If the surface is not renewed or roughed up by additional pounding, grinding becomes impossible. As noted in the introduction, Bartlett (1933:4) was told that metates were sharpened once every five days at Hopi.

Prior to the beginning of the analysis, it was assumed that metates would be used until they were worn out or became so thin that they cracked when pounding was used to renew the grinding surface. If this were the case, most of those recovered would have a hole in the trough, or a generally smooth trough with some indication of renewal pounding having occurred. It was also anticipated that more complete specimens would be recovered than actually were. Frequently, the assumption was not verified because few worn-out metates were found. This is in contrast to those from Pueblo Bonito where apparently worn-out metates were common (Judd 1954).

Four combinations of pounding and grinding were recorded (Table 9.14); they reflected the continuous range from initial surface preparation to those which were mostly ground and in need of renewal. The two most frequently observed categories were moderate pecking and moderate abrasion (Figure 9.13), and light pecking and moderate abrasion, indicating that the surface had been both renewed and ground. In either case, additional grinding could occur; although some of those in the latter class were in need of pounding. The third most commonly recorded category represented the initial pounding to renew the surface accompanied by at least some grinding. Three sites, all with very small sample sizes, did not have any metates meeting the latter combination.

Only 13 representatives of the fourth class were encountered. Twelve metates at 29SJ 389 and one at 29SJ 633 were ground completely smooth; there were no pits. As noted, it would be difficult to grind meal under such circumstances. It is possible that this wear pattern resulted from a secondary use of the

Table 9.14. Grinding surface preparation.

	Type of Grinding										
	Heavy Pecking, Light Abrading		Moderate Pecking, Moderate Abrading		Light Pecking, Heavy Abrading		No Pecking, Heavy Abrading		Unknown		
Site No.	No.	%	No.	%	No.	%	No.	%	No.	%	Total
29SJ 423	-	-	1	20.0	1	20.0	-	-	3	60.0	5
29SJ 1659	-	-	-	-	1	33.3	-	-	2	66.7	3
29SJ 628	3	10.0	8	26.7	17	56.7	-	-	2	6.6	30
29SJ 299	1	2.8	17	47.2	14	38.9	-	-	4	11.1	36
29SJ 724	2	9.1	11	50.0	7	31.8	-	-	2	9.1	22
29SJ 1360	2	11.8	6	35.3	9	52.9	-	-	-	-	17
29SJ 629	26	23.0	46	40.7	22	19.5	-	-	19	16.8	113
29SJ 627	9	4.3	93	44.7	71	34.1	-	-	35	16.8	208
29SJ 389	53	15.1	158	44.9	60	17.0	12	3.4	69	19.6	352
29SJ 390	-	-	5	83.3	-	-	-	-	1	16.7	6
29SJ 391	5	31.3	6	37.5	2	12.5	-	-	3	18.8	16
29SJ 827	17	26.2	28	43.1	17	26.2	1	1.5	2	3.1	65
29SJ 633	9	20.5	21	47.7	8	18.2	-	-	6	13.6	44
Totals	127		400		229		13		148		917

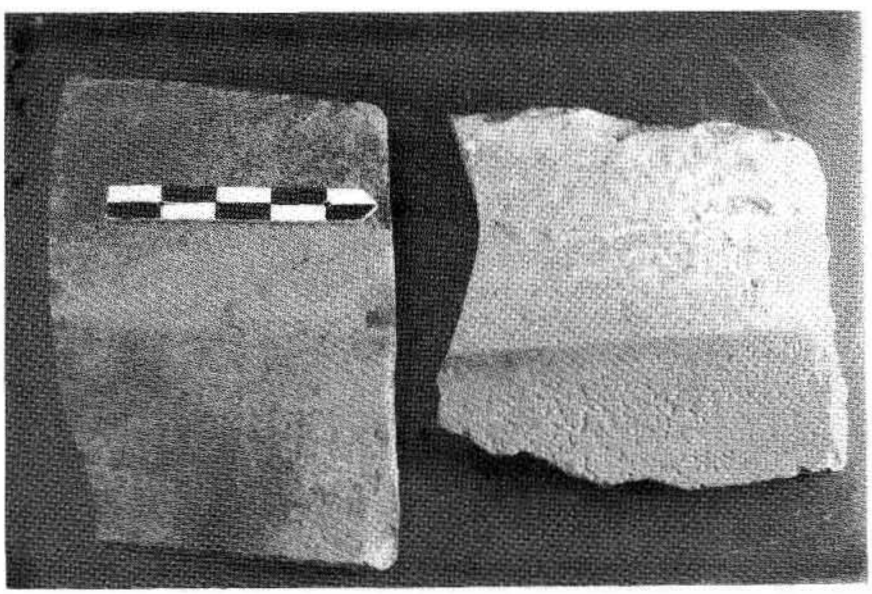


Figure 9.13. Examples of pecking and abrading: A) Left far end of metate (FS 6329) from Room 147 at Pueblo Alto (29SJ 389). B) Left far end of metate (FS 3118) from Room 4 of the East Ruin of the Pueblo Alto Complex. Note the same width of the lateral shelves. (15 cm scale) (NPS Chaco Archive Negative No. 23618).

Table 9.15. Characteristics due to milling.

	Characteristics												
	Undulant Trough		Battering		Asym. Left		Asym. Right		Striations		Lateral Shelf		
Site No.	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.
29SJ 423	1	50.0	-	-	-	-	-	-	1	50.0	-	-	2
29SJ 1659	1	33.3	-	-	-	-	-	-	2	66.7	2	66.7	3
29SJ 628	8	30.8	6	23.1	-	-	-	-	20	76.9	7	26.9	26
29SJ 299	9	33.3	4	14.8	-	-	-	-	19	70.4	18	66.7	27
29SJ 724	4	30.8	4	30.8	-	-	-	-	10	76.9	4	30.8	13
29SJ 1360	7	50.0	2	14.3	-	-	-	-	13	92.8	1	7.1	14
29SJ 629	19	20.9	-	-	2	2.2	3	3.3	82	90.1	-	-	91
29SJ 627	69	49.6	3	2.2	-	-	-	-	127	91.4	24	17.3	139
29SJ 389	93	43.0	2	0.9	1	0.5	6	2.8	171	79.2	-	-	216
29SJ 390	1	25.0	-	-	-	-	1	25.0	3	75.0	-	-	4
29SJ 391	3	50.0	-	-	-	-	1	16.7	5	83.3	-	-	6
29SJ 827	21	50.0	-	-	1	2.4	-	-	34	80.9	-	-	42
29SJ 633	13	37.1	-	-	-	-	-	-	29	82.8	-	-	35

metates or another use after they ceased to function primarily as metates. If either alternative were correct, this wear should have been included in the analysis of the secondary metate use or even post-metate recycling into other tools. This discussion is in the following section.

Grinding surface renewal was a fact of life for a metate-using miller. It obviously occurred at all sites because metates were recovered in a continuous range from initial preparation to essentially worn-out. Without renewal, grinding became impossible. This also means that hammerstones were an indispensable component of the miller's tool kit. The ends of manos were occasionally used to sharpen a trough's surface but were not relied on as it would decrease the mano's use-life. Lange (1959:116), citing an 1880 notation of Bandelier, mentioned the use of hammerstones for sharpening manos and metates. Bandelier commented on the ringing pounding of the Hopi grinders as they prepared for grinding by renewing the surfaces. Initially, I tabulated hammerstones and their distribution; however, given the uneven reporting in the literature and the profound lack of material in primary context, I ceased as there were other more plausible windmills on the horizon.

Characteristics Associated with Milling

Table 9.15 lists several traits that generally result from using the metate for grinding. Striations were ubiquitous—these fine parallel lines on the surface of metates, manos, and other ground stone result when the grains of sand in the sandstone cut the surfaces during the reciprocal grinding motion. The mano is locked into the same place by the walls of the trough so any harder grains tend to travel the same path and cut into the opposite surface until they are dulled or worn away. Most striations are visible on a surface which has been ground for a period of time in such a way that the pits begin to disappear. Striations are generally obliterated when the surface is renewed by pounding.

The variable entitled "lateral shelf" is actually a concomitant of the definition of a trough metate. Since this is recorded elsewhere, it was deemed redundant and not recorded for the sites analyzed later in time.

"Battering" was recorded if a concentration of hammerstone pits occurred in a small area. Unfortunately, the factors surrounding this variable are similar to those discussed above concerning a trough that has been ground completely smooth. There are multiple possibilities contemporaneous with grinding or occurring after the metate was recycled into other tools or uses. Battering may be associated with the milling; for example, those occasions when one area of the trough was pounded more than the remainder, or it could be the result of secondary contemporaneous use, or even post-metate use. Battered areas were found not only within the trough but could also occur anywhere else. In such a situation, battering could be associated with either the initial manufacture of the metate or with subsequent use.

Asymmetrical wear to the left or right was recorded only at the sites analyzed later in the Chaco Project. It refers to the relationship between the near-end of the trough and the near edge of the stone itself. In the majority of cases, the shape of the near-end of the trough is rectangular (see below). In most cases the longest edge of this rectangle, which is equivalent to the width of the trough, is parallel to the edge of the stone closest to the miller. Occasionally, however, it was not parallel and was in fact shifted to either the right or the left. In other words, the right (or left) corner of the end of the trough was closer to the end of the metate than was the other corner.

Presumably, this asymmetrical wear resulted from unequal pressure being put on the mano by the miller during the downward grinding stroke, that is, going away from the person. In such a situation, the person is putting greater pressure on the hand that the person uses the most. Because most people are right-handed, the majority of the asymmetrical wear should be to the right, which was clearly the case. Asymmetry to the right was almost three times as likely to occur (11 events to the right and four to the left).

Undulating trough walls (Figures 9.14, 9.15, and 9.16) were recorded at every site. They are the result of the miller using a new mano that is shorter than the existing distance between the two walls of the trough. Since Chacoan manos are almost always thinner than the metates and were made from the same stone, the manos wore out faster. The manos were wearing out in two directions—from the bottom up and in towards the middle from both sides. As the grinding progressively increased the depth of the trough, the sides of the mano were worn down and the width of the trough continuously decreased.

If the miller selected a new mano that was roughly as long as the one being replaced, the new one would take up where the old one stopped, and the walls of the trough would slope in a continuous arc to the bottom of the trough. On the other hand, if the new mano were shorter than the old one, a bulge would occur in the walls of the trough because less material had been worn away by the shorter mano. Each time this occurred, another bulge, or undulation, resulted. Because some of the replacement manos were almost the same length, some of the bulges were slight. When the mano was clearly shorter, however, the bulge was sharp, and occasionally, one or more vertical walls, rather than a curve, were present.

Metates with undulating walls represent a relatively high percentage. While the variation was from 21 to 50 percent, undulations were recorded at all sites.

Characteristics of the Trough

As variation existed in the walls of the trough, variability was also recorded across the trough's grinding surface. The shape of the grinding surface was recorded at the six sites studied later in the project (Table 9.16). Additional variables were considered during the first session of analysis but were determined to be nonproductive due to redundancy among other categories. The shape was recorded as flat, slightly concave, or very concave. If the center of the grinding surface was 1 cm or less deeper than the edges, it was recorded as slightly concave. Greater than 1 cm deep was recorded as very concave. The point of measurement was at the juncture of the bottom with the beginning of the curve leading to the trough's wall, and not at the top of the curve on the wall.

Those with either a flat or very concave grinding surface were rare; six of the former occurred at four sites and eight of the latter were found at three sites. Pueblo Alto (29SJ 389) yielded six of the eight metates with very concave grinding surfaces. The slightly concave surface was the most common. The high percentage in the unknown category reflects the lack of sufficiently complete pieces necessary to monitor the variable. The concave shape results from the slight differential wear on the mano. It is likely that the mano would have to be a harder material to wear down a consistently flat grinding surface, but the Chacoan manos and metates were from the same sandstone.

Shape of the Trough's Near-End

The shape of the trough's near-end was also recorded at the final six sites analyzed (Table 9.17).

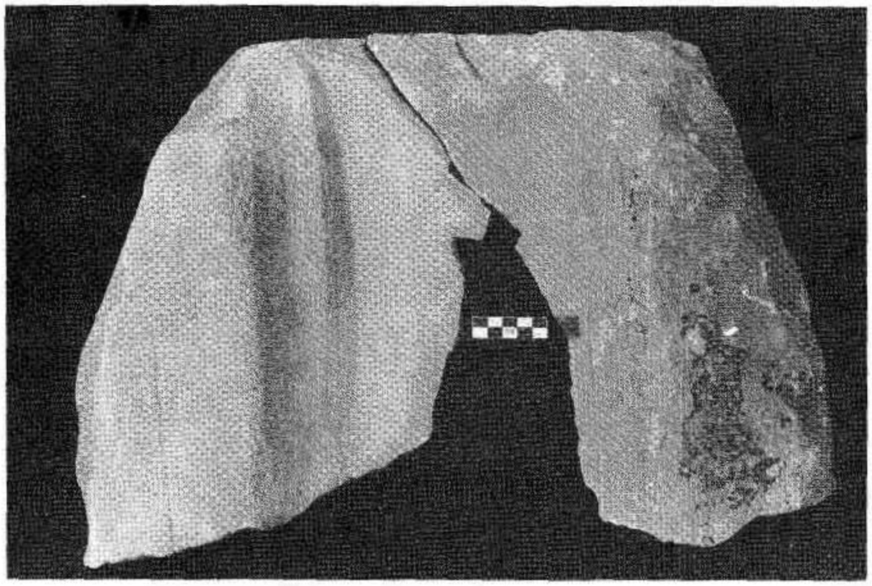


Figure 9.14. *Example of an undulating trough wall: Trough metate (FS 433-09) from Pueblo Alto (29SJ 389), Other Structure 6. (5 cm scale) (NPS Chaco Archive Negative No. 14225).*

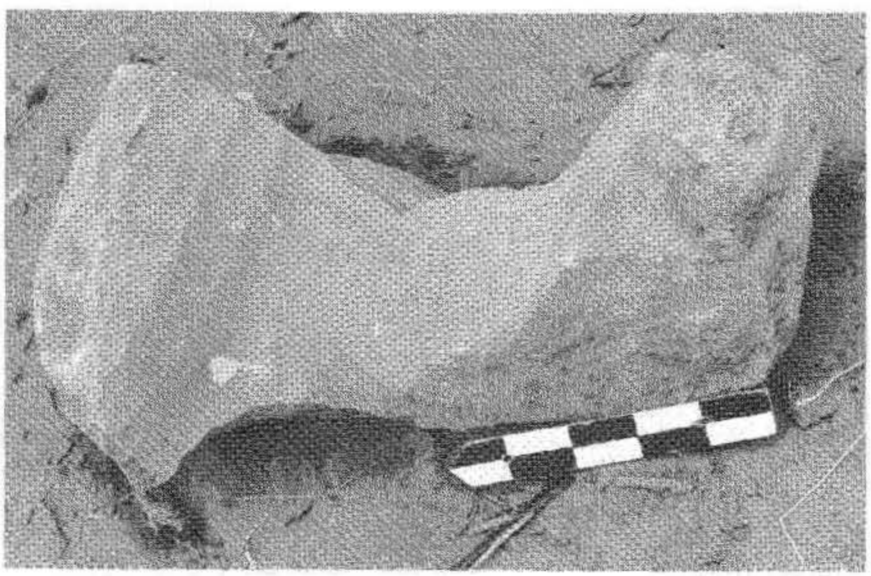


Figure 9.15. *Example of undulating trough walls: Trough metate fragment (FS 4232) from Pueblo Alto (29SJ 389), wall clearing of Plaza Feature 4. (15 cm scale) (NPS Chaco Archive Negative No.17955).*

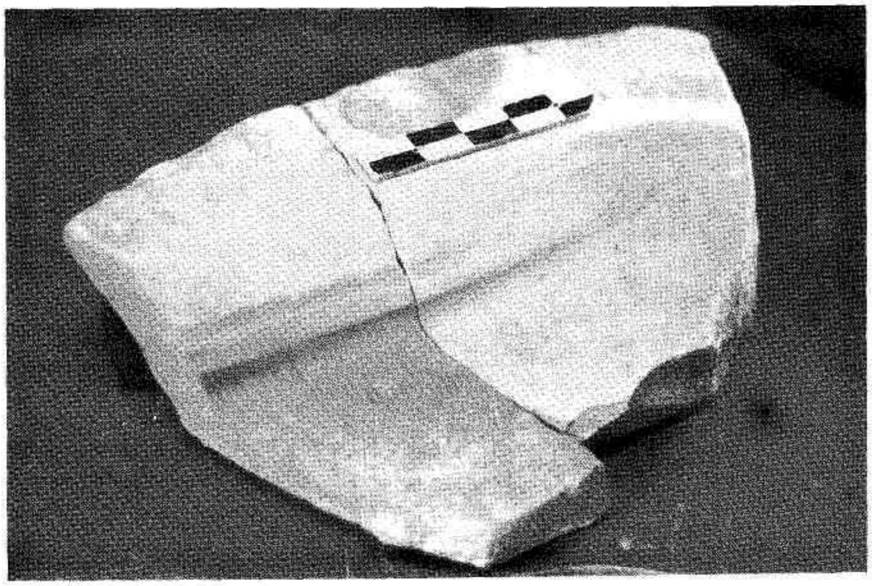


Figure 9.16. *Example of an undulating trough wall: Trough metate fragments from Pueblo Alto (29SJ 389). Right: FS 6766 from Room 143, Layer 1. Left: FS 5076 from Plaza Grid 117, Layer 1. (15 cm scale) (NPS Chaco Archive Negative No. 23614).*

Table 9.16. *Characteristics of the trough.*

	Characteristics of the Trough								
	Flat Bottom		Slightly Concave		Very Concave		Unknown		
Site No.	No.	%	No.	%	No.	%	No.	%	Total
29SJ 629	1	0.9	14	12.4	-	-	98	86.7	113
29SJ 389	1	0.3	28	8.0	6	1.7	317	90.1	352
29SJ 390	-	-	2	33.3	-	-	4	66.7	6
29SJ 391	-	-	1	6.3	1	6.3	14	87.5	16
29SJ 827	2	3.1	20	30.8	-	-	43	66.2	65
29SJ 633	2	4.5	2	4.5	1	2.3	39	88.6	44
Totals	6		67		8		515		596

Table 9.17. Shape of the near-end of the trough.

	Percentages			
Site No.	Rectangular	U-Shaped	Irregular	No.
29SJ 629	14.2	85.7	-	21
29SJ 389	14.1	84.6	1.3	78
29SJ 390	-	100.0	-	1
29SJ 391	25.0	75.0	-	4
29SJ 827	35.3	52.9	11.8	17
29SJ 633	66.7	33.3	-	3

Three possibilities existed—rectangular, "U" (i.e., horseshoe), or irregular. A rectangular end had square corners, while the "U" corners were rounded. Considering the mano's generally rectangular shape and the fact that they were locked into the same reciprocating motion by the trough's walls, the most frequently recorded variability should be rectangular. Such was the case at the two sites with the larger sample sizes; 29SJ 629 and 29SJ 389, where rectangular comprised approximately 85 percent. The small sample size accounts for the variation at the other sites.

It is not clear why the rectangular shape did not occur in every case. When using a smaller mano to replace a worn out earlier one, perhaps the miller pulled the replacement slightly closer to herself and farther onto the near-end shelf. The replacement mano would be shorter, lighter, and less constrained by the trough's walls. Through time, this action would wear away more of the center of the near-end shelf and create the appearance of a U. The few that were recorded as "irregular" are even more perplexing. This area of the metate may have been subjected to secondary use contemporaneously with its primary grinding function or used in another context after it ceased to be a metate. In either case, the additional use went undetected during the analysis.

Assessment of the Amount of Use

The assessment of the amount of use (Table 9.18) was recorded, in spite of the initial assumption that most metates would be used until worn-out. Light use was considered to be a trough which was worn one-third of the way or less through the metate. Moderate use measured between one-third and two-thirds and heavy use was greater than two-thirds. One metate was recovered with no use, and a category of "pecked outline" was added. One essentially identical pecked outline metate was recovered from Salmon Ruin (Shelley 1980). As discussed in more detail in the following section, less than 10 metates actually had a hole worn through the trough. All of the remaining metates had a sufficiently thick trough to permit more grinding. An actual percentage of wear, determined by the ratio of trough depth to overall stone thickness, is included in the following discussion. Those results generally agree with the more broadly defined categories of this variable.

The majority of metates were also the most worn—444 were worn more than two-thirds of the way through the stone. There are, however, six sites where the distribution between the medium and the heavy use is almost equivalent in numbers and percentage, but the small sample size is a factor. Metates with wear between one-third and two-thirds of the total thickness occurred 273 times; many months, if not years, of grinding could have occurred on these stones.

The most surprising category is represented by the 77 metates which were only lightly used, that is, with less than one-third of the stone removed. Such metates were recovered from every site. Had they been recovered in a primary context, they would represent the grinding stone being used when the site was abandoned but most were broken up and located in other than primary use contexts. The possibilities of destruction to prevent their use by enemies or breakage by the enemies themselves have been suggested but supporting evidence for such scenarios is lacking.

A single unused metate was recovered during the project. Site 29SJ 389 produced one metate with a roughened surface but with no evidence of any grinding. An outline of an open-at-one-end trough had been pounded into the upper surface with hammerstones. Several were recorded with use depths of 0.1 and 0.2 cm.

Floor Wear

As noted in the literature review, metates generally changed through time from a portable tool which could be moved around and even leaned against a wall when not needed, to a permanent

Table 9.18. Amount of use.

	Use							
	Light (<1/3)		Medium (1/3-2/3)		Heavy (>2/3)		Pecked Outline	
Site No.	No.	%	No.	%	No.	%	No.	%
29SJ 423	-	-	2	50.0	2	50.0	-	-
29SJ 1659	1	33.3	1	33.3	1	33.3	-	-
29SJ 628	8	30.8	12	46.1	6	23.1	-	-
29SJ 299	6	17.1	14	40.0	15	42.9	-	-
29SJ 724	4	22.2	7	38.9	7	38.9	-	-
29SJ 1360	2	11.7	6	35.3	9	52.9	-	-
29SJ 629	11	12.8	23	26.7	52	60.5	-	-
29SJ 627	11	6.3	49	28.0	115	65.7	-	-
29SJ 389	21	2.6	109	34.8	182	58.1	1	0.3
29SJ 390	2	33.3	2	33.3	2	33.3	-	-
29SJ 391	2	13.3	9	60.0	4	26.7	-	-
29SJ 827	8	13.3	27	45.0	25	41.7	-	-
29SJ 633	1	2.7	12	32.4	24	64.9	-	-

Table 9.19. Floor wear.

	Location of Floor Wear										
	None		Bottom		Edge		Both Bottom & Edge		Unknown		
Site No.	No.	%	No.	%	No.	%	No.	%	No.	%	Total
29SJ 423	-	-	-	-	-	-	-	-	-	-	-
29SJ 1659		-	-	-	-	-	-	-	-	-	-
29SJ 628	-	-	-	-	-	-	-	-	-	-	-
29SJ 299	-	-	-	-	-	-	-	-	-	-	-
29SJ 724	-	-	-	-	-	-	-	-	-	-	-
29SJ 1360	-	-	-	-	-	-	-	-	-	-	-
29SJ 629	38	33.6	57	50.4	-	-	-	-	18	15.9	113
29SJ 627	-	-	-	-	-	-	-	-	-	-	-
29SJ 389	166	47.2	114	32.3	2	0.6	9	2.6	61	17.3	352
29SJ 390	5	83.3	-	-	-	-	-	-	1	16.7	6
29SJ 391	5	31.3	6	37.5	-	-	1	6.3	4	25.0	16
29SJ 827	25	38.5	22	33.8	-	-	3	4.6	15	23.1	65
29SJ 633	22	50.0	13	29.5	1	2.3	-	-	8	18.2	44
Totals	261		212		3		13		107		596

fixture in a mealing bin. While it is generally assumed that metates were permanently set into adobe in mealing bins, the published literature concerning Chaco Canyon is frequently ambiguous. Occasional photographs in the archives show trough metates in bins which do not appear to be set in adobe (e.g., the only recorded bins at Chetro Ketl). Through repeated use, metates not set in adobe develop a polish on the surfaces which are in contact with the floor or with the supporting props because the stone moves with each grinding stroke.

That metates were still considered to be portable tools even later in time is not only indicated by the lack of mealing bins but occasionally by the metates themselves. For example, one partial metate recovered from Room 3, Plaza Feature 1 at Pueblo Alto (FS No. 922) had a concavity 8.5 cm long, 2 cm high, and 5 cm deep chipped into the left lateral side at the near-end. This metate was very large with the near-end shelf measuring 18 cm in width and the lateral shelves measuring 13 cm wide. The stone itself was tabular and quite flat; therefore, the underside was in full contact with the floor. This concavity facilitated moving the metate by providing a location to slip the fingers in under the stone when lifting.

Areas of polish, varying from 10 cm in diameter to the full width of the stone and normally not associated with other wear patterns, were recorded as floor wear (Table 9.19). There were no cases where the entire bottom of the stone was polished; rather, raised areas and the portions toward the far end were the most commonly polished—although during the analysis it was eventually observed on all portions of the under surface. The largest amount (44 percent) indicated no polish, whereas 36 percent had polish on the underside.

The unknown category (18 percent) represents areas of polish in conjunction with other wear. Apparent polish appeared in unlikely locations, such as cavities; or possible polish was disrupted by post-depositional processes.

In several cases, each from 29SJ 629 and 29SJ 389, an area of very high polish occurred on the underside. It was not only located on the upper portion of raised areas but also extended down their sides to the flatter portion of the underside. In one case, two raised areas, their sides, and the depression between them had this high degree of polish. In a number of cases, the lower far edge was both polished to this high degree and actually rounded from whatever activity was being performed. This polish may be the result of a pliable material such as leather being worked repeatedly back and forth and which is capable of conforming to the contours of the rock. It seems unlikely that this high degree of polish is the result of floor wear because it conforms to the contours of the stone. Portions of these contours, that is, the sides and concavities, could not be in contact with the floor. It is possible that they would be in contact with an adobe mortar, but it is unknown if slight movement against the bed of adobe could result in the high degree of polish exhibited on some metates. For this reason, it is labled as bin wear (Table 9.20), but the mechanism which created it is unknown.

This interpretation of polish resulting from bin wear is bolstered by the fact that identical wear was observed on the lateral edges of some metates, either alone or in combination with additional polish on the bottom of the stone (Table 9.19). If one assumes that adobe is not as effective a bonding agent as concrete and that a metate set into adobe is not completely immobile and further, it moves slightly during each grinding stroke, eventually the lateral edges would also be polished. An extended grinding experiment may offer more insight. As recorded in the table, three metates had polish only on their edges, two at 29SJ 389 and one at 29SJ 633; 13 were polished on the both the edges and underside.

Mealing Bins

While mealing bins had been uncovered during most of the excavations throughout the canyon, the most frequent observation is that they had been dismantled prehistorically, either due to a change in room function or to a reconstruction or replastering of the floor (e.g., Judd 1954:133-135; 1959:44-45 or the Chaco Project excavations). In addition to Pueblo Bonito and Pueblo del Arroyo, mealing bins or possible mealing bins (usually only remnants) were excavated in a pithouse between Bc 50 and Bc 51 (Kluckhohn and Reiter 1939), Room 19 at Bc 50, in two rooms at Bc 51, in one room each at Bc 58 and Bc 59 (Archive Number 2051 and 2106), and in four rooms at Bc 362. Vivian and Mathews (1964:92) note that none were recovered from Kin Kletso (although slabs in the rubble of collapsed upper story rooms could have been from bins); one room in Chetro Ketl had four bins; one set of mealing bins occurred at Bc 192; five mealing bins were found at Bc 362; and one occurred at Bc 236. At Shabik'eshchee Village, Roberts (1929:14) recorded one metate in a "fairly large oval" floor depression. During Chaco Project excavations, bins and/or remnants such as the catchment basins were recorded at 29SJ 1360, 29SJ 627, 29SJ 629, 29SJ 389, and others.

The number of bins ranged from one to 10 at Pueblo Bonito; with the possible exception of the room with 10, they were generally in living rooms rather than specialized grinding chambers. In

Table 9.20. Bin wear.

	Wear																	
	Near		Far		Lateral		Central		Far/Left		Far/Center		Lateral/End		Near/Far/End		All	
Site No.	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
29SJ 299	1	2.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29SJ 627	1	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.5
29SJ 389	7	2.0	17	4.8	8	2.3	3	0.8	8	2.3	1	0.3	-	-	1	0.3	2	0.6
29SJ 390	1	16.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29SJ 391	-	-	-	-	-	-	-	-	-	-	-	-	2	12.5	1	6.2	-	-
29SJ 827	1	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 9.21. Condition.

	Condition																		
	Whole and Usable		Analytically Complete, Not Usable		Fragment, No Complete Measurements		Fragment Length Only		Fragment Width Only		Fragment Thickness Only		Fragment Length and Width		Fragment Length and Thickness		Fragment Width and Thickness		
Site No.	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	Total
29SJ 423	-	-	3	60.0	2	40.0	-	-	-	-	-	-	-	-	-	-	-	-	5
29SJ 1659	-	-	1	33.3	2	66.7	-	-	-	-	-	-	-	-	-	-	-	-	3
29SJ 628	3	10.0	1	3.3	26	86.7	-	-	-	-	-	-	-	-	-	-	-	-	30
29SJ 299	6	16.7	3	8.3	27	75.0	-	-	-	-	-	-	-	-	-	-	-	-	36
29SJ 724	-	-	-	-	22	100.0	-	-	-	-	-	-	-	-	-	-	-	-	22
29SJ 1360	6	35.3	2	11.8	9	52.9	-	-	-	-	-	-	-	-	-	-	-	-	17
29SJ 629	6	5.3	3	2.7	16	14.2	-	-	-	-	83	73.5	-	-	2	1.8	3	2.7	113
29SJ 627	4	1.9	2	1.0	202	97.1	-	-	-	-	-	-	-	-	-	-	-	-	208
29SJ 389	2	0.6	11	3.2	30	8.5	-	-	2	0.6	275	78.1	1	0.3	12	3.4	19	5.4	352
29SJ 390	-	-	-	-	1	16.7	-	-	-	-	2	33.3	-	-	1	16.7	2	33.3	6
29SJ 391	1	6.3	1	6.3	-	-	-	-	-	-	14	87.5	-	-	-	-	-	-	16
29SJ 827	8	12.3	3	4.6	3	4.6	-	-	-	-	31	47.7	-	-	12	18.5	8	12.3	65
29SJ 633	-	-	1	2.3	7	15.9	-	-	1	2.3	30	68.2	1	2.3	2	4.5	2	4.5	44
Totals	36		31		347		0		3		435		2		29		34		917

addition to their generally dismantled state, the excavators commented not only on the almost complete lack of slab metates in association with bins but also on the almost complete lack of slab metates from the sites. The usual Southwestern generalization is that slab metates occurred in bins; whereas, in Chaco Canyon, trough metates were in the bins.

Another difference between the prehistoric bins and bins recorded during the ethnographic present derives not from the bins directly but from the absence of rock with varying degrees of natural coarseness in Chaco Canyon. Ethnographers commented on the juxtaposition of such materials and the ease with which meal is passed down the line of increasingly fine metates so that the end result is very finely ground material. In Chaco Canyon, the meal could have been as finely ground, but the technique would have been different and involved a combination of grinding surface pecking and extra effort on the part of the miller.

Mealing bins were found during the excavation of Rooms 103 and 110 at 29SJ 389; however, they had been dismantled by the room's occupants prior to replastering the floor. There were no bins used by the last occupants on the final floor in these two rooms. Room 103 had three mealing bins in the southwest corner and Room 110 had six mealing bins across the south wall. Broken pieces of metates were used in portions of the bin construction in Room 103. An adobe remnant still in place also revealed the shape of the corner of one of the metates being held in place.

Condition

Table 9.21 refers to the condition of the piece being analyzed; observations varied from whole and usable to a fragment from which no complete measurements could be obtained. Those coded as morphologically complete but unusable were broken into pieces, but a sufficient number of the pieces were recovered and matched together so that complete measurements could be determined. Pieces were matched not only from the same room but also from across the site (see the discussion and Table 9.21 [Appendix 9.B]). The pieces which could provide only a few measurements, and even those yielding no complete measurements were still useful. Many other attributes relevant to differing research questions were retained and were recorded in the same manner as if the piece were not broken.

Surprisingly few complete metates were found by the Chaco Project. A total of 36 whole and usable metates (4 percent of the number of items analyzed) were recovered from eight sites; five sites had none. Several of the individual site percentages were relatively high, although the small sample size issue is always germane. Complete metates were found at the following sites: 1) two out of 352 pieces (0.6 percent) at 29SJ 389, 2) four out of 208 pieces (1.9 percent) at 29SJ 627, and 3) six out of 113 pieces (5.3 percent) at 29SJ 629. For whatever reasons, these uniform rocks were too tempting a target for subsequent individuals, generations, or newcomers. Rather than continuing to use an apparently functional grinding tool for its intended purpose, they were destroyed long before they were worn-out.

The majority of the items analyzed were broken (n=854 or 96 percent). Of this number, 31 were considered analytically complete but unusable; all whole measurements and other attributes could be recorded. These metates were considered unusable because they were broken, not because they were worn-out. Examples of this category were recovered from almost every site; they were broken prehistorically but enough pieces were found and matched together to provide a total analysis. Following destruction, some pieces were recycled into other tools or building material.

The second greatest number of pieces analyzed were those for which no whole measurements were possible. A total of 320 pieces were clearly recognizable as metate fragments but were sufficiently broken that no complete length, width, or thickness could be determined. Table 9.21 reflects differences between the analysts; the subdivisions and combination of whole measurements were added during the second half of the analysis. It is unlikely that the sites analyzed earlier would not have yielded fragments without at least one whole measurement, especially thickness. The table indicates that almost all of the metates recovered were broken, but that an occasional piece represented a complete length or width and the thickness could be determined on many pieces (n=435).

These were not the smallest fragments recovered, however. The smallest, generally hand-size fragments were tabulated separately because little information relevant to the overall study would be gained by computerizing the measurements, weight, or occasional observations. Summaries are provided in Appendix 9F.

The Metate as a Multifunctional Tool

The emphasis of discussions concerning metates is always heavily weighted toward their primary function of maize and other seed grinding. Many of the Chacoan trough metates, however, were also contemporaneously used for a variety of other purposes and were multifunctional tools. Their size, shape, and weight provided sufficient mass to absorb blows from pounding without destroying the metate. Additional surfaces were available for secondary tasks. The three shelves surrounding most trough metates—two lateral and one at the near-end closest to the miller—were sufficiently large to be used in other household tasks. Because metates were recycled into other tools and architectural elements following their metate use-life, the analyses of additional metate functions focused on those activities which co-occurred with the primary activity of grinding. The recycling of metates into other tool types following their destruction is discussed in the next section.

In most cases, only one additional activity is indicated; in other instances, two or more activities were indicated, e.g., grinding hematite in one area and anvil wear in another. In such cases, an attempt was made to discern the primary and secondary activities. Location, size of the areas involved, and intensity of the wear patterns were considered. When no distinction was apparent, an arbitrary decision was made. The importance of the observation is the multiple functions, not which one was the most important.

As indicated in Tables 9.22, 9.23, 9.24, 9.25 and 9.26, metates were multifunctional tools at all 13 sites included in this analysis—even those with sample sizes as low as three and five. All temporal periods, pithouses, and surface rooms are represented. Up to four use areas were coded for the upper surface, the trough, and the right, left, and near-end shelves. The bottom side was considered as a single area. While the greatest number of additional use areas in the overall sample was four (n=2), the usual was one (n=279); the use of two areas occurred 37 times and three were noted five times.

For all sites, additional use varied from a low of 6.2 percent at 29SJ 827, to a high of 43.8 percent at 29SJ 391. The results at 29SJ 827 can be generally disregarded due to the relatively deteriorated nature of the previously excavated metates. They, along with the manos, hammerstones, and other miscellaneous ground stone, were left at the site following the excavation and were on the ground exposed to the elements and shifting sand for several decades prior to this analysis. For those sites with a sample size of 30 or more (excluding 29SJ 827), the percentages range from 11.5 to 38.6 of the total (Table 9.22).

As expected, the location of additional use was most frequent on the shelves surrounding the trough. These surfaces were most accessible even on a portable stone which could be turned over. Secondary use of the trough occurred at most sites—combinations of upper and lower surfaces and the trough were noted at 29SJ 629, 29SJ 389, and 29SJ 633. No combinations were recorded for 29SJ 390, 29SJ 391, or 29SJ 827, and the combinations were not considered at the other sites. Even in the case of more-than-one-use-areas, only one activity was monitored, for example, anvil wear on two locations. If a second activity occurred, such as pecking in addition to anvil wear, the second was recorded separately (Table 9.23).

Dense concentrations of hammerstone peck marks occurred on the undersides in 16 cases (Figure 9.12): at 29SJ 628 (1), 29SJ 629 (6), 29SJ 389 (3), 29SJ 391 (3), 29SJ 633 (2), and 29SJ 827 (1). Such a concentration was also observed on the bottom of the round metate excavated from Una Vida and left at Chaco (Vivian's FS No. 2209). It is uncertain whether these were the result of additional activity, the beginnings of a trough which was abandoned in favor of the other side, or the residuals from initial metate manufacture. The latter is most plausible as the metate's maker attempted to remove unwanted projections so that the stone would lie flat. Other activity on the bottoms of the metates could have occurred following its use as a grinding implement; additional variables, such as the presence or absence of polish from the floor or a bin, were considered. In some cases, an arbitrary decision was made concerning contemporary or post-metate use.

Table 9.22. Number of major secondary utilized surfaces.

	0		1		2		3		4		5		9		
Site No.	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	Total
29SJ 423	4	80.0	1	20.0	-	-	-	-	-	-	-	-	-	-	5
29SJ 1659	-	-	2	66.7	1	33.3	-	-	-	-	-	-	-	-	3
29SJ 628	18	60.0	11	36.7	1	3.3	-	-	-	-	-	-	-	-	30
29SJ 299	22	61.1	12	33.3	2	5.6	-	-	-	-	-	-	-	-	36
29SJ 724	19	86.4	3	13.6	-	-	-	-	-	-	-	-	-	-	22
29SJ 1360	12	70.6	5	29.4	-	-	-	-	-	-	-	-	-	-	17
29SJ 629	89	78.8	13	11.5	4	3.5	1	0.9	-	-	-	-	6	5.3	113
29SJ 627	108	51.9	73	35.1	17	8.2	3	1.4	2	1.0	1	0.5	4	1.9	208
29SJ 389	203	57.7	136	38.6	11	3.1	1	0.3	-	-	-	-	1	0.3	352
29SJ 390	4	66.7	2	33.3	-	-	-	-	-	-	-	-	-	-	6
29SJ 391	7	43.8	7	43.8	-	-	-	-	-	-	-	-	2	12.5	16
29SJ 827	60	92.3	4	6.2	-	-	-	-	-	-	-	-	1	1.5	65
29SJ 633	31	70.5	10	22.7	1	2.3	-	-	-	-	-	-	2	4.5	44
Totals	577		279		37		5		2		1		16		917

Table 9.23. Location of major secondary utilized surfaces.

	Location of Major Secondary Utilized Surfaces																		
	None		Rough		Adjacent		Opposite		Trough Adjacent		Trough/ Opposite		Adjacent/ Opposite		All Three		Unknown		
Site No.	No.	%	No	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	Total
29SJ 423	4	80.0	-	-	1	20.0	-	-	-	-	-	-	-	-	-	-	-	-	5
29SJ 1659	-	-	2	66.7	-	-	1	33.3	-	-	-	-	-	-	-	-	-	-	3
29SJ 628	18	60.0	6	20.0	4	13.3	2	6.7	-	-	-	-	-	-	-	-	-	-	30
29SJ 299	22	61.1	3	8.3	6	16.7	5	13.9	-	-	-	-	-	-	-	-	-	-	36
29SJ 724	19	86.4	-	-	1	4.5	2	9.1	-	-	-	-	-	-	-	-	-	-	22
29SJ 1360	12	70.6	1	5.9	2	11.8	2	11.8	-	-	-	-	-	-	-	-	-	-	17
29SJ 629	90	79.6	1	0.9	8	7.1	1	0.9	2	1.8	-	-	4	3.5	1	0.9	6	5.3	113
29SJ 627	113	54.3	14	6.7	66	31.7	15	7.2	-	-	-	-	-	-	-	-	-	-	208
29SJ 389	203	57.7	19	5.4	95	27.0	24	6.8	1	0.3	2	0.6	7	2.0	-	-	1	0.3	352
29SJ 390	4	66.7	-	-	1	16.7	1	16.7	-	-	-	-	-	-	-	-	-	-	6
29SJ 391	7	43.8	2	12.5	4	25.0	1	6.3	-	-	-	-	-	-	-	-	2	12.5	16
29SJ 827	60	92.3	-	-	1	1.5	3	4.6	-	-	-	-	-	-	-	-	1	1.5	65
29SJ 633	31	70.5	-	-	7	15.9	3	6.8	1	2.3	-	-	-	-	-	-	2	4.5	44
Totals	583		48		196		60		4		2		11		1		12		917

Table 9.24. Major secondary utilization.

	Type of Major Secondary Utilization																	
	Ground		Pecked		Gouge-Battered		Pigment		Groove		Anvil		Parallel Grooves		Passive Abrader		Pecks on Bottom	
Site No.	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
29SJ 423	-	-	-	-	1	20.0	-	-	-	-	-	-	-	-	-	-	-	-
29SJ 1659	2	66.7	1	33.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29SJ 628	3	10.0	5	16.7	2	6.7	1	3.3	-	-	-	-	-	-	-	-	1	3.3
29SJ 299	7	19.4	4	11.1	1	2.8	2	5.5	-	-	-	-	-	-	-	-	-	-
29SJ 724	-	-	2	9.1	1	4.5	-	-	-	-	-	-	-	-	-	-	-	-
29SJ 1360	-	-	1	5.9	1	5.9	3	17.6	-	-	-	-	-	-	-	-	-	-
29SJ 629	3	2.6	4	3.5	9	8.0	1	0.9	-	-	-	-	-	-	-	-	6	5.3
29SJ 627	9	4.3	57	27.4	25	12.0	3	1.4	-	-	-	-	-	-	-	-	-	-
29SJ 389	61	17.3	10	2.8	36	10.2	6	17.3	1	0.3	25	7.1	3	0.8	3	0.8	4	1.1
29SJ 390	1	16.6	-	-	1	16.6	-	-	-	-	-	-	-	-	-	-	-	-
29SJ 39	3	18.7	-	-	-	-	1	6.2	-	-	2	12.5	-	-	-	-	3	18.7
29SJ 827	2	3.1	1	1.5	1	1.5	-	-	-	-	-	-	-	-	-	-	1	1.5
29SJ 633	2	4.5	-	-	5	11.4	-	-	-	-	4	9.1	-	-	-	-	2	4.5

Table 9.25. Number of other utilized areas.

	Number of Other Utilized Areas												
	0		1		2		3		4		9		
Site No.	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	Total
29SJ 423	5	100.0	-	-	-	-	-	-	-	-	-	-	5
29SJ 1659	1	33.3	2	66.7	-	-	-	-	-	-	-	-	3
29SJ 628	26	86.7	4	13.3	-	-	-	-	-	-	-	-	30
29SJ 299	33	91.7	2	5.6	1	2.8	-	-	-	-	-	-	36
29SJ 724	22	100.0	-	-	-	-	-	-	-	-	-	-	22
29SJ 1360	15	88.2	1	5.9	1	5.9	-	-	-	-	-	-	17
29SJ 629	104	92.0	3	2.7	-	-	-	-	-	-	6	5.3	113
29SJ 627	187	89.9	18	8.7	2	1.0	-	-	1	0.5	-	-	208
29SJ 389	330	93.8	20	5.7	1	0.3	-	-	1	0.3	-	-	352
29SJ 390	6	100.0	-	-	-	-	-	-	-	-	-	-	6
29SJ 391	12	75.0	1	6.3	-	-	-	-	-	-	3	18.8	16
29SJ 827	63	96.9	1	1.5	-	-	-	-	1	1.5	-	-	65
29SJ 633	41	93.2	1	2.3	-	-	-	-	-	-	2	4.5	44
Totals	845		53		5		0		3		11		917

Table 9.26. Characteristics of other utilized areas.

	Types of Other Utilized Areas									
Site No.	Pigment	Ground Abraded	Gouged Pecked	Kill Hole	Striations	Battered (Passive)	Burned	Battered (Active)	Unknown	Total
29SJ 423	-	-	-	1	-	-	-	-	-	1 of 5
29SJ 1659	1	-	-	1	-	1	-	-	-	3 of 3
29SJ 628	1	5	1	-	-	1	-	-	-	8 of 30
29SJ 299	3	2	3	4	5	3	-	-	1	21 of 36
29SJ 724	-	-	1	-	-	-	-	-	-	1 of 22
29SJ 1360	1	2	2	1	-	-	-	-	-	6 of 17
29SJ 629	1	1	-	-	-	-	1	-	6	9 of 113
29SJ 627	5	8	13	-	6	10	1	-	1	44 of 208
29SJ 389	2	13	3	-	3	2	-	1	1	25 of 352
29SJ 390	-	-	-	-	-	-	-	-	-	0 of 6
29SJ 391	-	1	-	-	-	-	-	-	3	4 of 16
29SJ 827	-	-	1	-	-	-	-	-	2	3 of 65
29SJ 633	-	-	1	-	-	-	-	-	2	3 of 44
Totals	14	33	24	7	14	17	2	1	16	128 of 917

Because the metate provided a convenient surface for other tasks (Table 9.24) (Figures 9.17, 9.18, and 9.19), the major secondary use resulted from pounding, grinding, or gouging. The most common use was grinding/abrading (n=92), closely followed by pecking from hammerstones (n=87), and gouging/battering/hacking (n=84). Residual pigment was noted in 16 cases; hematite and occasionally limonite were expediently ground for use in decorations and paint. Anvil wear (Akins, this volume) was also recorded (Figures 9.20, 9.21, and 9.22).

Variables 5-9 (Table 9.24) were recorded only for 29SJ 629, 29SJ 389, 29SJ 390, 29SJ 391, 29SJ 633, and 29SJ 827. All were relatively rare. A single instance of an "incised groove" was noted; it was similar to those observed on shaft straighteners. The 29 cases of "ground/gouged" and the three of "passive abrader" were identical to wear patterns recorded on various anvils (Akins, this volume). As discussed previously, the 16 instances of "concentrations of pecks on the bottom" probably resulted from the removal of projections on the bottom of the rock to allow the metate to rest flat. If so, they are more appropriately considered part of the metate manufacture and not a result of concurrent use.

The three cases of "wide deep striations in the trough" (Figure 9.23), recorded at Pueblo Alto (29SJ 389), are not to be confused with the commonly observed fine striations on metates and manos resulting from the daily grind. Rather, these were 3 to 5 mm wide, several-mm-deep parallel grooves. They were sufficiently parallel and uniform that they resulted from a simultaneous activity rather than from some sequentially undertaken task.

In addition to the major secondary wear discussed above, there were 61 cases in which metates were used for what could be called tertiary wear (Table 9.25). Included within the 61 are 17 instances of quaternary wear, that is, a fourth distinct activity occurring in another discrete location on the metate. All were considered contemporary with the primary function of grinding. With respect to the tertiary and quaternary wear, there were 53 cases of using a single second area, five cases of using two areas, and three cases of using four areas. As seen in Table 9.26, these activities also resulted in battering, grinding, and gouging. These additional, but less extensive tertiary activities were similar to the major secondary uses, except for two instances of burning. One metate each from 29SJ 627 and 29SJ 629 was marked with a burned area, the characteristic red of burned sandstone, as if a small fire were started directly on the rock. The contexts of recovery did not suggest obvious post-use or post-depositional burning.

To summarize, grinding seed crops was the metate's primary activity and what gave them their final form. But metates were also multifunctional and were used at all sites as a platform for pounding, gouging, and other kinds of grinding. Up to four different activities were recorded on a single stone but the norm was one additional use. In spite of the presence of other tool types, such as anvils, wear identical to that recorded on anvils was occasionally recorded on a metate. There are occasions when it is more expedient to use a tool at hand than to dig the correct one out of the tool kit.

Metates were multifunctional tools with large flat surfaces providing a convenient, readily accessible platform for completing household tasks, in addition to grinding seeds. All surfaces were used, and an identical use was often found on several disparate areas of a surface.

Additionally, the multifunctional component of a trough metate was largely lost as open-at-one-end styles were replaced by open-at-two-end forms and was certainly lost when slab metates became the norm. Open-at-two-end forms do not have the near-end shelf and, at least in the few cases of the Chacoan assemblage, the lateral shelves are very narrow—in some cases, too narrow to permit use as a platform. Slab metates have no shelves at all; they are smaller, and they are usually permanently set into an adobe layer in a mealing bin, thereby precluding the use of the stone's bottom. While a limited amount of secondary battering or grinding could occur on the grinding surface of a slab metate, any extensive secondary use would destroy portions of the grinding surface which would then have to be repaired prior to the next grinding session.

Due to the smaller stone size of the usual slab metate, when compared to the usual open-at-one-end variety, permanent placement in a bin was necessary. The smaller size and correspondingly smaller weight made slab metates less stable and more easily shifted by each stroke of the mano. A constantly shifting

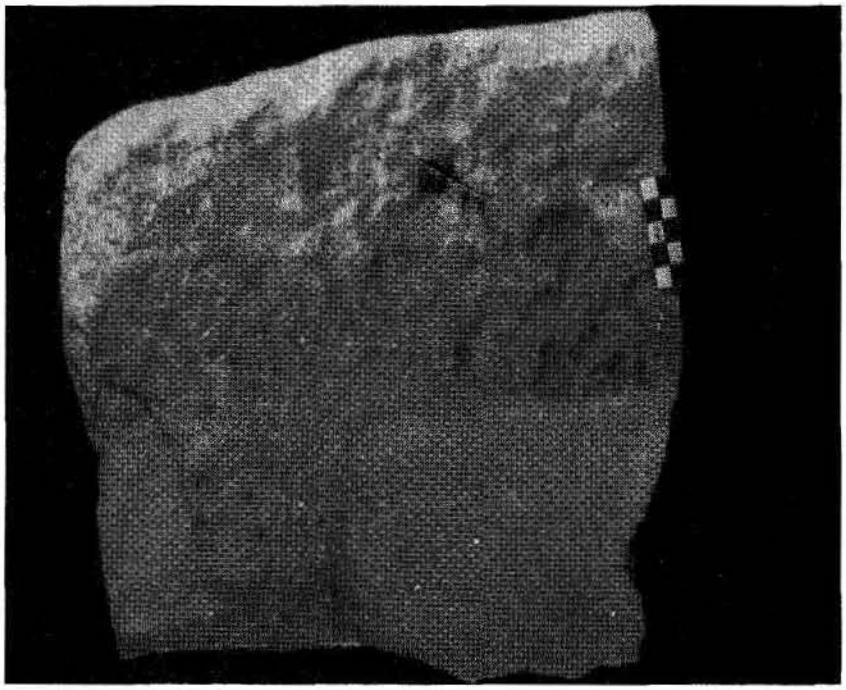


Figure 9.17. *Trough metate fragment (FS 530-06) with concentration of pecks recovered from Pueblo Alto (29SJ 389), Other Structure 7. (5 cm scale) (NPS Chaco Archive Negative No. 14222).*

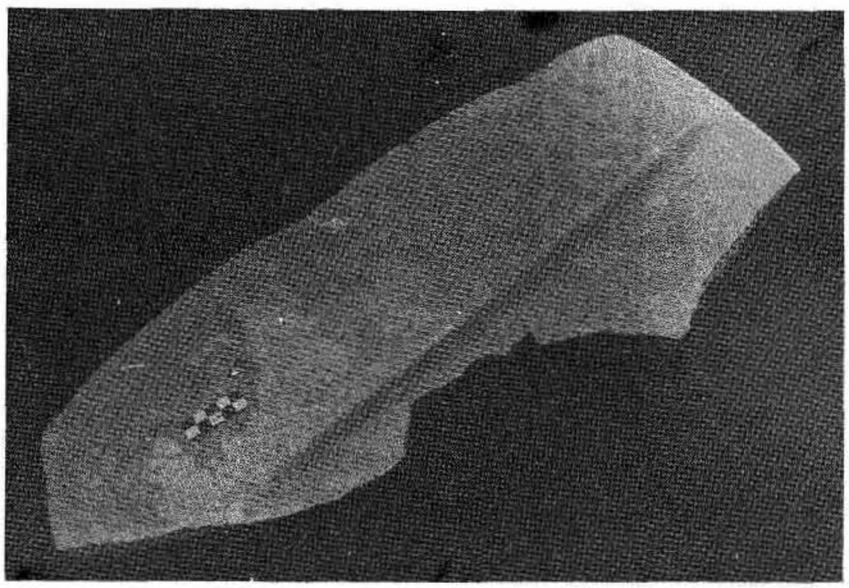


Figure 9.18. *Trough metate with concentration of peck marks. From Pueblo Alto (29SJ 389), Plaza 1, Grid 35. (5 cm scale) (NPS Chaco Archive Negative No. 14219).*

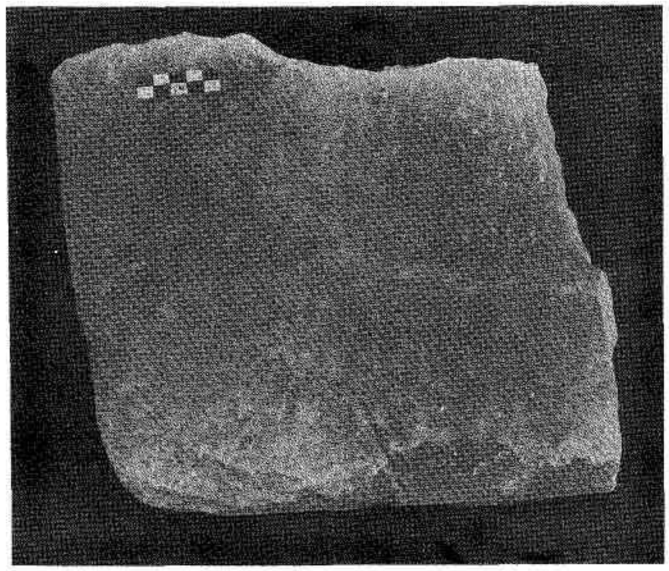


Figure 9.19. *Trough metate fragment (FS 1138) with peck marks in trough. From Pueblo Alto (29SJ 389), Room 103, Test Pit 5, 9 cm above floor. (5 cm scale) (NPS Chaco Archive Negative No. 14221).*

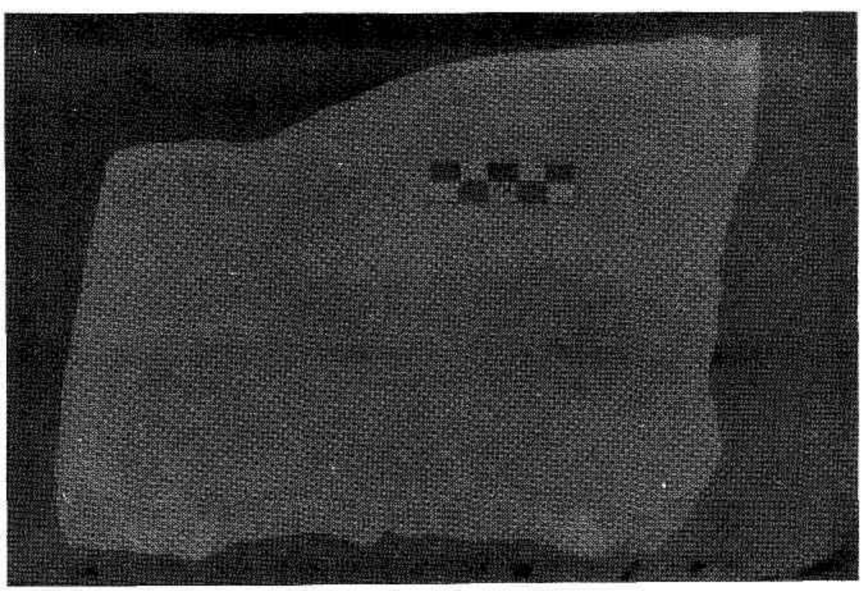


Figure 9.20. *Trough metate fragment (433-07) showing where bottom was used extensively as an anvil. From Pueblo Alto (29SJ 389), Other Structure 6. (5 cm scale) (NPS Chaco Archive Negative No. 14214).*

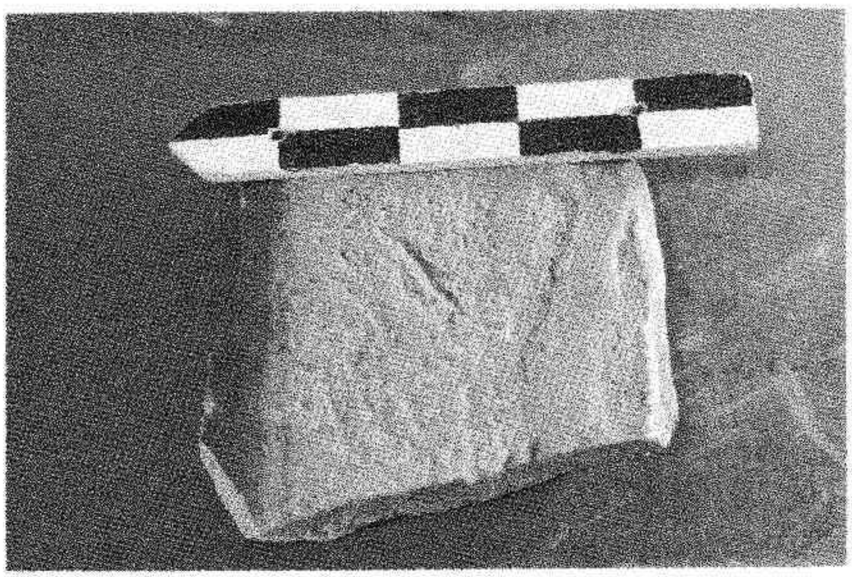


Figure 9.21. *Trough metate fragment with evidence of anvil wear. From Pueblo Alto (29SJ 389), Room 147, Test Trench 1, Layer 7. (15 cm scale) (NPS Chaco Archive Negative No. 23609).*

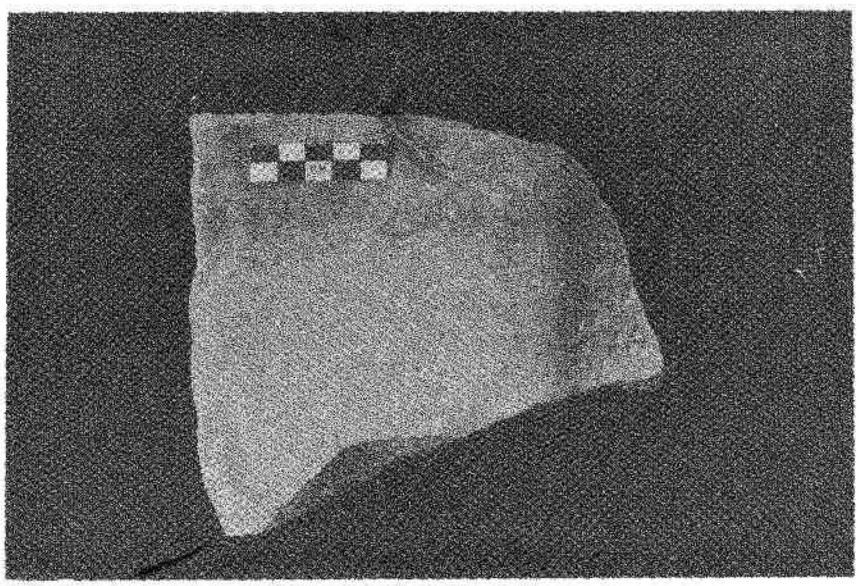


Figure 9.22. *Trough metate fragment (FS 1150) illustrating a shelf used as an anvil. From Pueblo Alto (29SJ 389), Room 103, Test Pit 7, Layer 1. (5 cm scale) (NPS Chaco Archive Negative No. 14213).*

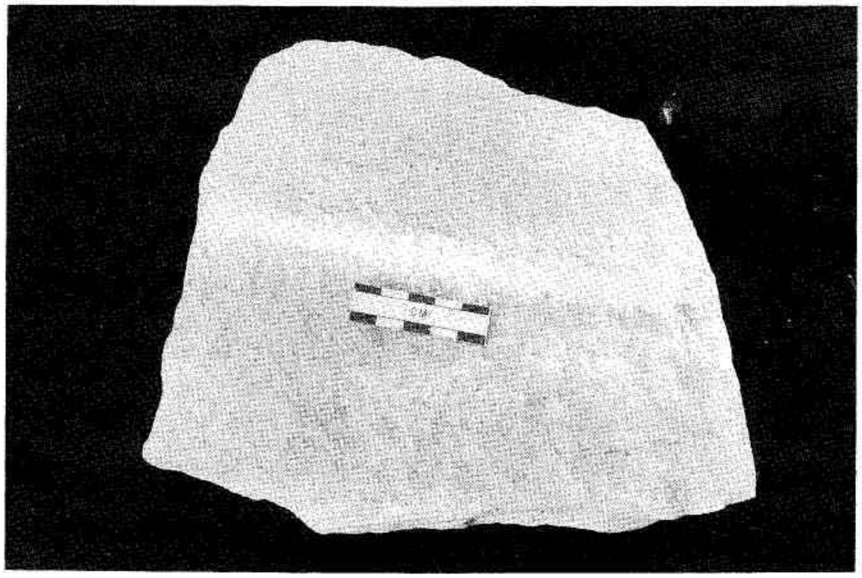


Figure 9.23. *Trough metate fragment (FS 4177-02) with deep striations. From Pueblo Alto (29SJ 389), Plaza 1, Grid 155. (5 cm scale) (NPS Chaco Archive Negative No. 15203).*

metate would be a distraction and would cause frequent interruptions as the miller paused to reposition it. The larger and much heavier trough metates had sufficient weight and volume to remain stable during use and to absorb blows without breaking during secondary use.

Trough and Slab Metates

As previously indicated, one of the underlying causes of the change in metate morphology was the association of the change in the races of maize with the change from trough to slab metates. The metate's primary function was to grind maize and seeds. The transition from basin to trough metate occurs within the context of the increasing dependence on agriculture and the change from grinding wild seeds to grinding cultivated maize. More ground material is produced per unit of the latter than is produced from the former.

Metates were basic to the adaptation and were an indispensible and functional tool required to prepare daily meals. Several different races of maize were ostensibly relied upon through time; later varieties had larger cobs with more rows of larger kernels and therefore produced more volume per unit of grinding. The kernels of the later varieties were softer and easier to grind than the earlier "flint" variety. The literature suggests that the slab metate was a response to the softer kernels because the walls of the trough metate were required to constrain the pieces of the flint corn as it was initially pulverized. The softer variety did not shatter with the same velocity.

Slab metates essentially co-occur with mealing bins. While the walls of the mealing bins would also serve to constrain flying pieces of kernels, as the walls of trough metates are alleged to do, this possibility has generally been overlooked. Because there were almost no slab metates and trough metates were extensively used in mealing bins, the issue is moot in Chaco Canyon.

Unfortunately, the archeological record of the sites selected by the Chaco Project did not yield metates in primary context, and the amounts of corn recovered were relatively low. The result is that the relationship of the metate's morphology and the race of corn, cannot be addressed. There is, however, an additional reason why the issue cannot be addressed at this time and certainly not in the manner in which it was originally conceived.

Mollie S. Toll (personal communication 1996) indicated that recent analysts have been unable to replicate the results of Hugh Cutler (the primary proponent of the differing races of maize) with their own data, and his distinctions have not withstood the test of time. The issue is not clear cut and apparently cannot be resolved definitively without molecular marker analysis and DNA-based genetic studies. Some results may be available within a few years. One drawback to the DNA study is that unburned material is required, limiting the results to a few archeological settings.

Toll indicated that relatively few kernels have been recovered from Chaco Canyon; therefore, even such basic information as a predominance of flint or flour maize (if that distinction is even real) is essentially unknown. Eight-, ten-, and twelve-row corn cobs have been recovered from sites in Chaco Canyon but their actual distribution has never been systematically studied. Some 12-row cobs have been recovered from greathouse sites, and it is Toll's impression that the 10-row cobs may be restricted to sites from one temporal period, but more study is required.

Questions which could be addressed include the spatial and temporal distribution of the morphological types, genetic markers and the issue of corn races with differing physical characteristics, and attempts to discern where they were grown. Were Chacoan farmers growing everything locally or were certain "types" of corn grown elsewhere and brought into the central canyon? Areas peripheral to Chaco Canyon averaged higher annual precipitation, were more stable, less stressed, and more predictable (Schelberg 1982). It would also be productive to include the effects of environmental factors such as precipitation and length of growing season in such a study because they alter the size of cobs and kernels.

A component of such a study should include the changes in the grinding characteristics of different types of maize after each have been placed in storage and allowed to dry out. The length of time in storage should be varied. Recently harvested flour corn grinds relatively easily, but how much more difficult is grinding after drying out? The duration for which maize maintains its nutritional value should also be ascertained.

Currently, the most that can be said in this regard is that the corn being ground in Chaco Canyon was best suited to the characteristics of an open-at-one-end trough metate; open-at-both-ends trough metates and slab metates were rare, but not unknown, and not all were from late sites. Through time, mealing bins evolved into more formal structures made of sandstone slabs and adobe. Nevertheless, trough metates continued to be used and were simply placed in the bins. Sometimes, they were immobilized in a bed of adobe in the bin; other times, they were not permanently fixed in the bins.

Metates—The End

The majority of the metates recovered during the Chaco Project were broken. In a few instances, sufficient pieces were recovered so that complete measurements could be determined; however, fragments of varying sizes were the norm. A reasonable initial assumption is that metate manufacture was sufficiently laborious that the millers would keep them until they were worn-out. To make a new one required procuring the stone; roughing out a blank; finishing it by pounding, flaking, pecking, and occasionally grinding; and finally starting a trough. After this process, it seems likely that it would be used until it was worn-out before recycling it into other tools and architectural elements. An exception are those metates reported to have been "killed" by pounding a hole through the trough to render them unusable.

Interest in this issue led to recording the variables intended to monitor reasons for metate disposal and/or recycling. Surprisingly, few of the Chacoan metates were either worn out or killed. Most appear to have had years of use left in them at the time of their destruction. Fragments were recycled into a variety of tool types such as manos, anvils, hammerstones, paint palettes, or abraders; or they became architectural elements such as building stones, a vent shaft collar, fire dogs, post shims, a slab-lined firepit, a step, a slab cover, or a base for a mealing bin catchment basin. Given that metates were already shaped, generally thin and uniform, they were ideal for recycling. Why this occurred so frequently prior to wearing out is curious.

Table 9.27 reports a use index: depth of the trough divided by the total thickness of the stone. As indicated, the greatest percentage of use at the sites was between 50 percent and 79 percent or, alternatively, between 20 percent and 50 percent of the stone remained unused. The range was from no use to 100 percent worn-out. No use was represented by one blank, that is, fully prepared with a pecked but not ground trough (recovered from 29SJ 389). A similarly pecked, but not ground, trough metate was recovered from the Salmon Ruin (Shelley 1980). Only four worn-out cases with holes in the trough were recorded from three of the sites, 29SJ 299, 29SJ 423, and 29SJ 389. Six metates were recorded with kill holes—one each from 29SJ 423, 29SJ 1659, 29SJ 1360, and 29SJ 389 (Figure 9.24), and two at 29SJ 390. Holes caused by wear were differentiated from kill holes by virtue of the accompanying impact blows and gouge marks associated with the latter and the fact that several centimeters of trough thickness remained.

While not discussed in detail, the thinnest part of the trough was also measured and recorded. Due to the irregularities in the bottom of a metate, using the total thickness of the stone would be deceiving if one were attempting to determine a metate's actual use-life in years. The irregularities were often approximately several centimeters less than the total, or maximum thickness. This effectively reduces the use-life of a metate—a hole would occur more quickly than if the stone were a uniform thickness. Using this number to determine the index of wear would increase the percentage of wear in some cases, but does not change the number actually worn-out.

The extent to which this could have been a concern to the millers is unknown. The decreasing thickness of the trough could be monitored on a portable stone but not on one permanently fixed into a bin. Nevertheless, only four metates were actually worn-out; therefore, a metate's use-life was not an issue of concern during the occupation of Chaco Canyon. This lack of concern for possible longevity was also apparent from another perspective. Several trough metates from 29SJ 389 were manufactured on extraordinarily thin rocks. One of the thinnest was a very hard gray piece only 3 cm thick (from Room 103). The trough was halfway through, or 1.5 cm deep (Figure 9.10). The thinnest was a fragment

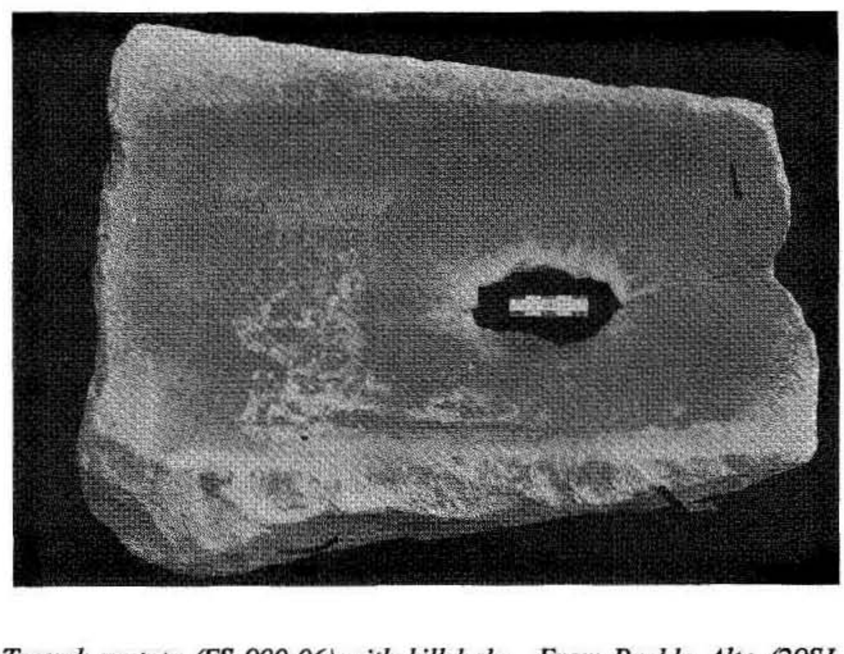


Figure 9.24. Trough metate (FS 900-06) with kill hole. From Pueblo Alto (29SJ 389), Plaza Feature 1. (5 cm scale) (NPS Chaco Archive Negative No. 14199).

Table 9.27. Percent of metate used.

	Percent Used																						
	0-9		10-19		20-29		30-39		40-49		50-59		60-69		70-79		80-89		90-99		100		
Site No.	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	Total
29SJ 299	-	-	2	5.8	3	8.8	5	14.7	4	11.8	8	23.5	6	17.6	4	11.8	1	2.9	-	-	1	2.9	34
29SJ 423	-	-	-	-	-	-	-	-	-	-	1	25.0	1	25.0	-	-	-	-	-	-	2	50.0	4
29SJ 627	-	-	2	1.3	10	6.7	10	6.7	9	6.0	27	18.0	39	26.0	27	18.0	22	14.7	4	2.7	-	-	150
29SJ 628	-	-	3	12.5	4	16.7	2	8.3	2	8.3	4	16.7	2	8.3	6	25.0	1	4.2	-	-	-	-	24
29SJ 724	-	-	-	-	2	22.2	1	11.1	-	-	2	22.2	3	33.3	-	-	1	11.1	-	-	-	-	9
29SJ 1360	-	-	1	7.1	-	-	1	7.1	2	14.3	3	21.4	3	21.4	2	14.3	2	14.3	-	-	-	-	14
29SJ 1659	-	-	-	-	-	-	1	33.3	-	-	1	33.3	1	33.3	-	-	-	-	-	-	-	-	3
29SJ 629	1	1.5	-	-	2	3.0	4	6.1	8	12.0	11	16.7	17	25.8	15	22.7	8	12.1	-	-	-	-	66
29SJ 389	1	0.3	2	0.7	10	3.3	28	9.3	24	7.9	71	23.5	71	23.5	57	18.9	32	10.6	5	1.7	1	0.3	302
29SJ 390	-	-	1	20.0	1	20.0	-	-	-	-	1.	20.0	1	10.0	-	-	1	20.0	-	-	-	-	5
29SJ 391	-	-	-	-	1	7.7	1	7.7	4	30.8	3	23.1	2	15.4	-	-	2	15.4	-	-	-	-	13
29SJ 633	-	-	-	-	-	-	5	13.9	2	5.6	10	27.8	6	16.7	8	22.2	5	13.9	-	-	-	-	36
29SJ 827	-	-	4	7.0	3	5.3	3	5.3	8	14.0	11	19.3	12	21.1	12	21.1	4	7.0	-	-	-	-	57
Totals	2		15		36		61		63		153		164		131		79		9		4		717

from the wall clearing of Circular Structure 2 in the southeast corner of the plaza; it was 2 cm thick (Figure 9.25).

Expedient behavior is one of the few observable reasons that the metates were broken up. Such behavior by a few families occurred at a temporally later site such as 29SJ 633. Many fragments were on the surface and limited excavations recovered pieces used in wall construction; most of those on the surface were from fallen walls. The site's occupants scrounged metates from other nearby abandoned sites in and around Marcia's Rincon and broke them into convenient building stones. Expedient behavior involving the use of metates during construction episodes at Pueblo Alto was noted at several locations, including construction of such large entities as Kiva 15, Plaza Feature 1, and several of the Other Structures in the main plaza, or smaller more personal facilities such as mealing bins in Room 103, and a firepit in Room 147.

During the analysis, the metate fragments were analyzed to the fullest extent possible; usually at least one complete measurement (length, width, thickness, etc.) was possible, as were observations of manufacture, and secondary use. Because metate morphology is distinctive, pieces of all sizes were recognized. The smallest pieces were so incomplete, however, that they were simply counted, weighed, and measured, but not included in the computerized inventory.

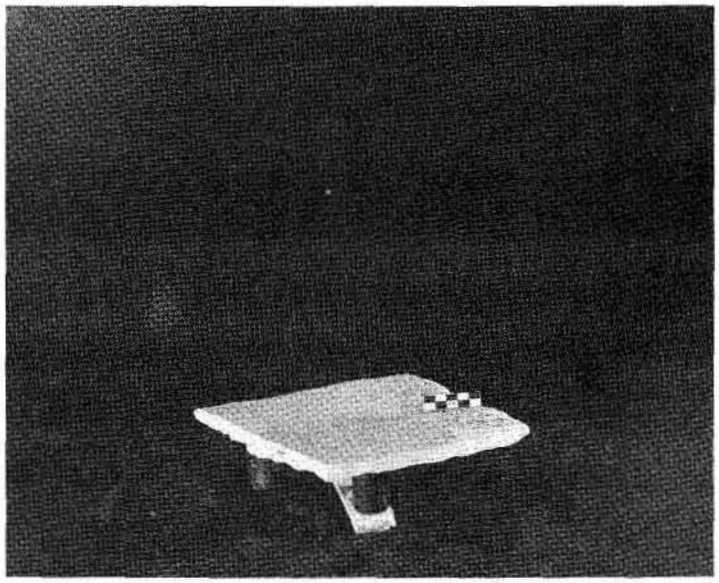
Following the destruction of a metate, some portions were simply discarded and others were remanufactured. Metate recycling took two major forms: use as other tools and use as architectural elements (Figure 9.26; and Appendix B). These will be discussed in turn. Overall, the number of tools made from broken metate pieces was a respectable percentage of the total recovered (remember that if two or more pieces could be joined into one larger piece, these were analyzed as a single piece). The total, 273 pieces recycled into new tools and architectural elements, represented 29.8 percent of the pieces analyzed (Table 9.28). There were 239 individual tools, 25 multipurpose tools, and the use-wear of six could not be determined. Essentially all categories of the large tool component of the Chacoan tool kit were represented. At least one such item was recovered from each site.

These tools included palettes, anvils, fire dogs, a mano, crusher/choppers, hammerstones, active abraders, numerous passive abraders, and several tools which combined two of these functions. Rare forms included the edge of one fragment from 29SJ 633, which resembled a modern crosscut saw blade due to the manner of its flaking, and another which was recorded as a "notch" from 29SJ 389. This notch is identical to those from the European Upper Paleolithic except that it is sandstone rather than a silicious material. One piece became a mano at 29SJ 629; two pieces became post shims, one each at 29SJ 627 and 29SJ 629; and two drill bases (platforms with holes drilled into them) were found, one each at 29SJ 627 and 29SJ 389. A barely utilized metate, broken and reused as a slab cover, is illustrated in Figure 9.27.

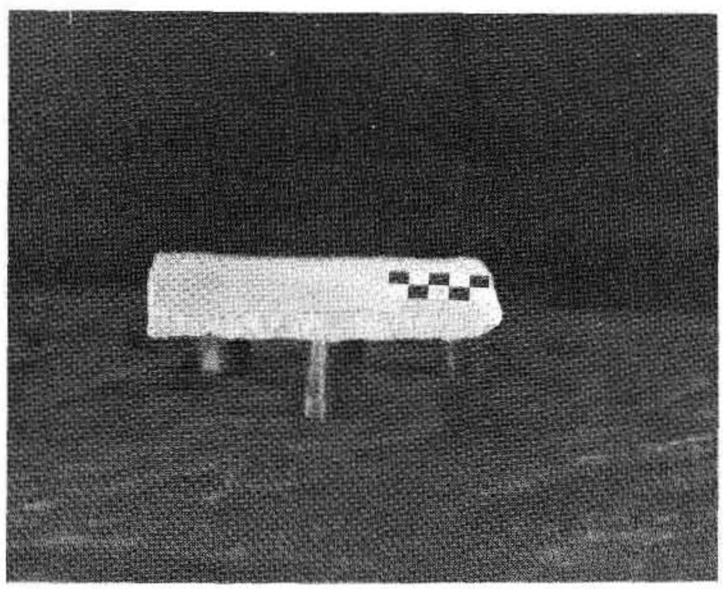
Disposition

This variable monitored the end of the Chacoan's active use of the metates on a day-to-day basis (Table 9.29). As was often the case, the initial assumption that most would be worn out from intensive use was not confirmed; in fact, almost none were worn-out (only two at 29SJ 629 and one at 29SJ 389). Two metates at 29SJ 389 and two at 29SJ 390 had been killed. The category of "not obvious" was used to record those which were whole and apparently usable. These had no breaks or cracks, had many centimeters of thickness remaining in the trough, and some of the troughs showed little use following their final sharpening. Perhaps these were the last metates in use at the time of final abandonment and they were not subsequently scavenged.

The largest number of metates, from 50 percent to 70 percent, had been broken. The breaks ranged from simply broken in half, usually along the long axis, to smashed into numerous pieces. Because none of the broken metates were recovered in a primary context, failure during use or sharpening cannot be determined, although some must have failed because their trough fragments were thin. While it is easy to recognize a metate fragment, the piece in hand may not be the one that failed. When a metate can no longer be used for its primary purpose because it is shaped, regular, smooth and conveniently located, it is efficient to break it up for use as another tool or building stone. Approximately 10 percent of the



A



B

Figure 9.25. *Thinnest (2.0 cm total thickness) trough metate fragment (FS 431-02) recorded during analysis. A and B) from Pueblo Alto (29SJ 389), Other Structure 2, (5 cm scale) (NPS Chaco Archive Negative Nos. 14052 and 14053).*

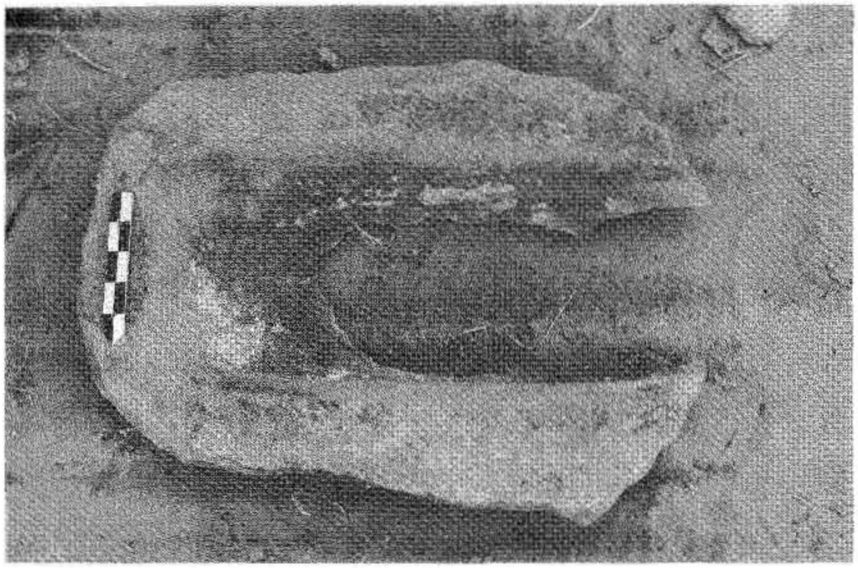


Figure 9.26. *Trough metate used in construction of partition wall in Room 103 of Pueblo Alto (29SJ 389). (15 cm scale) (NPS Chaco Archive Negative No. 17953).*

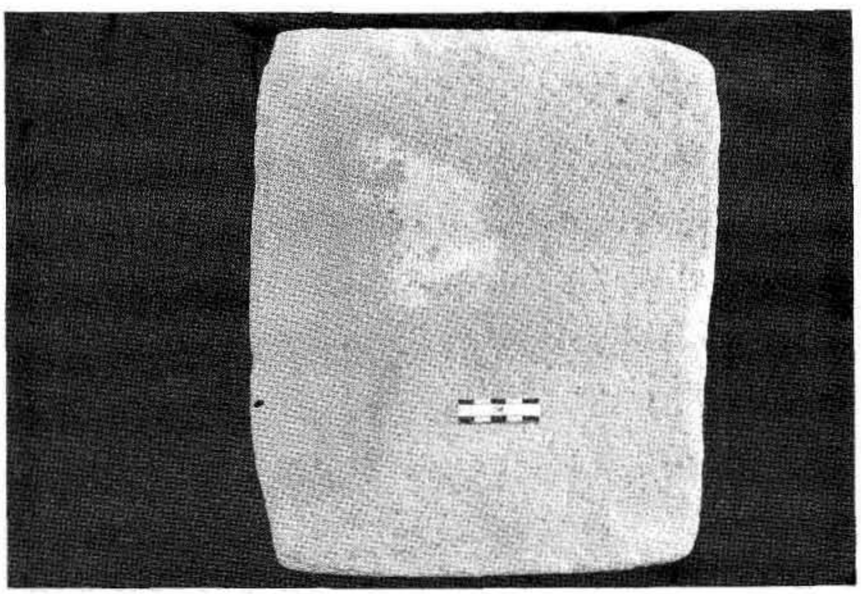


Figure 9.27. *Barely used trough metate (FS 434) that functioned as a slab cover—trough side up. From Pueblo Alto (29SJ 389), Other Structure 6. (5 cm scale) (NPS Chaco Archive Negative No. 14201).*

Table 9.28. Other artifact type.

	Other Artifact Type																	
	None		Palette		Anvil		Firedog		Crusher		Hammerstone		Active Abrader		Mano		Vent Shaft Collar	
Site No.	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
29SJ 423	4	80.0	-	-	1	20.0	-	-	-	-	-	-	-	-	-	-	-	-
29SJ 1659	-	-	1	33.3	1	33.3	-	-	-	-	-	-	-	-	-	-	-	-
29SJ 628	18	60.0	2	6.7	3	10.0	1	3.3	1	3.3	1	3.3	-	-	-	-	-	-
29SJ 299	22	61.1	3	8.3	3	8.3	-	-	1	2.8	-	-	2	5.6	-	-	-	-
29SJ 724	18	81.8	-	-	2	9.1	1	4.5	1	4.5	-	-	-	-	-	-	-	-
29SJ 1360	13	76.5	-	-	2	11.8	-	-	-	-	-	-	-	-	-	-	-	-
29SJ 629	79	69.9	-	-	1	0.9	2	1.8	21	18.6	2	1.8	2	1.8	1	0.9	-	-
29SJ 627	109	52.4	3	1.4	28	13.5	8	3.8	29	13.9	4	1.9	3	1.4	-	-	1	0.5
29SJ 389	262	74.6	1	0.3	18	5.1	-	-	32	9.1	-	-	7	2.0	-	-	-	-
29SJ 390	5	83.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29SJ 391	6	37.6	-	-	1	6.3	1	6.3	1	6.3	-	-	1	6.3	-	-	-	-
29SJ 827	55	84.6	-	-	2	3.1	-	-	4	6.2	-	-	-	-	-	-	-	-
29SJ 633	32	72.7	1	2.3	2	4.5	-	-	2	4.5	-	-	-	-	-	-	-	-
Totals	623		11		64		13		92		7		15		1		1	

Table 9.28. (continued)

	Other Artifact Type																	
	Post Shim		Passive Abrader		Saw Edge		Drill Base		Mealing Bin Base		Metate Bin Construction		Anvil/ Crusher		Anvil/ Firedog		Anvil/Active Abrader	
Site No.	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
29SJ 423	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29SJ 1659	-	-	-	-	-	-	-	-	-	-	-	-	1	33.3	-	-	-	-
29SJ 628	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29SJ 299	-	-	1	2.8	-	-	-	-	-	-	-	-	1	2.8	-	-	1	2.8
29SJ 724	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29SJ 1360	-	-	2	11.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29SJ 629	1	0.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29SJ 627	1	0.5	1	0.5	-	-	1	0.5	-	-	-	-	15	7.2	3	1.4	1	0.5
29SJ 389	-	-	15	4.3	-	-	1	0.3	1	0.3	1	0.3	1	0.3	-	-	7	2.0
29SJ 390	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	16.7
29SJ 391	-	-	3	18.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29SJ 827	-	-	5	7.7	-	-	-	-	-	-	-	-	-	-	-	-	1	1.5
29SJ 633	-	-	6	13.6	1	2.3	-	-	-	-	-	-	-	-	-	-	-	-
Totals	2		33		1		2		1		1		18		3		11	

Table 9.28. (continued)

	Other Artifact Type																
	Slab Cover		Notch		Crushed Active Abrader		Crushed Mano		Step		Building Stone		Firepit Liner		Unknown		
Site No.	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	Total
29SJ 423	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
29SJ 1659	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
29SJ 628	-	-	-	-	1	3.3	1	3.3	-	-	-	-	-	-	2	6.7	30
29SJ 299	-	-	-	-	-	-	1	2.8	-	-	-	-	-	-	1	2.8	36
29SJ 724	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22
29SJ 1360	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17
29SJ 629	-	-	-	-	-	-	-	-	1	0.9	-	-	-	-	3	2.7	113
29SJ 627	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	207
29SJ 389	3	0.9	1	0.3	2	0.6	-	-	-	-	1	0.3	1	0.3	-	-	354
29SJ 390	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
29SJ 391	-	-	-	-	-	-	-	-	-	-	3	18.8	-	-	-	-	16
29SJ 827	-	-	-	-	-	-	-	-	-	-	1	1.5	-	-	-	-	68
29SJ 633	-	-	-	-	-	-	-	-	-	-	Many	-	-	-	-	-	44
Totals	3		1		3		2		1		5+		1		6		921

Table 9.29. Disposition by site.

Site No.	Percentages						Number
	Worn-out	Killed	Construction	Not Obvious	Broken	Reused	
29SJ 629	1.8	-	11.5	5.3	56.6	24.9	113
29SJ 389	0.3	0.6	10.0	0.6	63.5	25.1	351
29SJ 390	-	33.3	-	-	50.0	16.7	6
29SJ 391	-	-	25.0	6.2	43.7	25.0	16
29SJ 827	-	-	9.2	9.2	67.7	13.8	65
29SJ 633	-	-	2.3	2.3	70.4	25.0	44

metates at sites 29SJ 629, 29SJ 389, and 29SJ 827 (sites with a large sample size—Table 9.29) were reused in construction, in walls, firepits, mealing bins, post shims, etc. Approximately 25 percent of the metate fragments from each of the six sites (large and small sample sizes—Table 9.29) had been reused as other tools (see discussion above for details).

Normally, only some of the pieces of the prehistorically broken metates were recovered. The exceptions were the two or three broken in half. Appendix B presents the results of the metate match study which was an effort to fit pieces of metates back together. In all but one case, the fragments locked together like the pieces of a puzzle. This was done to gain a better understanding of the number of individual metates at a site and to trace the divergent paths taken by the individual pieces following the metate's destruction. Approximately 10 percent of the total number of fragments from a site fit together. The reuse of the tools by both the site's inhabitants and those from other nearby sites rendered any attempt to determine a total number of metates as pointless; however, the detailed provenience recording system of the Chaco Project permitted tracing fragments through the site. As recorded in Appendix B, pieces of the same metate were recovered from a pithouse and a room, a kiva and a room, features within a room, and between rooms. Following all use and reuse of a metate, the pieces were entered into the archeological record.

Conclusions

As with any analytical undertaking, some propositions were clearly confirmed and others were less so; some of the recorded variables were less useful than others and several—such as encrustation or angle of the trough—were abandoned long before the analysis was complete. The assemblage was marked by a low number of whole metates and the lack of metates in their primary context. Metates were multifunctional tools, not only maize-grinding tools. Effort was put into their manufacture; random stones were not simply collected and used without modification. Manufacturing techniques included pecking, abrading, and flaking. The most readily available stone was not the most frequently used. When it could be observed, relatively few had been worn-out; their end came as a result of being broken for other uses. Most were broken prehistorically, with the pieces being recycled into other tools and architectural elements. Very few had kill holes.

The Chaco Project recovered neither metates in mealing bins nor intact bins. No Utah-type metates, no decorated metates, no extraordinarily large or miniature metates, and no graded series of stones with differing degrees of coarseness or any other material than sandstone were found.

It is clear that open-at-one-end trough metates were the grinding tool of overwhelming choice; trough metates open-at-both-ends and slab metates were statistically invisible. Many of the latter were recovered at the temporally latest sites or late reoccupations of earlier sites.

It is also clear that the argument of increasing surface grinding area, and the presumed associated increase in grinding efficiency, must be reconsidered. There was not, in all areas of the Southwest, a uniform lineal progression through time from basin to trough to slab metates; nor is there necessarily a continuous increase in grinding surface area from trough to slab forms. The sequence is a useful heuristic device but strict adherence masks regional variability and hinders consideration of the underlying causes of the changes in the basic metate's shape. Multiple causal variables were undoubtedly involved, including the number of individuals participating in the procuring and manufacturing processes, the number of persons being provided for, and the characteristics of the material being ground.

One of the propositions originally considered was that the change from trough to slab metates resulted from the introduction of different races of maize with differing characteristics, such as hardness of the kernels, the volume of material within each kernel, and perhaps, changes in the grinding process, such as soaking the kernels prior to grinding. Two very real problems prevented any definitive testing of the proposition. The first was the simple problem of the archeological record in Chaco Canyon. The continuous use, reuse, and changing use of the sites and portions of the sites precluded the recovery of relevant material in their primary contexts. In many cases, only portions of metates were recovered in secondary or even tertiary contexts. A related archeological issue was the general lack of preservation of maize and certainly a lack of sufficient quantities of maize from various temporal periods to make even inferential statements.

The second problem is that the entire issue of identifying different races of maize is under investigation. The conventional wisdom has not been substantiated. The requisite DNA testing is only now being developed but may require unburned or uncharred kernels; therefore, it may be applicable only in a limited set of circumstances.

It is also necessary to include environmental factors because they play a role in the development of kernel and cob size. Size is directly related to the volume of material produced per unit (cobs or kernels), and the volume required is related to the number of persons being fed. Until more accurate tests are devised and several relatively undisturbed sites are excavated, or the issue is examined on a pan-Southwestern basis, thereby increasing the sample sizes, the question of causality remains moot—at least for Chaco Canyon. Again, more than one cause was in effect, and the results from one Southwestern location may be less relevant for another.

The portion of the study which considered the metate as a multifunctional tool produced more encouraging results. In addition to its primary purpose as a grinding platform, the open-at-one-end trough metates provided simultaneous multiple surfaces for battering, bashing, cutting, grinding, and pecking. Metates from all sites and all time periods were so used. Presumably, much of this additional use was expedient behavior because no unique use-wear was detected. For example, anvil wear or paint grinding occurred on metates; at the same time, however, tools specifically classified as only anvils or paint palettes occurred at the same sites.

As the surrounding lateral and near-end shelves disappeared during the transition from trough to slab metate, this element of multifunctionality was also lost because the majority of secondary and tertiary use occurred on the shelves. Secondary use was curtailed on open-at-two-end trough metates, not only due to the loss of the near-end shelf, but also due to the generally narrow lateral shelves which accompany this form. The open-at-both-ends (and slab) metates were manufactured on smaller stones and the lateral shelves were only a few centimeters wide; whereas, lateral shelves varying between 10 and 20 cm wide were common on the open-at-one-end form at sites in Chaco Canyon.

Another use surface was lost when metates were permanently fixed in mealing bins and the bottom of the rock was no longer available. Contrary to conventional wisdom, trough metates were routinely used in mealing bins in all sites in Chaco Canyon; some were permanently fixed in place with adobe mortar and others were loose. One concomitant of permanently setting metates in place is that the stone can be smaller. Larger stones are needed for impermanently placed metates in order to absorb the force and motion resulting from the grinding. Smaller stones are easier for a single individual to handle, but if that smaller stone is used as a slab metate set permanently into a bin, the multifunctional aspect is generally lost, unless one wishes to damage the grinding surface.

At some time, the metates ceased to be used in their primary capacity of grinding. They were broken up and the pieces were often recycled into other tools and uses. As most were neither worn-out nor killed, there is no clear basis for making statements concerning their treatment. It would seem that the efforts which went into their procurement, transport, and manufacture would guarantee their use until they broke during resharpening or a hole was worn through the bottom of the trough. But such was not the case. Their generally tabular form, regular shape, and parallel lines apparently made them attractive targets for expediently breaking them and using the pieces in other capacities.

Concerning recycling as tools, fragments were found to have been reused as anvils, palettes, crushers, hammerstones, manos, active and passive abraders, drill bases, firedogs, and others. Fragments were also reused as architectural elements, including ashlars, in the main walls of rooms and kivas and later in walls used to subdivide a room, as a vent shaft collar and vent shaft ashlars, as post shims, components of mealing bins and wall niches, slab covers for pits, firepits, and as steps.

This recycling occurred within and between sites. The within site movement of the pieces was tracked by the metate matching study which fit pieces back together. Pieces recovered from within a single provenience, such as a room, were matched, as were pieces between a room and a later kiva set into it, and from different rooms across the site. The between site recycling is inferential and based on the large number of metate fragments used in the wall construction at a temporally late site whose occupants scrounged metates from other abandoned nearby sites.

Similar styles of metates were recovered from the small-house and greathouse sites. All metates were open-at-one-end but thin and thick; gray and tan forms with varying degrees of manufacturing effort were also ubiquitous. No single category of form or any other variable considered during the analysis was found exclusively at one site or at one category of site (e.g., at greathouses). The largest were recovered during other excavations at the greathouse sites of Pueblo Bonito and Una Vida. There were some differences in percentages in certain categories. For example, more thin metates with shelves wider than 10 cm and made from the hard gray sandstone were found at Pueblo Alto than at the small-house sites. This could be a result, however, of the closer proximity of Pueblo Alto to the source of the stone as it could be from any other factor.

As curation costs increase and space decreases, metates are a likely candidate for disposal in the field. The results of this study suggest that a wealth of information can be ascertained from such a basic item as a metate if they are analyzed as a multifunctional tool. Their change in morphology is an interesting problem requiring considered analysis. Several causes were at work. Whether or not they will be determined depends in large part on the extent to which analysts keep an open mind and pursue the answers.

Appendix 9A

Review of Published Literature

Chaco Canyon Sites

All available literature (published and unpublished reports, notes, and photographs) was reviewed in order to determine the numbers and kinds of metates recovered during prior excavations in Chaco Canyon. Observations were recorded on metates left at excavated sites and elsewhere in the canyon.

Shabik'eshchee Village Basketmaker III; 29SJ 1659 (Roberts 1929)

"The metates were all of the same general type and quite characteristic in form" (Roberts 1929:132). Fortunately, Roberts included a photograph and a brief discussion of metates in general; further, several of his observations are useful. One observation was that the stones were conveniently sized and shaped and could be used with little alteration. Except for the trough, they were unmodified; those illustrated bear witness. A number of them were worn-out and at least some were in the two trash mounds; however, he gave no actual numbers (nor did he indicate the total number of metates recovered). Reuse of metates (most of which were worn-out) consisted of incorporation into the slab linings of the excavated walls of the houses (House K and others); they were used in the construction of bins (House F-1) and one was perhaps a step in the antechamber of House F-1.

As was usual for this time period, most of the metates were portable and were set up on several small stones when needed. There was one interesting exception, however. In House A, a metate was located in an oval depression in the floor (he did not indicate whether or not it was set in adobe). He suggested that the small depression next to the metate held the mano. House B had a similar, but empty, pit. Houses D and X had metates set up for use in the bins in the southern portion of the houses; those in House X had their respective manos with them.

Half House Basketmaker III, Bc 244, Bc 273; 29SJ 1657 (Adams 1951)

This pithouse was exposed by Chaco Wash erosion and a portion of it was destroyed prior to excavation. It was dated between A.D. 700 and 740 (Adams 1951:289). The most prominent stone artifacts on the floor were three open-at-one-end trough metates, one of which was in its position of use (supported by three small piles of slabs). The other two were propped against the wall of the house. There were also three manos and a hammerstone. Also recovered from the floor fill (or near floor fill) were four hammerstones, two manos, a trough metate fragment, and a grinding stone (Adams 1951:281-282). Based on the overall measurements of the rocks (the only ones given), these metates were somewhat smaller than those found by Roberts at Shabik'eshchee Village.

The Three-C Site Early Pueblo II; Bc 243; 29SJ 625 (Vivian 1965)

This site consisted of nine rooms, two kivas, and a trash midden. There were seven rooms and the kivas for living and two rooms for storage (Vivian 1965:9, 16). A few minor artifacts were recovered, but the number in any one group was too small for comparative purposes (Vivian 1965:37). The metates were all shallow-trough, open-at-one-end, and made of sandstone. There were no mealing bins present and the metates were presumably entirely portable.

Leyit Kin Pueblo II-III; Bc 26, 29SJ 750 (Dutton 1938)

Student excavators during the 1934 season were instructed to disregard such stone material as manos, metates, and hammerstones, of which large quantities had already been excavated (Dutton 1938:16). In fairness to Dutton, it should be pointed out that she did keep track of the number of such items from each major provenience.

Manos and metates comprised a major portion of the stone material from this site, with hammerstones also being very numerous. Significantly, all of the metates but six (two of which were from the surface) came from those levels and chambers constituting the unit of the pueblo last occupied (Dutton 1938:66-67). The second unit of the pueblo (the first period of long-term occupation) had neither metates nor mealing bins, which led Dutton to infer that there were no "industrial pursuits of a communal nature at Łeyit Kin during this time." This does not, however, preclude reuse of metates by the final occupants (Third unit, Mesa Verde affiliation) and casual comments throughout the report indicate that metates were reused (e.g., outside of Room 1, a final occupation room, a metate was incorporated into the construction of a slab-lined firepit).

It is very difficult to determine if the final occupation had mealing bins—Dutton's descriptions are nebulous. There may have been three: two in Room 2 and one in Room 4; however, none are in a "normal" position with respect to a wall for bracing one's feet. No slab metates were found in either of these two rooms. Of the five slab metates from this site, three were from Kiva B (as were a number of other categories of ground stone); unfortunately, there is no hint of their context.

Dutton (1938:35) indicates that one slab metate had cornmeal on it. Judd (1954) thought that the cornmeal on metates reported by Pepper (1920) was actually ground white clay for plastering. As Dutton left this metate in the field, one can but wonder. White ground material was also reported at "Anna Shepard's Dig."

There were 44 trough metates, five slab metates, and one metate was unclassifiable. There was a total of 162 manos and 67 hammerstones.

<u>Tseh So</u> Pueblo I-III; Bc 50; 29SJ 394 (Brand et al. 1937)

There were 84 fragments and whole metates recovered from both the Pueblo I and Pueblo II levels. These were a single type, the open-end trough or scoop metate, which is usual for these horizons. Those from the Pueblo I and Pueblo II period did not differ radically, although metates from the substructure were usually constructed from larger slabs than those of Pueblo II. Several had red paint, presumably ochre, ground in their troughs, and one had gypsum ground on it. There were twice as many manos as metates (Brand et al. 1937:90-91).

Two manos and a trough metate were recovered during the 1939 excavation (Senter 1939:4, 8). Archival material lists a trough metate fragment from the west end of the refuse mound (Chaco Archive 018B) and three uncatalogued metates, possibly from the 1937 season (Chaco Archive 195A).

The 1949 stabilization report for Bc 50 indicates that in Room 19 portions of four well-preserved mealing bins were exposed in the southeast corner. No further information was given.

<u>Bc 50-51</u> Pueblo I-III; 29SJ 394 and 29SJ 395 (Kluckhohn and Reiter 1939)

Woodbury (in Kluckhohn and Reiter 1939:58-79) analyzed the ground stone artifacts (other than arrow-shaft smoothers) from Bc 51 and noted that 22 metates were recovered. There were none found in either bins or permanent positions; apparently they were all portable. When comparing Bc 50 and Łeyit Kin, there were relatively few metates at this site. There was no evidence of any use other than grinding of corn, except for the miniature (because it was too small to economically grind corn). The stones were only roughly shaped, and in some cases they were almost unworked (Kluckhohn and Reiter 1939:58-59).

There were 19 trough metates: 14 were open-at-one-end; five were open-at-both-ends. There were three basin metates and one slab metate. (NOTE: This totals 23 metates.)

Ninety-eight manos were recovered; this was four and one half times the number of metates (<u>not</u> seven times, as Woodbury says [Kluckhohn and Reiter 1939:59]).

Archival material (Chaco Archive 195A) lists an uncatalogued metate from this site.

The 1950 stabilization report (Vivian 1950) indicates that there were five slab-lined mealing bins in Room 47.

<u>Bc 53</u> Ignorance Hollow; Judd's Pithouse 1; 29SJ 396 (Field notes from the Summer Session 1940; Field Catalog for Bc 53; Chaco Archive 262B)

Ten rooms and several kivas were excavated. Combining the information from the above three sources resulted in the following tabulation (information was by room and level number; all metates were from the fill of rooms):

Metates:	3 whole; 10 fragments.
Manos:	21 whole; 12 fragments.
Hammerstones:	6

There is no way to assess the completeness of this list.

Bc 54 29SJ 1922 (Bullen 1941)

Four rooms and three kivas were excavated; several rooms were outlined. Other rooms were present but not outlined. Twenty-five hammerstones, 14 manos, and eight trough metates were found. Most (all?) of the metates were from the fill of Room 2 and Kiva A. There were two classes of metates—thin and thick, with the latter being thicker than 2.5 in. and two of the former were 1 and 1.5 in. thick. One metate fragment had a rectangular box one-eighth in. deep pecked into the "upper surface" (near-end?), and the surface of the box was "reddened with powder" (Bullen 1941:28).

Bc 56 29SJ 753 (Excavated in 1941 by the University of New Mexico Field School; Chaco Archive 254A)

Eight rooms and the portion of a kiva which had not eroded away were excavated. Two metates were noted. One, a trough metate open-at-one-end, was found (apparently in position of use) on the floor of Room 5 and the other, a slab metate, was found on the floor of Room 8.

There is no way to assess the completeness of this list.

Bc 58 29SJ 398 (Field catalog—excavated by the University of New Mexico Field School in 1947)

Twelve rooms, two kivas, and a refuse area were investigated. The following were noted (all from Rooms 3, 4, 7, 9, 10, and 14, except for a mano and a mano fragment from Kiva A). Location within rooms was not clearly specified.

Metates:	2 whole, 1 fragment, 1 miniature
Manos:	5 whole, 8-10 fragments
Hammerstones:	8

There is no way to assess the completeness of this list.

Bc 59 Tom Mathews Dig; 29SJ 399 (Field Catalog from 1947 University of New Mexico Field School; Chaco Archive 2059)

Thirteen rooms and three kivas were excavated, representing approximately two-thirds of the site; one additional kiva was noted in the unexcavated portion. The trash midden was sampled. The following were noted as having been found in the fill of the rooms (Rooms 1, 3, 5, 6, 7, and 9):

Metates:	1 fragment (plus several more) and 3 "milling stones"
Manos:	9 fragments and 6 whole
Hammerstones:	4

There is no way to assess the completeness of this list. Four "stationary metate-basins" were in Room 7—a small irregular room considered to be a mealing room. The fact that they were said to be 10 in. from the wall is curious.

Bc 193 Lizard House; 29SJ 1912 (Maxon 1963)

This site consisted of 17 rooms and 3 kivas; it was constructed during two different periods with unrelated masonry and architectural patterns (Maxon 1963:1-3). The following were noted:

Metates:	1 fragment and 1 whole; both were trough open-at-both-ends. One was from the floor fill of Room 10 and the other from Room 12.
Manos:	15 whole or fragments.

There was a row of mealing bins in Room 10 that had been partially dismantled "probably at abandonment." Maxon thought that abandonment was leisurely because most of the goods and timbers were taken from the site prehistorically (Maxon 1963:30). There was no trash midden.

Bc 236 29SJ 589 (Bradley 1971)

This site consisted of 10 rooms, one kiva, and an underlying pithouse. This site is unusual for Chaco Canyon because it has 16 slab metates, and this is almost as many as has been reported from all of the other excavated Chaco Canyon sites. Bradley noted that the first construction period was relatively late in the Chaco sequence (ca. A.D. 1150) and that it was reoccupied in the early A.D. 1200s. Three of the trough metates came from the lower floors, whereas, all but one of the slab metates came from the upper floors or the room fill.

Metates:	4 trough and 16 slab (whole or fragments)
Manos:	36 whole or fragments
Hammerstones:	15

In Rooms 8-9, two slab metates were set into shallow depressions in the floor and plastered into place; another was in a similar floor depression across the room from these two. In Room 9 a slab metate was plastered in a bin which had sandstone slab sides on the south and east and a 3 in. high rim of clay on the north side. On this same floor was a small trough metate that had apparently been propped up on two stones. There were several miniature trough and slab metates as well (the latter are probably abraders).

Kin Kletso Pueblo III; Yellow House, 29SJ 393 (Chaco Archive Field Notes; Vivian and Mathews 1965)

Kin Kletso, a late greathouse site on the canyon floor that presumably had a special function within the Chacoan organization had portions of 32 metates, of which 24 were fragments of trough metates. There were seven probable fragments of slab metates and one whole slab metate. All of the trough metates were open-at-one-end and were essentially all from the tabular sandstone lenses found in the canyon. The thickest was only 8.75 cm, and the majority were approximately 6 cm thick; some had shelves up to 15 cm wide. There were 43 whole or fragmentary manos and 37 hammerstones.

There were no mealing bins; however, there were numerous trimmed sandstone slabs that could have come from roof or upper story bins. Vivian and Mathews (1965:92-93) note that 60 such slabs were recovered but that many were obviously from firepits. Seven trough metate fragments (29 percent of this type), 15 manos (35 percent), and 10 hammerstones (27 percent) were from several layers in Room 5. This room was filled with refuse. Room 44 had five of the seven probable slab metates (and five of the manos). The remainder of the metates were scattered in low numbers in nine other rooms.

Pueblo del Arroyo Pueblo III; 29SJ 1947 (Judd 1959)

This is a classic Bonito Phase greathouse on the floor of the canyon approximately one-quarter mile from Pueblo Bonito which was partially excavated (50-60 percent) between 1923 and 1926. Of the 44 metates and metate fragments recovered, one was recorded as being a slab metate. Eighteen were the thin, tabular sandstone, six were thicker sandstone, and the remainder were not discussed. Reuse of metates was incidentally noted and included: some were used as deflectors (Room 3 and Kiva B); one was used as an outside vent shaft cover for Room 3; several slightly used metates were utilized as door slabs in room 8B-I, and one was recovered from the fill of Kiva J. There was one that had been used as a metate on both the upper and lower surfaces; a similar metate was also recovered from Pueblo Bonito, as well as one each from 29SJ 423 and 29SJ 299. Also recovered were 143 whole and fragmentary manos and 125 hammerstones (plus an unknown number of unrecorded ones [Judd 1959:135-136]).

Judd (1959:136) took care to point out that at Pueblo Bonito only trough metates were recovered (by both Pepper and Judd) and that Woodbury (1954) and Bartlett (1933) misunderstood Pepper's terminology and incorrectly attributed the presence of slab metates to Pueblo Bonito. He thought that at both Pueblo Bonito and Pueblo del Arroyo, the thinner tabular trough metates belonged to the Pueblo II portion of the population, and the thicker ones belonged to the later inhabitants of these sites.

Judd's single slab metate was located in a bin in one of the last portions of the site to be occupied. It should be noted, however, that its mano was 2.5 cm smaller than the surface, and clearly visible in Plate 48 are rims (shelves) around the grinding surface. It looks like a trough metate to me. If the measurements for some of the troughs he gave are accurate, they were among the smallest trough metates to be recovered from Chaco Canyon.

Pueblo Bonito 29SJ 387 (Pepper 1920)

Pepper (1920:Table 3) listed 121 metates recovered by the Hyde Exploring Expedition's work in Pueblo Bonito; all were trough, open-at-one-end.

(NOTE: There are some errors in this table; for instance, there are 32 manos and no metates listed for Room 72, but the actual totals according to the text are 12 manos and 20 metates.) Completely unique to Chaco Canyon was one metate that had a scroll design pecked into the shelf surrounding the trough, which was covered with red paint. The trough was large, with an area of 1,222 cm (Pepper 1920:90). The metates from Room 17 were interesting for several reasons. Based on the photograph (Pepper 1920:78), it is obvious that they were quite large, were well-worn (or worn-out), and many of the troughs had undulations indicating the use of a new mano. There were multiple grinding troughs in a single rock, and worn-out metates were so placed as to "catch the material being ground" (Pepper 1920:85). Pepper said that the room was covered with white cornmeal; however, Judd (1954:137-138 footnote) disputes this and believes that the material was white sandstone that was being ground as a pigment. Given that Pepper indicates that the fill in this room was very shallow, I believe Judd's interpretation to be correct. Pepper found a concentration of white sandstone in Room 27 that was associated with a mortar and pestle and his workmen all agreed that this was where the ancients ground pigment for their dry paintings (i.e., sand paintings). Judd (1954) also thought that Room 17 and the next two or three to the south were for the preparation of clay used for pottery manufacture and other purposes. A pile of potter's clay and mullers lay at the south end of Room 212. In 1964, Judd simply noted that these metates were for pulverizing white sandstone for wall decoration (Judd 1964:175). A metate that had been used on both sides came from Room 10 (Pepper 1920:58; see also Pueblo del Arroyo).

An interesting situation was uncovered in Room 72 where they found a "mass of metates" (Pepper 1920:257). There were 20 metates, many of which were on edge, "as though they had been stored in this room. Some were finished and had been used. Others were in the course of construction, while some had merely been roughed into shape from sandstone slabs." There were 12 manos and four hammerstones. Apparently, this was the only such situation in Pueblo Bonito (and in the canyon) because Judd (1954) specifically noted that they did not find such a workshop. This is, however, very similar to the situation reported for the Salmon Ruin (see below); there, the existence of a specialized workshop was interpreted as evidence for supra-family organization within Chacoan society (Shelley 1980:114).

Metates were found in the roof-fall of upper story rooms (including Rooms 38 and 54). Reuse was indicated by metates being used for the sides of bins (e.g., Room 42); one was converted into a pestle for a mortar that was also found (Room 27); and in Room 84, a metate was used as the door sill for a north wall door. In two rooms (Room 20 and Room 38) Pepper indicated that manos with several degrees of coarseness were found. (From his general descriptions and the illustrations, some of these could have been abraders, but there is no way to clarify the situation.) There were several interesting differential distributions of manos and metates—for example, in Room 71 there were two metates and 20 manos; Room 45 had one metate and 10 manos; Room 68 had two metates and 39 manos, and Room 80 had 31 manos and five metates. Pepper (1920:Table 3) listed 605 manos recovered.

<u>Pueblo Bonito</u> (Judd 1954)

Of the 87 unbroken metates recovered, 53 were in rooms of the third and fourth type masonry, and 80 percent of these were the thicker variety (that is at least 3 in. thick). Many were discarded, but others had fallen from the second story. Twenty-five metates were recovered from six Old Bonitian rooms, four of which were used as dumps; of these, 15 were thick, three were tabular, and seven were unknown. None were in their original position of use. No slab metates were recovered.

Reuse of metates was noted in the slab linings of firepits and in the walls of storage bins; a perfectly good one was used as a door sill in Room 227; another was used to plug a hatchway to the room below; and a portion of one was used as a step for the east door of Old Bonitian Room 320. No metate with a scroll design or anything similar to that found by Pepper was located (Judd 1954:136).

Most of the stones from which metates were made were a size that one person could carry; however, in the fill of Room 251 they found five trough metates, each of which weighed at least 150 lbs. (68 kg)! Judd did not consider any of these to be as large as the two illustrated by Pepper (1920:84-85) as coming from Room 17. One metate I located from Una Vida, at the Mockingbird Canyon Dump in

Chaco Canyon, weighed 105 lbs. or 48 kg; an unprovenienced one, also at the Mockingbird Canyon Dump, weighed 100 lbs. or 45.5 kg.

From the rubble of rooms built above and over the eastern portion of Kiva Q, they recovered 23 metates and fragments of both the thin and the thick varieties; all were worn-out. The thicker ones frequently had secondary channels cut into their grinding troughs by rubbing stones.

Of the 436 manos recovered, 12 were taken to the U.S. National Museum; only two of the metates were taken to the National Museum. Most of the metates from Pueblo Bonito and Una Vida are currently in the Mockingbird Canyon Dump in Chaco Canyon, while others are scattered around the sites, the canyon, and the visitor's center.

Both Judd (1954:138-139, Plate 26) and Pepper (1920:59-60) each found one interesting metate-like artifact, and each investigator considered it to be for ceremonial purposes (e.g., grinding together cornmeal and bits of shell and turquoise). The two metate-like artifacts are remarkably similar to each other, and even their grinding surfaces are similar. Judd was certain that this was a local type because he found fragments of several others during the excavations (how many and where is not indicated). He noted that it was similar to the Utah-type metates that had a rectangular depression ground into the near-end, presumably to serve as a mano rest. It is difficult to analyze artifacts from a photograph; however, I do not believe that these are similar to Utah-type metates because the rectangular box appears to be ground into the far-end of the metate and not the near-end. The wear of the trough clearly comes up to the top of the stone at the end opposite the box; on any other metate, it does this only at the near-end. Therefore, the box, rather than being used as either a mano rest or to hold the material to the ground, is placed at the far-end to receive what was being ground. They are both undoubtedly correct in ascribing an essentally ceremonial function to this form of metate; however, it is nothing at all like a Utah-type metate.

The above-noted ceremonial metates clearly had a great deal of energy invested in their construction. For the normal metates, Judd (1954:135) noted that some were unshaped and others were extensively modified.

Chacoan Outliers

Aztec Ruin (Morris 1928)

This site was heavily reoccupied by Anasazi with Mesa Verde affiliations and there was little in situ Chacoan material; there was some Chacoan trash. The effect of this reoccupation was to obscure many aspects of the Chacoans and presumably, the majority of the metates and mealing bins that were recovered were representative of the latter reoccupation. Morris recognized three types of metates: one type was a thin, rectangular, and trough open-at-one-end metate made of a rather fine-grained greenish sandstone; the nearest outcrop of this material was several miles from the site. They generally had a near end of 3 to 4 in. (7.62 to 10.16 cm), and the stone was not worked except for blocking it out. The other two types were made on large river boulders and were distinguished by being either trough or slab metates (Morris 1928:29-30).

Morris excavated a number of small sites (villages) surrounding the greathouse; he called this aggregate of sites, "The Annex," and distinguished the individual sites by building numbers. These were apparently mostly (all?) Mesa Verde construction. There were three mealing bins with upright slab walls (several metates were used as the slabs for one of the bins) in one of the rooms of Building 2. Morris (1928:235) used the term, "grist basin," for the slab-lined receptacle (for the ground meal) that was dug into the floor at the far end of the metate. Two of the three metates were present and both were slabs. This prompted a footnote by Morris (1928:236) saying that, "I have never seen a trough metate enclosed in a bin." While generally the case in some Southwestern locations, this is not true in Chaco Canyon, as noted by Judd (1954) and the Chaco Project. Morris recovered 11 metates of all types from four of the seven or eight buildings of the Annex. There was one additional single mealing bin.

From the greathouse of Aztec Ruin, Morris recovered 100 whole and fragmentary metates of all types and noted the impressions of 13 more in the adobe of several mealing bins. Most metates were recovered from refuse layers of roof-fall. Some were in situ in mealing bins, including a single example with a grist trough dug into a second-story floor (Room 128). Others were in the roof/floor-fall of both second and third stories (e.g., Rooms 95, 103, 196, 152, 191). The third-story room above Room 136 was particularly interesting because of the variety and quantity of stone artifacts, along with some pottery and perishable material, which were stored (or "cached") in it. Included were 12 metates. The three mealing rooms recovered or identified were all second-story rooms, and perhaps the one in Room 121[2] was a Chacoan mealing room. Morris noted that several metates were used for grinding paint, one was used as a step, one to cover a pit, and a few were used in wall construction.

Salmon Ruin (Shelley 1980)

This site was similar to Aztec in that it was originally a Chacoan outlier that was intensively reoccupied by Mesa Verdeans (the Secondary Occupation). Fortunately, the excavation at Salmon was a recent undertaking and the problem of relating material culture to its makers was seriously addressed. Of the 133 whole and identifiable metates (out of a total of 156?), 100 were assigned to a distinct cultural period (Table 9A.1). Thirty-two trough metates and 10 slab metates belonged to the Chacoan occupation, whereas, during the Secondary and Secondary/Mixed occupations, there were 10 trough and 37 slab metates and 13 trough and 42 slab metates, respectively.

The Chacoans clearly favored trough metates and the Mesa Verdeans favored slab metates; this difference is attributed to the Chacoan's reliance on flint corn and the Secondary people's higher percentage of flour corn in their diet. Flour corn is easier to crush, therefore, easier to keep in the confines of the grinding surface; the walls of the trough metate no longer are necessary and their function is replaced by the confines of the mealing bin (Shelley 1980:107-114).

This indicates that at the Salmon site and in Chaco Canyon proper, the spread of slab metates was not the result of diffusion but rather was an association between differing cultural affiliations that had varying percentages of easier-to-grind corn in their diet.

There is a difference between the Chacoans of Salmon and the Chacoans of Chaco Canyon in the frequency of trough versus slab metates. At no site in the canyon, except for the late and presumably Mesa Verde affiliated sites, such as 29SJ 589, is the percentage of slab metates even 1 percent. If the degree of hardness of the corn being ground is a causal factor in the overall morphology of the metate, then the Chacoans of the canyon were clearly grinding hard corn—either flint corn or corn hardened from storage.

One Room (Room 84W) appeared to have been for the manufacture and maintenance of metates. Seventeen were found, including a "blank," which had a trough in the initial stages of being formed and one which was broken transversely during the process of sharpening the trough. In addition to the metates, 43 hammerstones (20 percent of the total) were recovered from this room (Shelley 1980:113-114). This collection of artifacts and metates in various stages of manufacture is similar to the situation in Room 72 at Pueblo Bonito, where Pepper excavated and found 20 metates ranging from those being initially manufactured to used ones.

Table 9A.1. Metates from Salmon Ruin.[a]

		Percentages			
Period	Dates (A.D)	Trough	Slab	Unknown	Total
Undifferentiated	1088-1263	32	62	5	N=133
"Primary"	1088-1116	75	22	3	N= 43
Intermediate	???	22	78	-	N= 9
Secondary	1185-1263	21	77	2	N= 48
Secondary and Mixed	???	23	75	2	N= 56

[a] Data taken from Shelley (1980).

Escalante Site Nemetz (1977)

This site is considered to be a Chacoan outlier with a number of architectural traits similar to "the McElmo Phase" structures in Chaco Canyon. Seven rooms and a kiva were excavated; of the 18 metates recovered, 12 were complete. Two were basin metate fragments incorporated into walls, and one trough metate fragment was recovered. The remaining 14 were slab metates (Nemetz 1977:196-199). In her conclusions, Nemetz considers the relationship between Escalante and the Chacoan site of Kin Kletso (supposedly McElmo Phase) and emphasizes architecture, ceramics, and metates. With respect to the metates, she concludes that the two sites indicate differences that would not be expected if they belonged to a single phase (Kin Kletso had trough metates); however, if one considers the functional aspect of metates in relation to the corn being ground, we would expect the softer flour corn to have predominated at Escalante. Unfortunately, there was only one cob recovered; as expected it was an eight-rowed cob. Her emphasis on trait similarity between ecologically differing areas is unwarranted and her questioning of the possible affiliation between the two sites is an example of the problems that can result from the trait approach to archeology; the emphasis of the argument should be on adaptation and process, not on shared mental templates.

Dominguez and Escalante Ruins (Reed et al. 1979)

The Dominguez Ruin is a Mesa Verde site that is located 150 m from the Chacoan outlier of Escalante. It is a small village site that was contemporary with Escalante, but was unusual because one or two high-status burials were found in several of the rooms. The excavator of the site (Reed) believed that they were associated with Escalante rather than Dominguez. The site consisted of four rooms and a small kiva, in which four slab metates were recovered. They had been generally shaped by unifacial spalling and pecking (Reed 1979:76-77).

Guadalupe Ruin (Pippin 1979)

Unlike Salmon, Aztec, and Escalante, which were outliers to the north of the canyon, Guadalupe was an outlier to the south; like the others, it was intensively reoccupied by Mesa Verde affiliated Anasazi. The total number of metates recovered is unknown; however, the pattern is similar to that of Salmon, in that trough metates were associated with the Chacoan occupation. Pippin gave a breakdown of the whole metates: eight slab, two open-ended trough, two miniature trough, and one basin. (NOTE: The one open-ended trough metate illustrated [Pippin 1979:Figure 28d] is clearly not open at both ends but is open-at-one-end with a near-end of at least 3 cm.) Of the classifiable fragments, 76 percent were trough and 14 percent were slab. Pippin attributed the preponderance of trough metates to their occurrence in post-occupational fill, trash, and roof strata because they were reused in wall construction by the secondary occupants. The distribution of the whole metates indicated that they were used on roofs, and two were found on or directly above floors. A pollen sample from inside of a slab-lined mealing bin was composed of 80 percent Chenopodiineae, with Roseae and Zea comprising the remainder. A secondary mealing bin had both Roseae and Zea pollen, while a sample from a secondary slab metate had 39 percent grass pollen. A sample from a mano had an equally high percentage of grass and 45 percent Zea (Pippin 1979:185-191, 264-265).

Village of the Great Kivas (Roberts 1932)

No mealing bins were found in any of the rooms in the original roomblock; the appearance of mealing bins was definitely associated with the appearance of slab metates, and this was about the time that the population of the community was "augmented by an appreciable number of people" (Roberts 1932:33, 140). Trough metates of sandstone and basalt were associated exclusively with the original rooms and only slab metates, also of sandstone and basalt, were associated with the latter periods. Room 49 had a mealing bin for two metates, and Room 23 had a set for three metates, which were graded in degrees of coarseness. Both of these rooms were adjacent to rectangular rooms with kivalike features. Room 57 had a mealing bin for three metates and an empty adjacent fourth bin that may have been for storage; each compartment was formed by upright slabs (Roberts 1932:33, 37, 39, 44, 140). (NOTE: This is one of the very few references to a graded series of metates from the Chacoan area. It was associated with a later building phase but may have been contemporary with a great kiva. Roberts [1932] reported a series of manos graded from fine to coarse. He also noted that although metates were both basalt and sandstone, most were lava because there was an outcrop only a few miles from the site, whereas the sandstone had to be carried from a much greater distance.)

The Mesa Verde Area

Site 499 Early Pueblo III (A.D. 1100 to 1150) (Lister 1964)

This site included 12 ground floor rooms (there were possibly 15 to 18 overall), two kivas, and a tower. Two rooms each had two mealing bins; one of these (Room 12) was too small for habitation and perhaps functioned only as a mealing area (Lister 1964:20, 45). Of the 17 whole or fragmentary metates recovered, 15 were slab metates and the other two were trough metates or fragments. All were recovered from room or kiva fill, except one of the trough metates which was on the surface. Seven were from the lower floor of Room 10 and four were from Kiva B. None were recovered from the trash midden.

Big Juniper House Pueblo II-Pueblo III (Swannack 1969)

Twenty rooms, or areas numbered as rooms, and three kivas were completely excavated. Eleven additional rooms or areas were outlined; the South Trash Mound was almost completely excavated and the shallow East Trash Mound was only trenched. Swannack noted three types of metates: 1) trough—open-at-both-ends, 2) slab, and 3) slab/trough, which was being described for the first time. Unfortunately, Swannack is another of the investigators who labels metates with a very narrow near-end (several centimeters or less) "open-at-two-ends," but this is not the case. Of the five supposed open-at-two-end metates he illustrated (Swannack 1969:109, Figure 97a-e), at least three (Figure 97c-e and perhaps Figure 97b) are closed-at-one-end with a narrow shelf. This leaves one or two true open-at-both-end metates in this figure. Swannack notes that this was the most common type and that there were five complete and 24 fragments; however, we do not know the actual distribution of the two metate types at this site because of the merging of two types into one. This is unfortunate because there appears to have been a morphological transition recorded in the archeological record of the site.

Most of this type were made of locally available fine-grain sandstone; one was coarse sandstone. Three had "localized concave grinding surfaces on the back" and may have served as "unspecialized milling stones." Shaping of the stone was rough—bifacial spalling followed by pecking—and the backs were frequently ground to remove irregularities. Swannack considered one to be unusually well finished (Figure 97a); however, by Chaco Canyon standards, this one would only be average.

Of the five slab metates recovered, three were whole. Two were volcanic breccia and the rest were sandstone. The edges were spalled or bifacially flaked and one was ground on the back. There were three whole metates and three fragments of the third type. Swannack (1969:115) notes that perhaps these were trough metates that had one of the lateral shelves knocked off and were then used as slab metates.

Room 11 was a workroom for grinding corn; it had several mealing bins that were missing their metates but did have supports for them. Of the 40 metates listed (Swannack 1969:Table 9), 38 were from test trenches, rooms, or kivas and only two were from the trash mound (Swannack 1969:110-115). Reuse was noted in the construction of several bins and in a room wall. Finally, a number of illustrated "unspecialized milling stones" (Swannack 1969:120-121) are abraders, and while they were used for grinding it probably was not for foodstuffs.

Long House Late Pueblo III (A.D. 1200 to 1290s) (Cattanach 1980)

This site consisted of approximately 150 rooms, 21 kivas, and a plaza area. There was also a Basketmaker III pithouse and indications of occupations during Pueblo I and Pueblo II. Of the 96 complete, fragmentary, or blank metates recovered, 90 were slab metates, and six were trough. The slab metates consisted of 87 used on one side and three with two grinding surfaces. Three of the remaining six were trough metates that had been remodeled into slab metates by removing the shelves and three were trough metates. Eight of the 82 complete or fragmentary metates that had been used were recovered from the trash mound slope, and of these 82, 77 (94 percent) were fine-grained sandstone, three were conglomerate, one was fossiliferous shale, and one was blocky micaceous basalt (Cattanach 1980:261-264). The mealing bins were often poorly preserved and few measurements could be taken. Four were in each of Rooms 9, 1, 21, and 52. Three were in Room 56, and Room 3 had from one to three. Metates were found in kivas and rooms other than these six, occasionally embedded in the floor, but no other bins were located.

<u>Badger House</u> Intermittent occupation during Pueblo II and Pueblo III (Hayes and Lancaster 1975)

The metate data is summarized for Badger House and its surrounding community; while specific data are provided for each individual provenience, it would not be productive to compile the detailed measurements for this overview. Therefore, the following comments and observations are offered. A total of 220 whole and fragmentary metates were recovered; 48 were nearly complete. There were only 13 whole or fragmentary slab metates and these were all from Badger House proper; however, given the context of these and the trough metates, Hayes felt that the conversion to slabs began in Late Pueblo II and was completed by Late Pueblo III. Unfortunately, Hayes (like Swannack 1969:17) considered trough metates with a narrow near-end shelf to be open-at-both-ends, but as noted, this is not accurate. The two illustrated are clearly closed-at-one-end (Hayes and Lancaster 1975:151, Figures 189 and 190). Hayes characterized nine trough metates as being open-at-both-ends; however, because of this mixing of the terminology, we are uncertain of the number. This is unfortunate because the archeological sequence of this site spanned the transition of types. The slab metate illustrated (Hayes and Lancaster 1975:152, Figure 191) is a good example of what the surface should look like. The surface illustrated (Hayes and Lancaster 1975:151, Figure 190b) is not that of a slab metate, as the caption indicates. This surface is the backside of a trough metate and was used as an abrader, probably during the metate use-life (i.e., this was a multifunctional tool and not a sequentially used single-function tool as indicated).

Energy investment in the preparation of the stone ranged from none to fully dressed by pecking and grinding on all surfaces. The amount of use varied from essentially unused (a trough depth of 0.1 cm) to worn-out. About one-tenth of the total number of metates with a wide near-end had a depression for the mano in it and resembled the typical Utah-type metate. There was a progressive reduction in the overall size of the stone, but the length of the grinding surface remained essentially the same, as did the average grinding surface area (744 cm^2 for the closed-at-one-end metates with a wide shelf, as compared to 733 cm^2 for the slabs) (Hayes and Lancaster 1975:152).

Details of the archeological context were given in the individual proveniences. Casual perusal indicates that they were reused in construction, to block a door, as manos, and other things. Several large metates were noted, including one which weighed 59 lbs. and one which weighed 98 lbs! Several were found on the floor in the position of use; two were propped up on small sandstone rocks, and two were plastered into the floor with adobe. One unusual aspect of the distribution of metates is that 24 (11 percent) were recovered from the trash mound at Badger House. This is the highest percentage of any of the sites reviewed for this report.

<u>Mug House</u> Pueblo III (Rohn 1971)

This multicomponent site consisted of 90 domestic rooms and eight kivas; 45 of the rooms were considered to be dwelling rooms, 40 were for storage, and two were designated as sleeping rooms. There was an especially tight cluster of tree-ring dates between A.D. 1063 and 1076, which probably represents construction and occupation of Component A. Components B and C dated between A.D. 1100 and 1260 (Rohn 1971:19, 24). Of the 105 whole and fragmentary metates recovered, 104 were slab metates which Rohn subdivided into two styles based on their thickness. Eighty were thin and 24 were blocklike; 85 percent of the thin metates were made of local Mesaverde sandstone, whereas 75 percent of the blocky ones were made of material that had to be imported. This material was coarser than the local sandstone. There were indications of 18 mealing bins, but none contained metates. A single fragment of a trough metate was found in previously disturbed fill. Six complete and one fragmentary metate blank were found (Rohn 1971:201-203). Forty-five of the dwelling rooms, 40 of the storage rooms, and two sleeping rooms contained metates.

In addition to 492 manos and 28 blanks, 411 whole hammerstones were found, including a concentration of 25 in the fill of Room 29/1—where six mealing bins were located. Twelve manos were also found in this room (Rohn 1971:203, 206, 211).

The Mogollon Region

Grasshopper Pueblo Pueblo IV

There exists no comprehensive treatment of this site or its artifacts; however, the majority of the metates recovered were slab metates (J. Jefferson Reid, personal communication 1981). Ciolik-Torrello's dissertation (1978:112) noted that there were 30 mealing bins, 86 slab metates, 20 other metates, 505 whole and fragmentary manos, 198 hammerstones, and 87 axes on 67 late abandoned floors.

Appendix 9B

Metate Matches

During the metate analysis an attempt was made to fit broken pieces together. This was undertaken for several reasons; they include acquiring complete measurements for at least one dimension, reducing the number of individual fragments in order to arrive at a more accurate estimate of the total number of metates from a given site or provenience, and adding to the overall assessment of provenience contemporanity. The latter is based on the assumption that the pieces resulting from a metate being broken up for reuse, in other contexts than grinding, would be reused at about the same time. Although this would not be the case in every situation, in the absence of tightly refined chronometric dating, it is better than nothing. In Chaco Canyon this reuse was usually construction—either new or remodeling of existing features or structures.

A match occurred when two or more separate fragments were fitted or joined back together. Although most pieces locked together tightly, if one of the pieces has been ground (either actively or passively) on the common edge, the fit was less than tight. In one case from Pueblo Alto, an intermediate piece was missing; however, there was no doubt of their common origin due to the similarities in all other variables, including the almost crystalline structure of that particular piece of sandstone. During the analysis, the pieces from a site were spread out and examined for similarities suggestive of a common origin. Such variables as color, shape, thickness, and style were particularly useful clues. Color could be deceiving as some pieces were black or red from reuse in firepits. Intrasite matches were not attempted, although the sites within Marcia's Rincon (29SJ 627, 29SJ 628, 29SJ 629, and 29SJ 633) offer an interesting cluster for such an undertaking. Pieces from a single metate were frequently recovered from different proveniences such as several features within a room, different rooms, or a room and a kiva. One metate from Pueblo Alto was broken in half and used in the construction of two rooms separated by approximately 50 meters.

As noted in the chapter introduction, several archeologists proposed using metates as barometers of social conditions—such as the degree of dependence on agriculture—especially if the survey being recorded was regional in scope. Implicit in this suggestion is the idea that each fragment represents an individual metate. This is not the case, as the results of the metate matching study indicate that from 10 to 18 percent of the fragments can be reunited. This decreases the total number represented. If someone is interested in the number at a site, it is more accurate to record the minimum number of individuals (e.g., the far right end or the near shelf) as is common in faunal analysis.

Table 9B.1 is a list of metates matched during this study. Several metate matches are illustrated in Figures 9B.1-9B.6.

Table 9B.1. (continued)

Site	Field Specimen No.	Provenience	Comments
	5345 5453	Kiva 15, Test Pit 4, Layer 6 Kiva 15, South Wall	Wall construction, base of wall
	1647 5683	Room 110, North Wall, Wall Niche 16 Room 110, Floor 1, Mealing Bin No. 3	Used to plug opening of niche Construction of kneeling area for Bin 3. (Note: do not physically connect but definitely from same metate)
	6329	Room 147, Floor 1, Firepit 1	6 fragments representing approx. 2/3 of a single metate used in firepit construction
	900-04	Plaza Feature 1, TT 1	2 pieces from right side and far end; bottom of stone continuously rounded and required plastering in bin or wedged with rocks for use.
	900-03	Plaza Feature 1, TT 1	3 pieces making up 2/3 of a metate
	874 882	Plaza Feature 1, Room 4, TT 1, Layer 2 Plaza Feature 1, Room 4, TT 3, Layer 2	Maximum thickness of stone is only 2.5 cm!
	917 921	Plaza Feature 1, Room 3, TP 3, Layer 2 Plaza Feature 1, Room 3, TP 4, Layer 4	After breaking up the metate, FS 921 used as a passive abrader. Both pieces were burned.
	922	Plaza Feature 1, Room 3, TP 5, Layer 2	2 pieces
	949 950	Plaza Feature 1, Room 3, Grid 20, Layer 3 Plaza Feature 1, Room 3, Grid 20, Layer 4	2 pieces
	921 972	Plaza Feature 1, Room 3, TP 4, Layer 3 Plaza Feature 1, Room 3, Floor 1, Fl. Artifact 5	Following metate breaking, FS 921 used as a passive abrader; then broken into 2 pieces. FS 972 not used following metate breaking.
	463-03	Other Structure 7 - North of Room 209	Wall clearing. After metate broken up, trough pecked w/hammerstone, flaked along entire length, used as paint palette for hematite.
	566	South of Kiva 8	Wall clearing. FS463-03 & 566 in construction of 2 separate kiva/room blocks approx. 18 m apart.
	433-08	Other Structure 6	2 pieces from wall clearing
	433-09	Other Structure 6	2 pieces from wall clearing
	433-01 434	Other Structure 6 Other Structure 6	2 pieces from wall clearing 1 piece from wall clearing Metate weighed over 150 pounds!; worn-out or killed; trough used as a passive abrader.
	4001	Plaza Wall 1 (east of Kiva 10)	2 pieces from wall clearing
	4165	Plaza Grid 35	2 pieces from west 1/4 of PG 35, Layer 2
	5076 6766	Plaza Grid 117, TT 3, Layer 1, Level 2 Room 143, TT 6, Layer 1	Debris from wall-fall, Room 3, Plaza Feature 1. Wall-fall. FS 5076 & 6766 room construction approx. 50 m apart
	4291	Plaza 1	2 pieces from wall clearing, north of Rooms 198 and 200; Layer 2
	120	Circular Structure 1	2 pieces from wall clearing
29SJ 390	022	Wall clearing	Wall-fall
29SJ 827	Unknown	Unknown	Site excavated by Voll in 1960s? Of the 97 metate fragments left at the site, 12 were matched into 6 pairs representing from 10% to 100% of a complete metate.

Table 9B.1. (continued)

Site	Field Specimen No.	Provenience	Comments
	5345 5453	Kiva 15, Test Pit 4, Layer 6 Kiva 15, South Wall	Wall construction, base of wall
	1647 5683	Room 110, North Wall, Wall Niche 16 Room 110, Floor 1, Mealing Bin No. 3	Used to plug opening of niche Construction of kneeling area for Bin 3. (Note: do not physically connect but definitely from same metate)
	6329	Room 147, Floor 1, Firepit 1	6 fragments representing approx. 2/3 of a single metate used in firepit construction
	900-04	Plaza Feature 1, TT 1	2 pieces from right side and far end; bottom of stone continuously rounded and required plastering in bin or wedged with rocks for use.
	900-03	Plaza Feature 1, TT 1	3 pieces making up 2/3 of a metate
	874 882	Plaza Feature 1, Room 4, TT 1, Layer 2 Plaza Feature 1, Room 4, TT 3, Layer 2	Maximum thickness of stone is only 2.5 cm!
	917 921	Plaza Feature 1, Room 3, TP 3, Layer 2 Plaza Feature 1, Room 3, TP 4, Layer 4	After breaking up the metate, FS 921 used as a passive abrader. Both pieces were burned.
	922	Plaza Feature 1, Room 3, TP 5, Layer 2	2 pieces
	949 950	Plaza Feature 1, Room 3, Grid 20, Layer 3 Plaza Feature 1, Room 3, Grid 20, Layer 4	2 pieces
	921 972	Plaza Feature 1, Room 3, TP 4, Layer 3 Plaza Feature 1, Room 3, Floor 1, Fl. Artifact 5	Following metate breaking, FS 921 used as a passive abrader; then broken into 2 pieces. FS 972 not used following metate breaking.
	463-03	Other Structure 7 - North of Room 209	Wall clearing. After metate broken up, trough pecked w/hammerstone, flaked along entire length, used as paint palette for hematite.
	566	South of Kiva 8	Wall clearing. FS463-03 & 566 in construction of 2 separate kiva/room blocks approx. 18 m apart.
	433-08	Other Structure 6	2 pieces from wall clearing
	433-09	Other Structure 6	2 pieces from wall clearing
	433-01 434	Other Structure 6 Other Structure 6	2 pieces from wall clearing 1 piece from wall clearing Metate weighed over 150 pounds!; worn-out or killed; trough used as a passive abrader.
	4001	Plaza Wall 1 (east of Kiva 10)	2 pieces from wall clearing
	4165	Plaza Grid 35	2 pieces from west 1/4 of PG 35, Layer 2
	5076 6766	Plaza Grid 117, TT 3, Layer 1, Level 2 Room 143, TT 6, Layer 1	Debris from wall-fall, Room 3, Plaza Feature 1. Wall-fall. FS 5076 & 6766 room construction approx. 50 m apart
	4291	Plaza 1	2 pieces from wall clearing, north of Rooms 198 and 200; Layer 2
	120	Circular Structure 1	2 pieces from wall clearing
29SJ 390	022	Wall clearing	Wall-fall
29SJ 827	Unknown	Unknown	Site excavated by Voll in 1960s? Of the 97 metate fragments left at the site, 12 were matched into 6 pairs representing from 10% to 100% of a complete metate.

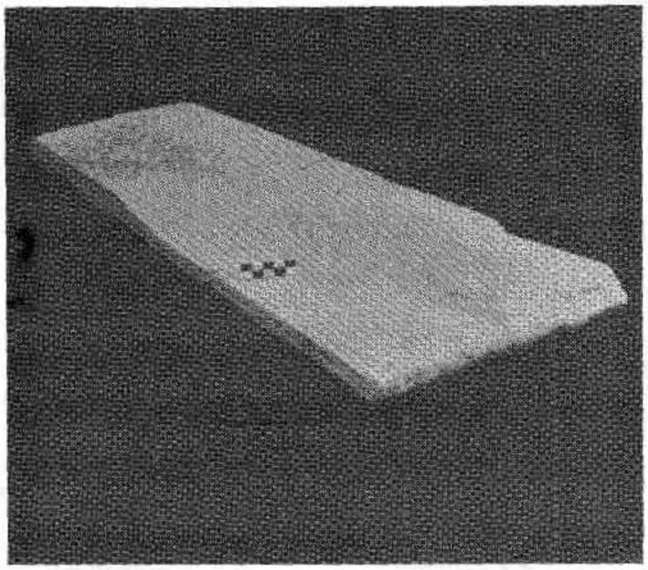


Figure 9B.1. *Three metate fragments (FS 1158-2, 1158-5, and 1138-4) from Room 103 at Pueblo Alto (29SJ 389). (5 cm scale) (NPS Chaco Archive Negative No. 14036.)*

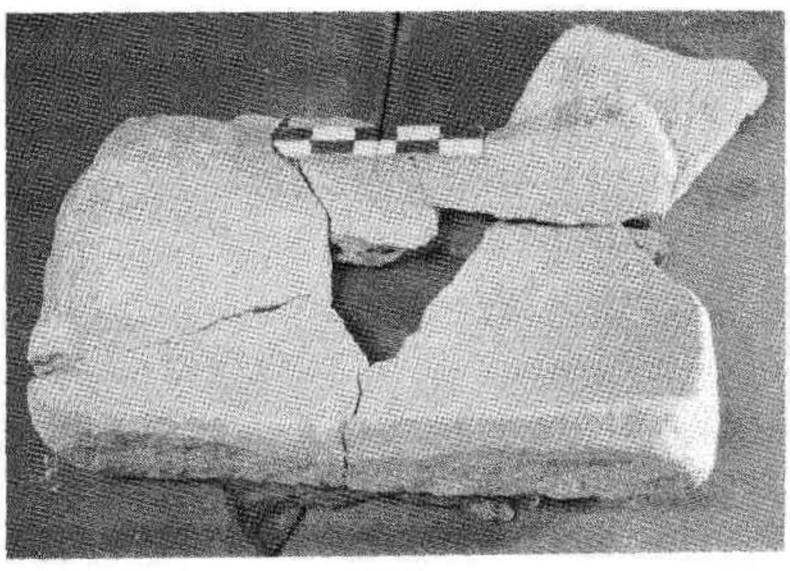


Figure 9B.2. *Reconstructed metate (FS 1624, FS 5460, FS 5455, FS 5456, and FS 1624) from Room 110 and Kiva 15 at Pueblo Alto (29SJ 389). (15 cm scale) (NPS Chaco Archive Negative No. 23635.)*

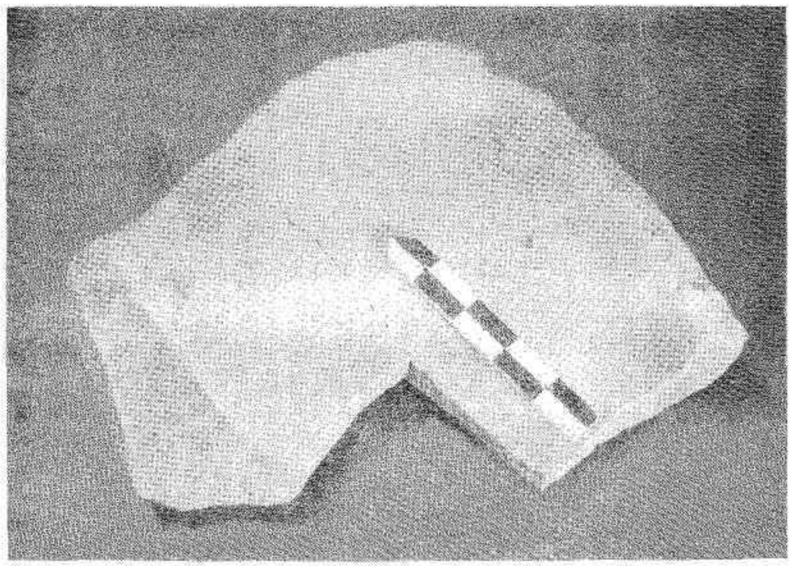


Figure 9B.3. *Two metate fragments recovered from the south wall construction and fill of Kiva 15 at Pueblo Alto (29SJ 389). FS 5345 on left; FS 5453 on right. (15 cm scale) (NPS Chaco Archive Negative No. 23634.)*

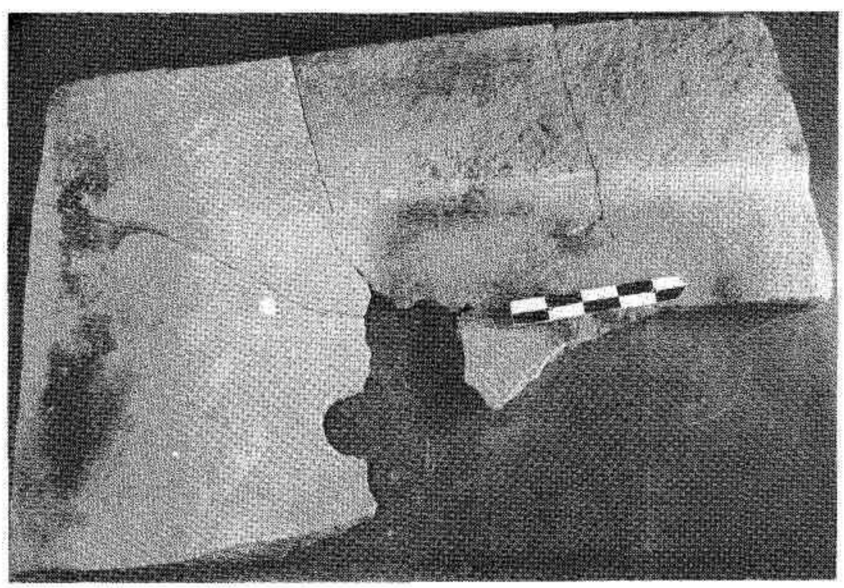


Figure 9B.4. *Six metate fragments (FS 6329) recovered from Firepit 1, Floor 1, Room 147 at Pueblo Alto (29SJ 389). (15 cm scale) (NPS Chaco Archive Negative No. 23616.)*

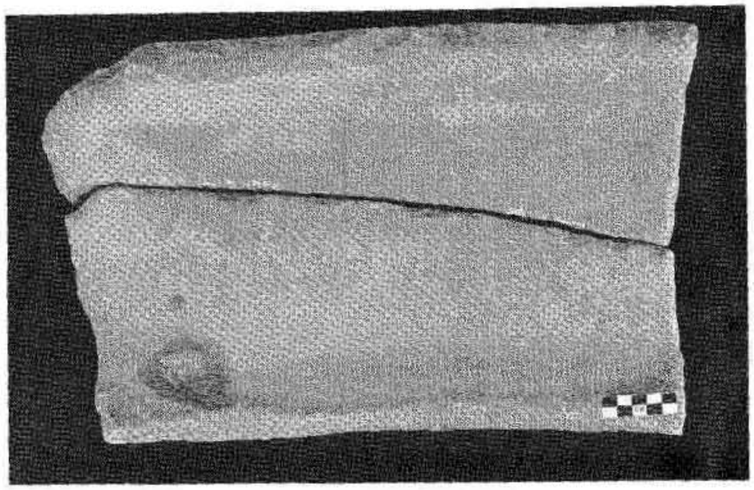


Figure 9B.5. *Two metate fragments from wall clearing south of Kiva 8 at Pueblo Alto (29SJ 289). FS 463-03 and FS 566 were found in construction material from two separate kiva/roomblocks located 18 m apart. (5 cm scale) (NPS Chaco Archive Negative No. 14071.)*

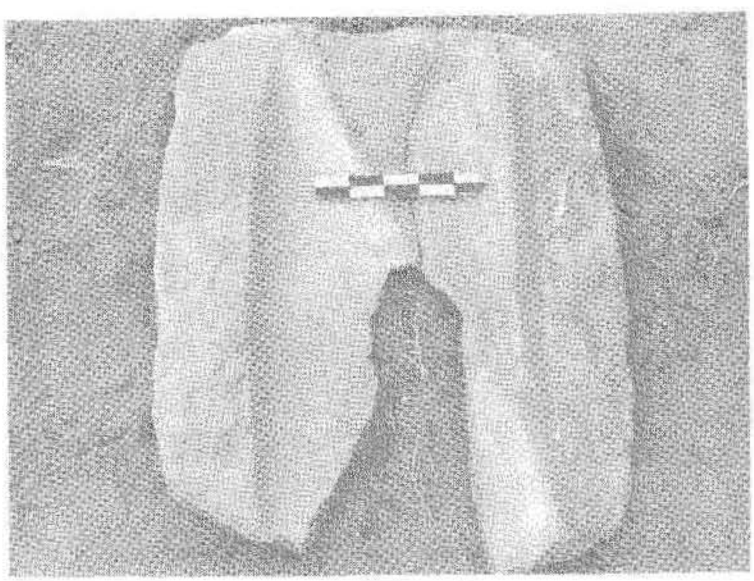


Figure 9B.6. *Two metate fragments (FS 4291) from Plaza 1, wall clearing at Pueblo Alto (29SJ 389) north of Rooms 200 and 198, Layer 2. (15 cm scale) (NPS Chaco Archive Negative No. 17957.)*

Appendix 9C

Intermediate Metate Analysis Form (LJH)

Variable No.	Category Description	Column Number(s)
01-08	Provenience Coding (same as inventory)	1-18
09	Weight	19-24
	Dimensions	
10	Length	25-26
11	Width	27-28
12	Thickness	29-30
13	Burning	31
	0 - None	
	1 - Partially	
	2 - Utilized surface	
14	Encrustation	32
	0 - Insignificant	
	1 - Complete	
	2 - Utilized Surface	
15	Hardness	33-34
	01 - Soft sandstone	
	02 - Medium sandstone	
	03 - Hard sandstone	
	For other materials, see coding conventions	
16	Color	35
	1 - Tan	
	2 - Gray	
	3 - Mixed	
17	Geological Structure	36
	1 - Tabular	
	2 - Tabular irregular	
	3 - Massive tabular	
	9 - Unknown	
18	Grain Size	37
	1 - Fine	
	2 - Medium	
	3 - Very fine	
19	Manufacture	38
	0 - Unmodified	
	1 - Modified	
	Dimensions of Utilized Surface	
20	Length	39-40
21	Width	41-42
22	Depth of trough	43-44
23	Thinnest part of trough	45-46
24	Near-end shelf width	47-48
25	Assessment of Amount of Use	49
	1 - Light (0 - 1/3)	
	2 - Medium (1/3 - 2/3)	
	3 - Heavy (greater than 2/3)	
	9 - Unknown	

Variable No.	Category Description	Column Number(s)
26	Grinding Surface Preparation 1 - Heavy pecking/light abrasion 2 - Moderate pecking/moderate abrasion 3 - Light pecking/heavy abrasion 9 - Unknown	50
27-28	Characteristics Associated with Grinding 0 - None 1 - Undulant trough walls (or bevelled) 2 - Battering/crushing 3 - Striations 4 - Lateral shelf 9 - Unknown	51-52
29	Longitudinal Cross-section 0 - Other 1 - Flat 2 - Open-end trough 3 - Double-sided 4 - Double open-end 9 - Unknown	53
30	Latitudinal Cross-section 1 - Trough 2 - Double-sided trough 3 - Stepped trough 9 - Unknown	54
31	Plan View 1 - Rectangular 2 - Angular-irregular 3 - Rounded-irregular 4 - Round	55
32	Major Type 0 - Other 1 - Trough one-end-open 2 - Trough two-ends-open 3 - Two-sided trough 4 - "Other trough" (for fragments) 9 - Unknown	56
33	Number of Major Secondary Utilized Surfaces (Contemporary with its use as a metate)	57
34	Location of Major Secondary Utilized Surfaces 1 - Trough 2 - Adjacent/contiguous 3 - Opposite	58
35	Characteristics of Major Secondary Utilization 1 - Ground/abraded 2 - Battered/hacked/pecking/chipping 3 - Gouged 4 - Pigment	59
36	Number of Other Utilized Areas (Contemporary with its use as a metate)	60

Variable No.	Category Description	Column Number(s)
37-38	Characteristics of Other Utilized Areas 0 - N/A 1 - Pigment 2 - Ground/abraded (passive) 3 - Gouged/pecked 4 - "Kill hole" 5 - Striations 6 - Battered/crushed 7 - Burned	61-62
39	Other Artifact Types 00 - N/A 01 - Palette 02 - Anvil 03 - Firedog 04 - Crusher/chopper 05 - Metate 06 - Hammerstone 07 - Abrader 08 - Mano 10 - Vent shaft collar 11 - Hearth slab/anvil	63-64
40	Condition 1 - Whole (usable) 2 - Complete (broken, unusable) 3 - Fragment	65
41	FS Number	73-78
42	Item Number	79-80

Appendix 9D

Final Metate Analysis Form

Variable No.	Category Description	Column Number(s)
01-08	<u>Provenience Coding</u> (same as inventory)	1-18
09	<u>Weight</u>	19-24
	<u>Dimensions</u>	
10	Length	25-26
11	Width	27-28
12	Thickness	29-30
13	<u>Burning</u> 0 - None 1 - Partially 2 - Utilized surface 3 - Completely	31
14	<u>Floor Wear</u> 0 - None 1 - Light on bottom 2 - Medium on bottom 3 - Heavy on bottom 4 - Light on edge 5 - Medium on edge 6 - Light on both 7 - Medium on both 8 - Heavy on both 9 - Unknown	32
15	<u>Hardness</u> 01 - Soft sandstone 02 - Medium sandstone 03 - Hard sandstone For other materials, see coding conventions	33-34
16	<u>Color</u> 1 - Tan 2 - Gray 3 - Mixed 4 - Other	35
17	<u>Geological Structure</u> 1 - Tabular 2 - Tabular irregular 3 - Massive regular 4 - Massive irregular 5 - Massive	36
18	<u>Grain Size</u> 1 - Fine 2 - Medium 3 - Very fine 4 - Medium fine	37

Variable No.	Category Description	Column Number(s)
19	Manufacture 0 - Unmodified 1 - Chipped/flaked 2 - Abraded 3 - Pecked 4 - 1 and 2 5 - 1 and 3 6 - 2 and 3 7 - 1, 2, and 3	38
	Dimensions of Utilized Surface	
20	Length	39-40
21	Width	41-42
22	Depth of trough	43-44
23	Thinnest part of trough	45-46
24	Near-end shelf width	47-48
25	Assessment of Amount of Use 1 - Light (0 - 1/3) 2 - Medium (1/3 - 2/3) 3 - Heavy (greater than 2/3) 4 - Pecked outline	49
26	Grinding Surface Preparation 1 - Heavy pecking/light abrasion 2 - Moderate pecking/moderate abrasion 3 - Light pecking/heavy abrasion 4 - No pecking/heavy abrasion	50
27-28	Characteristics Associated with Grinding 0 - None 1 - Undulant trough walls 2 - Battering/crushing 3 - Striations 4 - Lateral shelf 5 - Asymmetrical wear to left (at near-end) 6 - Asymmetrical wear to right (at near-end)	51-52
	Blank	53
29	Shape of Near-end of Trough 4 - 5 - 6 - Irregular	54
30	Plan View 1 - Rectangular 2 - Angular-irregular 3 - Rounded-irregular 4 - Round	55
31	Major Type 1 - Trough one-end-open 2 - Trough two-ends-open 3 - Two-sided trough 4 - "Other trough" (for fragments) 5 - Slab 6 - Basin 7 - Ceremonial beautiful 8 - Utah	56
32	Number of Major Secondary Utilized Surfaces (Contemporary with its use as a metate)	57

Variable No.	Category Description	Column Number(s)
33	Location of Major Secondary Utilized Surfaces 1 - Trough 2 - Adjacent/contiguous 3 - Opposite 4 - 1 and 2 5 - 1 and 3 6 - 2 and 3 7 - 1, 2, and 3	58
34	Characteristics of Major Secondary Utilization 1 - Ground/abraded 2 - Pecked 3 - Gouged/battered/hacked (passive) 4 - Pigment 5 - Incised groove 6 - Ground/gouged (anvil wear) 7 - Wide, deep, parallel grooves in trough 8 - Passive abrader 9 - Concentration of pecks on bottom	59
35	Number of Other Utilized Areas (Contemporary with its use as a metate)	60
36-37	Characteristics of Other Utilized Areas 1 - Pigment 2 - Ground/abraded (passive) 3 - Gouged/pecked 4 - 5 - Striations 6 - Battered/crushed 7 - Burned 8 -	61-62
38	Other Artifact Types (Subsequent to being a metate) 01 - Palette 02 - Anvil 03 - Firedog 04 - Crusher/chopper 05 - Metate 06 - Hammerstone 07 - Active abrader 08 - Mano 10 - Vent shaft collar 11 - Post shim 12 - Passive abrader 13 - Saw edge 14 - Drill base 15 - Passive abrader with undulations in trough 16 - Base for mealing bin 17 - Mealing bin construction 33 - Shaped slab cover 44 - Notch 55 - Step	63-64

Variable No.	Category Description	Column Number(s)
	88 - Building stone 27 - Bin wear on near-end 60 - Bin wear on far-end 61 - Bin wear on lateral edge 62 - Bin wear on center trough 63 - 60 and 61 64 - 60 and 62 65 - 61 and 62 66 - 60, 61, and 62 67 - 27, 60, 61, and 62	
39	<u>Condition</u> 1 - Whole and usable 2 - Analytically complete and unusable 3 - Fragment: No whole measurements possible 4 - Fragment: Length only 5 - Fragment: Width only 6 - Fragment: Thickness only 7 - Fragment: 4 and 5 8 - Fragment: 4 and 6 9 - Fragment: 5 and 6	65
	<u>Dimension of Non-utilized Surface</u>	
40	Left lateral shelf	66-67
41	Right lateral shelf	68-69
42	<u>Characteristics of Trough</u> 1 - Flat bottom 2 - Slightly concave (less than 1 cm) 3 - Very concave (greater than 1 cm)	70
43	<u>Amount of Work Invested in Artifact</u> 1 - None/unmodified 2 - Slight 3 - Moderate 4 - Extensive 5 - Superior	71
44	<u>Disposition</u> 0 - Killed and broken 1 - Worn-out (with hole in bottom) 2 - Killed 3 - Reused in construction 4 - Reused in construction with hole 5 - Reused in construction with kill hole 6 - No obvious reason 7 - Broken 8 - Has become another artifact	72
45	<u>FS Number</u>	73-77
	<u>Blank</u>	78
46	<u>Angle of the Trough</u>	79-80

Appendix 9E

Grinding Surface Area

The most frustrating aspect of the metate analysis was the general lack of complete metates from which to calculate grinding surface area. As discussed, increasing grinding surface area from basin to trough to slab metate is considered by many Southwestern archeologists to be a pan-Southwestern occurrence. This did not occur in Chaco Canyon; slab metates are absent.

The increase in grinding surface area from basin to trough is as much a function of changing adaptation from gathering seeds to dependence on maize agriculture, as it is from any other factor. Open-at-one-end trough metates occurred in such large numbers in Chaco that all other types disappear statistically. The lack of complete metates and the woefully inadequate sample sizes render any statistical comparison invalid; therefore, some observations will be offered based on the material available.

One additional fact complicated consideration of the grinding surface area. The first analyst measured the width of the trough at the top and I measured it at the bottom. I used the bottom width because I hoped to consider issues that perhaps were related to the cessation of use of a metate—if not obviously worn out. Very few were worn out, and most appeared to have many months of grinding remaining.

As the mano grinds into the metate, the mano's ends are worn away and the grinding surface area decreases. At some point as the grinding surface decreases, it may be that the cornmeal output declined sufficiently that it was more efficient to begin to use a new metate with a larger grinding area. This would account for the few metates that were worn out and looked to be perfectly adequate. The lack of metates in primary context and the lack of whole ones precludes a meaningful analysis toward that suggestion.

It is clear that new manos were used in Chaco metates. Table 9E.1 lists a sample of measurements

Table 9E.1. Undulations, depth in centimeters from top of metate.[a]

	Undulations		
Site and FS No.	First	Second	Third
29SJ 629			
FS 561	0-3	3-5	5-7
FS 726	0-2	2-6	-
FS 1104	0-3.3	3.3-6.4	-
FS 1883	0-2.5	2.5-5	-
FS 2007-1	0-4	4-? (broken)	-
FS 2007-2	0-4	4-8	-
FS 2830	0-3.5	3.5-7	7-9
FS 3286	0-7	7-9	-
FS 3574	0-3.5	3.5-7	-
29SJ 389			
FS 433-5	0-3	3-6	6-9
FS 433-7	0-1.5	1.5-2	-
FS 433-8	0-2	2-4	4-5.5
FS 433-9	0-5	5-6	6-8
FS 822-2	0-6	6-9	9-11
FS 822-3	0-3	3-5	-
FS 886	0-4	4-6	-
FS 900-1	0-2	2-4	-
FS 900-2	0-5	5-8	-
FS 904	0-6	6-13	-
FS 920	0-2	2-5	-
FS 1534	0-1.5	1.5-3.5	3.5-4.5
FS 4232-1	0-2	2-4.5	4.5-6
FS 5308-3	0-1	1-3	-

[a] Note: This is a sample. Not all undulant trough walls were measured.

Table 9E.2. Average area at top of metate in square centimeters.

	Trough—Open-at-one-end		Trough—Open-at-two-ends		Slab	
Site Name/No.	Area	Number	Area	Number	Area	Number
29SJ 423	697	3	-	-	-	-
29SJ 1659	813	4	-	-	-	-
29SJ 628	708	5	-	-	-	-
29SJ 299	848	18	-	-	-	-
29SJ 724	-	-	-	-	-	-
29SJ 1360	822	13	861	2	-	-
29SJ 629	940	5	920	1	777	1
29SJ 627	879	5	945	2	-	-
29SJ 389	1,024	44	813	2	-	-
29SJ 390	1,180	2	-	-	-	-
29SJ 391 (Una Vida)	1,145	11	-	-	-	-
29SJ 827	964	20	1,008	6	-	-
29SJ 633	966	1	-	-	540	2?
Pueblo Bonito	1,074	17	-	-	-	-
29SJ 395	-	-	-	-	1,200	1
Visitors Center	1,058	1	-	-	720	1
Casa Rinconada	1,200	1	-	-	-	-
Bc 59	934	3	-	-	-	-
Mockingbird Dump	-	-	1,033	5	-	-
29SJ 838	-	-	-	-	861	2
29SJ 753	-	-	-	-	918	1

Table 9E.3. Average open-at-one-end trough dimensions by site.

Site	Trough length (cm)	Trough width, top (cm)	Trough width, bottom (cm)	Difference, top-bottom (cm)
29SJ 423	36	19	-	-
29SJ 1659	36	19	-	-
29SJ 721	-	-	-	-
29SJ 628	36.5	19.5	-	-
29SJ 299	40	21.5	-	-
29SJ 724	-	16	-	-
29SJ 629	40.5	22.2	17.7	4.5
29SJ 1360	39.5	19	15	4
29SJ 627	39.5	19	-	-
29SJ 389	45.2	22.9	18.5	4.4
29SJ 390	-	29	25	4
29SJ 391	45	26.2	22.6	3.6
29SJ 827	42.7	23	19.1	3.9
29SJ 633	-	21.8	18.3	3.5
Pueblo Bonito	44	24.1	20	4.1
Bc 59	41.7	22.3	20	2.3

of undulations in the trough walls. These occur when a smaller, but less worn, mano is used. Up to three undulations were recorded.

In an attempt to increase the sample size of length and width measurements, I used averages that were based on complete measurements from each site. I also determined the average loss of trough width from the top to the bottom and examined those numbers, but in the end the results seemed too artificial. Given the long temporal use and reuse of the sites in Chaco Canyon and the general lack of metates recovered in primary context, it is not clear what a detailed reconstruction of grinding surface area would be measuring. Also, the different measurements obtained by different analysts (noted above) affects the average lengths and/or widths and reconstructed widths of either the top or the bottom.

Ignoring sample size, it is clear that the few open-at-two-ends trough metates and slab metates have much smaller grinding surface areas than do the hundreds of open-at-one-end trough metates (Table 9E.2). The former styles do not represent an increase in area or "efficiency" over the latter—as is alleged to be the case. It is clear, however, that the grinding surface area of the open-at-one-end trough metates was increasing through time in Chaco Canyon. The grinding surface area at the earlier sites averaged in the 700-900 cm^2 range, while the latter sites were in the 1000-1100 cm^2 range (Table 9E.2).

With the exception of the single large slab metate from 29SJ 395, all of the remaining slab metates in Table 9E.2 represent a loss of hundreds of square centimeters of grinding area. This is not efficient. The grinding surface areas of the open-at-two-ends trough metate are, with several exceptions, between the areas of the slab and open-at-one-end varieties (Table 9E.2). The two exceptions are the average of 1,008 cm^2 for six examples at 29SJ 827—a late site excavated in the 1958 and the unprovenienced ones from the Mockingbird Dump. The latter are probably from Pueblo Bonito, but there is no way to confirm the site of origin.

A spatial plot of grinding surface length-by-width produces several clusters among earlier sites. The late sites are not as closely grouped and are clearly larger in size. Group 1 includes 29SJ 423, 29SJ 1659, and 29SJ 628. Group 2 includes 29SJ 299, 29SJ 1360, 29SJ 629, and 29SJ 627. Bc 59, 29SJ 827, Pueblo Bonito, 29SJ 389, and 29SJ 391 are each progressively larger.

Table 9E.3 presents the average trough length, the average width at the top and the bottom, and the difference between the latter two measurements. Although the difference in top and bottom width measurements may not seem important, the effect is significant. If a trough were 45 cm long, then a trough width of 22 cm at the top produces a grinding area of 990 cm^2, whereas a bottom width of 18 cm results in an area of 810 cm^2. This is a loss of 18 percent of the grinding capacity. Unless researchers report whether the trough width was measured at the top or at the bottom, it will not be possible to compare grinding surface area from site to site.

Appendix 9F

Metate Fragments

The tables in this appendix consist of measurements and remarks concerning the small fragments from 29SJ 389 and 29SJ 633, and the infield recorded fragments at 29SJ 633. These fragments were too small and missing many of the variables recorded for the computer-based analysis; therefore, Table 9F.1 provides length, width, thickness, weight, and remarks, where pertinent, for metate fragments from 29SJ 389 (Pueblo Alto). These fragments were returned to the laboratory for analysis, but they are not part of the computerized data set.

Table 9F.2 provides measurements and remarks for 137 metate fragments representing small pieces to complete metates. These were not returned to the laboratory and are not part of the computerized database. Due to the limited testing and excavation undertaken at 29SJ 633 and concomitant lack of overall provenience control, leaving these fragments in place on the site's surface was deemed most prudent.

Tables 9F.3 and 9F.4 provide summaries of shelf-width and overall metate thickness for 29SJ 633. As can be seen, all categories of metates discussed in the detailed recording in this chapter are represented at 29SJ 633.

A total of 214 metate fragments (44 in the computerized data set, 33 reported in Table 9F.1, and 137 field analyzed—Table 9F.2) from 29SJ 633 are included in this chapter. Time and decreasing daylight did not permit a complete inventory of all metate fragments at the site; however, this is a representative cross-section.

Table 9F.1. Weights and measurements of metate fragments from 29SJ 389 (Pueblo Alto).

No.	FS No.	Major Provenience	Length	Width	Thickness	Weight (g)	Remarks
			Measurements in cm				
1	1280	Room 103	11	5	2	227	Floor 3, fill
2	1277	Room 103	9	12	2	312	Floor 3, contact
3	1312	Room 103	14	5.5	3	397	Floor 3, Posthole 2, construction
4	1293	Room 103	10	9	3	369	Floor 3, Mealing Bin 1
5	1294	Room 103	7	5	1.5	113	Floor 3, Mealing Bin 1
6	1296	Room 103	8	13	3	425	Floor 3, Mealing Bin 1
7	1293	Room 103	7.5	11	3	397	Floor 3, Mealing Bin 1, construction
8	1293	Room 103	9	10	2.5	284	Floor 3, Mealing Bin 1, construction
9	1293	Room 103	14	12	2.5	737	Floor 3, Mealing Bin 1, construction
10	1296	Room 103	5	8	2.5	510	Floor 3, Mealing Bin 1, construction
11	1297	Room 103	10	5	2	142	Floor 3, Mealing Bin 2
12	1297	Room 103	7	9.3	3	340	Floor 3, Mealing Bin 3
13	1300	Room 103	12	7	2	284	Floor 3, Mealing Bin 3
14	1302	Room 103	18	9	2.5	624	Floor 3, Mealing Bin 3, construction
1	5312	Room 109	14.5	9	2.3	567	Reused as chopper
1	5328	Kiva 15	13	12	4	737	Fill
2	5331	Kiva 15	13	13	3	794	Fill
3	5453	Kiva 15	15	15	2	680	South wall, construction
4	5453	Kiva 15	16	12	3	567	South wall, construction
5	5455	Kiva 15	13	10	3	539	North bench, construction, chopper
6	5456	Kiva 15	13	10	5	680	North wall, construction
1	1550	Room 110	10.5	7.5	3.5	454	Floor 2, fill
2	1686	Room 110	12	8.5	4	652	Wall Niche 5, construction
3	5405	Room 110	9	14	2	312	Floor 1, fill
4	5408	Room 110	9	14	1.5	255	Floor 1, fill
5	5688	Room 110	9	5	2	142	Other Pit 5, construction
1	7039	Room 112	15	19	6.5	2,608	Fill
2	7086	Room 112	15	12	2	454	Fill
3	7043	Room 112	12.5	16	4	1,049	Fill, palette
4	7029	Room 112	5	11	1.5	170	Fill

Table 9F.1. (continued)

No.	FS No.	Major Provenience	Length	Width	Thickness	Weight (g)	Remarks
			Measurements in cm				
5	7029	Room 112	9.5	13	2.5	539	Fill
1	2746	Room 142	11	6	6	652	Fill, chopper
1	6879	Room 143	9	8	3	340	Floor 1, Posthole 6, construction
1	6029	Room 146	11	18	2	595	Fill, palette
1	6251	Room 147	17.5	6.5	6.5	1,134	Fill
2	6329	Room 147	10	10	3	510	Floor 1, Firepit 1, construction
3	6329	Room 147	20	14	4	1,588	Floor 1, Firepit 1, construction
4	6329	Room 147	15	9	5	1,332	Floor 1, Firepit 1, construction
5	6331	Room 147	8	9	2	227	Fill
6	6342	Room 147	10	11	2.5	454	Fill, chopper
1	6305	Kiva 10	5.5	3	2	71	Fill
1	718	Plaza Feature 1, Room 4	8	4	1.5	85	Floor 3, contact
2	885	Plaza Feature 1, Room 4	10	5	2.5	227	Fill
3	891	Plaza Feature 1, Room 4	9	7	4	397	Fill
1	913	Plaza Feature 1, Room 3	19	16	4	1,531	Fill, half burned
2	914	Plaza Feature 1, Room 3	19	19	6	2,268	Fill, half burned
3	915	Plaza Feature 1, Room 3	10	11	6	907	Fill, half burned
4	917	Plaza Feature 1, Room 3	14	20	4	1,219	Fill, burned
5	917	Plaza Feature 1, Room 3	20	15	6	2,381	Fill, burned
6	917	Plaza Feature 1, Room 3	17	14	3	936	Fill, half burned
7	918	Plaza Feature 1, Room 3	8	4	5	284	Fill, burned
8	918	Plaza Feature 1, Room 3	17	13	9	2,325	Fill, burned

Table 9F.1. (continued)

No.	FS No.	Major Provenience	Measurements in cm: Length	Width	Thickness	Weight (g)	Remarks
9	920	Plaza Feature 1, Room 3	11	9.5	5	737	Fill, chopper
10	921	Plaza Feature 1, Room 3	8	5	5	170	Fill, burned
11	921	Plaza Feature 1, Room 3	9.5	8	2.5	369	Fill
12	923	Plaza Feature 1, Room 3	18	10	10	1,758	Fill, half burned
13	941	Plaza Feature 1, Room 3	11	8	5	737	Fill, half burned, anvil
14	841	Plaza Feature 1, Room 3	20	12	6	1,644	Ramp construction associated with fourth replastering, burned
15	818	Plaza Feature 1, Room 3	18	12	7	1,985	Floor 1, burned
16	985	Plaza Feature 1, Room 3	11	8	3.5	539	Fill, Firepit 1, burned
17	814	Plaza Feature 1, Room 3	16	13	4	1,049	Fill, Firepit 3, burned
1	79	Plaza 1, Kiva 14	4	7.5	2.5	113	Wall clearing, abrader
2	80	Plaza 1, Other Structure 6 (N)	10	7	2	227	Wall clearing
3	95	Plaza 1, Grid 96	11.5	7	2.5	482	Fill, anvil wear
4	291	Plaza 1, Rooms 198 and 200	22.5	15	4	1,502	Wall clearing, passive abrader
5	333	Plaza 1, Grid 75	6	10	4	397	Fill, active abrader
6	374	Plaza 1, Grid 35	11.5	15.5	3	765	Floor 4, active abrader
7	374	Plaza 1, Grid 35	11	12	7	1,134	Floor 4, hammerstone
8	283	Plaza 1, Other Structure 6 (W)	21	24	3	2,268	Wall clearing, passive abrader
9	283	Plaza 1, Other Structure 6 (W)	10.5	5.5	5	369	Wall clearing
10	283	Plaza 1, Other Structure 6 (W)	10	10.5	2	340	Wall clearing, wide deep striations, passive abrader
11	355	Plaza 1, Grid 30	10	16	6	1,899	Fill, burned
12	?	Plaza 1, Grid 116	13	8	9	709	Fill
1	502	Trash Mound	14	7	3	425	Level 1
2	542	Trash Mound	20	10	4	1,219	Level 3
3	577	Trash Mound	11	13	4	680	Level 18
4	597	Trash Mound	15	9	1	340	Level 10
5	626	Trash Mound	13	11	2	595	Fill

Table 9F.1. *(continued)*

No.	FS No.	Major Provenience	Measurements in cm Length	Width	Thickness	Weight (g)	Remarks
6	626	Trash Mound	16.5	15	3	936	Fill
7	1642	Trash Mound	8	9	3	425	Fill, active abrader, burned
8	1642	Trash Mound	12	11	4	737	Fill
9	1737	Trash Mound	12	7	3	340	Level 24-31
10	4824	Trash Mound	18	13	3	709	Level 82, wide deep striations
11	1825	Trash Mound	9	8	3	284	Level 81
1	339	Room 8	15	17	5	1,402	Surface, burned
2	377	Room 8	14	9	4	794	Fill
3	383	Room 8	8	8	4	340	Floor fill
1	14	Room 7	12	13	4	680	Surface, SE Quad
2	14	Room 7	13	10	2	454	Surface, SE Quad
3	158	Room 7	21	8	10	2,381	Fill, NE Quad, reused as chopper, partially burned
4	753	Room 7	20	7	13	2,268	Rock Concentration 1, SW Quad
5	255	Room 7	16	9	6	907	Fill, NE Quad
6	255	Room 7	10	9	2	227	Fill, NE Quad
7	98	Room 7	12	8	6	907	Fill, SW Quad
8	20	Room 7	12	9	2.5	284	Fill, SE Quad
9	20	Room 7	8	12	2.5	397	Fill, SE Quad
10	20	Room 7	15	10	3	510	Fill, SE Quad
11	20	Room 7	17	7	4.5	737	Fill, SE Quad
12	20	Room 7	10	15	9	1,134	Fill, SE Quad
13	857	Room 7	10	9	6.5	851	Subfloor 2, NE Quad, partially burned
14	810	Room 7	10	13	4	624	Floor fill (1), SW Quad, burned
15	663	Room 7	8.5	7	2.5	227	Floor fill (1), SW Quad, partially burned
16	856	Room 7	7	7	2.5	170	Subfloor (2), NE Quad
17	602	Room 7	10	8	3.5	340	Fill, NW Quad
18	141	Room 7	10.5	10	3	624	Fill, NE Quad, partially burned
19	21	Room 7	13	8	3	454	Fill, SE Quad, reused as chopper
20	225	Room 7	6	7	3	199	Fill, SE Quad
21	97	Room 7	12	13.5	4.5	1,247	Fill, SW Quad, reused as anvil
22	108	Room 7	8	8	2.5	170	Fill, NW Quad

Table 9F.1. (continued)

No.	FS No.	Major Provenience	Measurements in cm Length	Width	Thickness	Weight (g)	Remarks
23	64	Room 7	14	14	3.5	766	Fill, SW Quad
1	306	Plaza 1	14	10	6	822	Surface, Test Trench 1
2	310	Plaza 1	7	6	6	227	Surface, Test Trench 1
3	310	Plaza 1	15	13	5	907	Surface, Test Trench 1, partially burned
4	310	Plaza 1	26	22	3.5	2,608	Surface, Test Trench 1
5	315	Plaza 1	14	20	5	1,814	Surface, Test Trench 1, reused as anvil and passive abrader
6	336	Plaza 1	10.5	9	3	425	Surface, Test Trench 1
7	1132	Plaza 1	11	14	2	454	Fill, Test Trench 3

Table 9F.2. Metate fragments from the surface of 29SJ 633, in-field recording.

Number	Measurements in cm Length	Width	Thickness	Weight (g)	Remarks
1	44	21	9	6,800	One-half of trough metate. Trough is 43 cm long
2	19	23	9	3,175	
3	21	27	4	1,814	
4	18	15	8	1,361	
5	28	23	7	4,536	Intense anvil wear on near end, possibly contemporaneous with metate use
6	29	11	10	4,082	
7	19	18	7	3,175	Original metate had near end of 1 cm in width; reused as a metate (using same trough) but near-end shelf of 7 cm
8	22	9	9	1,814	
9	22	22	7	4,990	
10	23	22	10	5,443	
11	23	10	7	1,814	
12	53	28	6	14,061	One-half trough metate; trough is 45 cm long
13	24	21	5	3,629	Possible slab metate?/trough only?
14	46	28	10	9,072	One-half trough metate; trough is 43 cm long
15	54	25	13	12,247	Two-thirds trough metate; trough is 53 cm long
16	49	38	15	20,865	One-half trough metate; trough is 48 cm long
17	28	15	7	3,175	
18	23	13	7	1,814	
19	24	25	11	5,897	
20	25	21	14	6,350	Reused as anvil
21	12	10	4	454	Reused as mano
22	16	11	5	907	
23	21	14	13	3,175	
24	13	24	9	2,722	
25	13	16	6	1,134	
26	20	17	7	2,722	
27	16	23	9	2,722	Reused as anvil
28	9	14	5	454	
29	35	10	6	2,722	
30	32	19	11	7,711	Near end is 16 cm wide
31	14	7	9	907	
32	16	13	6	1,361	
33	20	15	5	2,268	Trough only 0.5 cm deep

Table F.2. (continued)

Number	Measurements in cm Length	Width	Thickness	Weight (g)	Remarks
34	23	18	6	3,629	
35	21	16	8	4,082	
36	22	23	10	4,082	
37	30	15	9	3,175	
38	30	22	6	4,990	
39	26	19	14	4,082	
40	30	27	12	7,711	One-half of trough metate (laterally)
41	25	18	7	3629	
42	18	12	7	2,268	
43	28	10	6	1,814	
44	16	17	5	1,361	
45	30	14	11	3,629	
46	48	23	7	6,350	One-half of trough metate
47	15	14	9	1,361	
48	19	15	5	1,361	
49	24	16	6	1,814	
50	19	20	8	2,722	
51	19	18	6	1,361	Burned
52	19	21	7	2,722	
53	23	21	6	3,629	Near end is 17 cm wide
54	41	24	9	9,072	
55	40	17	9	5,897	One-half of trough metate
56	27	18	10	5,443	
57	21	47	10	11,793	Trough is asymmetrical to right
58	20	16	5	907	Fragment is trough only
59	16	13	7	1,361	
60	18	9	10	1,814	
61	26	12	9	2,268	
62	28	21	11	6,350	Undulation in trough
63	15	19	10	2,722	
64	39	33	8	11,340	Two-thirds of trough metate
65	23	26	9	5,897	
66	12	11	6	454	
67	28	22	7	2,268	
68	27	10	10	2,268	

Table F.2. (continued)

	Measurements in cm				
Number	Length	Width	Thickness	Weight (g)	Remarks
69	24	17	9	4,536	
70	22	18	?	2,268	
71	12	10	6	454	
72	23	25	10	4,536	
73	21	12	12	4,082	Undulation in trough
74	25	20	7	3,175	
75	31	15	9	4,536	
76	23	12	6	3,175	
77	31	18	4	3,175	Trough only
78	26	14	8	4,082	
79	12	14	6	1,361	
80	52	14	13	12,247	Trough is 51 cm long
81	25	23	9	4,536	Slab?
82	28	18	10	5443	
83	10	8	?	227	Trough only
84	11	11	8	907	
85	6	14	4	340	
86	15	4	?	454	Trough only
87	23	17	9	2,722	Trough is asymmetrical to right
88	40	16	10	4,082	
89	19	14	7	1,812	
90	17	18	8	907	
91	17	11	7	907	
92	27	14	7	3,629	
93	26	18	7	3,175	
94	15	18	5	680	Burned
95	20	29	9	5,897	
96	23	15	4	1,814	
97	15	7	?	907	
98	26	15	8	2,722	Reused as passive abrader
99	31	16	10	3,629	
100	13	22	3	1,361	Lateral shelf is 19 cm wide
101	46	41	8	14,061	Two pieces match to form whole metate. Trough is 44 cm long
102	24	11	9	2,722	One undulation in trough
103	27	12	6	2,722	

Table F.2. (continued)

	Measurements in cm				
Number	Length	Width	Thickness	Weight (g)	Remarks
104	26	28	9	5,897	
105	17	12	13	3,175	
106	44	29	6	9,072	Near end is 24 cm wide!
107	20	12	3	907	Trough only
108	26	18	9	4,082	
109	28	17	9	5,443	Trough reused as passive abrader
110	25	15	8	3,629	
111	52	13	13	11,340	Trough is 51 cm long
112	11	10	8	680	
113	11	14	5	1,361	
114	14	6	4	181	Burned
115	9	8	5	91	Very fragmentary
116	17	4	7	454	Very fragmentary
117	19	5	6	907	Very fragmentary
118	29	17	10	4,536	
119	47	16	13	10,433	Two undulations in trough
120	18	22	6	2,722	
121	30	30	7	4,990	
122	23	9	11	3,175	One undulation in trough
123	46	14	9	6,350	Trough is 45 cm long
124	20	21	8	2,268	
125	20	12	4	1,134	
126	17	10	11	2,268	
127	22	12	5	1,361	One undulation in trough
128	23	12	6	2,268	
129	26	9	11	2,722	
130	15	11	8	1,814	
131	15	13	5	454	
132	19	21	9	4,536	
133	38	19	8	4,990	
134	47	12	14	13,154	Two undulations in trough
135	32	13	12	7,938	
136	26	32	10	9,525	Trough is 24 cm wide at top, 20 cm wide at bottom
137	23	22	5	4,536	

Table 9F.3. Width of lateral or near-end shelves of metates from 29SJ 633, in-field recording.

Less than 10 cm	10-15 cm	Greater than 15 cm
89 (all lateral)	23 (15 lateral)	5 (2 lateral)

Table 9F.4. Thickness of metates from 29SJ 633, in-field recording.

Less than 8 cm	Greater than 8 cm
69	58

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Chapter Ten

Ornaments of the Chaco Anasazi

Frances Joan Mathien

The analysis of ornaments and minerals from the NPS Chaco Project provides information that supplements other artifact analyses and assists in the interpretation of the "Chaco Phenomenon." This chapter will present the major conclusions reached after an examination of the literature from previous excavations at sites in Chaco Canyon, an analysis of ornaments and minerals from sites excavated during the Chaco Project, a review of available material from other excavated sites in Chaco Canyon and surrounding areas, and discussions with colleagues associated with the project.

Over 20 sites were excavated or tested during the Chaco Project. Numerous ornaments were recovered from these sites that range in time from Archaic through Pueblo III, as well as Navajo. Ornaments were made from a variety of materials, some of which were also present in sites as raw materials or partially worked artifacts. This chapter is not an all-inclusive report; readers who want details on ornaments and minerals from each site excavated by the Chaco Project are referred to the published site reports (Mathien 1987, 1988, 1991, 1992b, 1993) or to the combined draft overview (Mathien 1985). Additionally, two sites that were excavated by NPS, but were not a part of the Chaco Project, have been analyzed (Mathien 1990a, 1990b). The data from those two sites were not incorporated into this report; they do not change the conclusions reached herein.

Because a number of questions regarding the manufacture and use of ornaments cannot be answered unless a more comprehensive study of the available materials is undertaken, an examination of unworked or partially worked minerals was included. This additional material provides information on minerals that were not used as ornaments, except on rare occasions. Some of these, e.g., hematite, limonite, and selenite, were assigned a low priority during analysis; they were counted, but were not analyzed in great detail. Some of them occur naturally in nearby deposits; many were not listed for all sites as a result of cultural events or because they had not been systematically collected. Several questions relating to materials, the personnel and technology involved in jewelry-making, and ultimately, inferences about social organization, however, illustrate the reasons for including these unworked or partially worked minerals.

What minerals and other materials were locally available prehistorically for ornament manufacture?

Which of these available materials were used for ornaments?

What materials were imported from other areas, either as finished ornaments or as raw material for the production of jewelry?

Can jewelry workshop areas be documented for the Chaco Anasazi? Or, for other Anasazi groups?

What was the technology used for the manufacture of ornaments? What are the limits of this technology, based on the evidence available?

What inferences can be made regarding the possible values of these materials to the prehistoric population and social interaction among different groups?

To answer these questions, several different studies were outlined. Some information regarding these studies has been documented elsewhere: sources of turquoise (Mathien 1981, 1992a; Mathien and Olinger 1992); location of jewelry workshops in Chaco Canyon (Mathien 1984a); identification of materials used in small white discoidal beads (Mathien 1984b); possible local sources of argillite (Mathien 1994); and detailed studies on ornaments and minerals from Chaco Canyon sites (Mathien 1985). This report will summarize the methods used, present the results obtained, and address the questions listed above.

Methods

Several types of data were recorded for each ornament and mineral examined. All were listed by provenience (e.g., site number, general provenience unit and unit number, general level, floor indicator, layer-level and level characteristic, feature category and feature number, and feature level category); field specimen (FS) number or catalog number, as well as specimen number; material type; dating; artifact class and shape; evidence of manufacture or modification (e.g., evidence of perforations, striations, drilling, notching, grinding, polishing, beveling, carving); color and matrix, if present; condition of the artifact; and measurements in centimeters (length, width, thickness, and perforation size). For some of these categories, further explanation is needed.

Material Identification

To assess the materials found at numerous sites, lists of known ornaments and minerals from all previously excavated sites in Chaco Canyon were obtained from the field catalog sheets, as well as from published and unpublished reports.

Geological type specimens for those materials were collected by A. Helene Warren and David W. Love, both geologists formerly associated with the Chaco Project. These type collections were used as references during identification of minerals that were not familiar to the author; Warren and Love were consulted when comparisons of artifacts to the type collection specimens was inconclusive.

All shell or suspected shell items were identified as to species, if possible, by Helen DuShane of the Division of Malacology, Los Angeles County Museum of Natural History. In addition to the shell artifacts recovered from sites surveyed or excavated during the Chaco Project, she classified shells from earlier excavations that were curated by the National Park Service Chaco Project. Land snails from one site (29SJ 626), which was analyzed later (Mathien 1990a), were identified by Richard Smartt, Curator of Zoology, New Mexico Museum of Natural History.

During the course of these material identifications, several problems arose. They affect the answers to several of the questions listed above.

Shell versus Calcite/Travertine (Mexican onyx)

Small white discoidal beads had been modified so that their original material is not obvious; it could be bone, calcite/travertine, or shell. Judd (1954:92-93) noted that the material from Pueblo Bonito ". . . has been variously designated . . . as stone, bone, and shell . . . those actually tested proved to be shell." Not all field workers are able to correctly identify materials, especially if the beads are dirty or the field hands are untrained in mineral identification. Unless the classifier is familiar with an area and the problem, the wrong material type may be assigned to an object (Mathien 1984b).

Following DuShane's examination of the "shell" material and discussions with Warren, one result was a study of how to tell shell from calcite/travertine if the material has been greatly modified. DuShane noted that many of the small white discoid beads could have been either shell or some other white stone of a similar composition. She was not familiar with the geology of New Mexico, but Warren was aware of numerous calcite/travertine deposits and she was able to discern differences among the specimens. Proper material identification was important because calcite/travertine is a material that is quite abundant in northwestern New Mexico (Northrop 1959), but shell is a long-distance import, usually from the Gulf of California or the Pacific Coast (Keen 1971). Correct identification of such materials affects interpretations of trade networks. A method was needed to clarify these distinctions for other analysts (including this one).

Because both materials are calcium carbonate and respond similarly when a drop of acid is placed on them, a more detailed examination of the artifacts was necessary. Review of this problem (Mathien 1984b) indicates that the growth patterns in the shell produce fine layers that look very much like the ridges in a fingerprint. Shell often, but not always, retains a glossier appearance than calcite/travertine. Calcite/travertine often exhibits dark lines which result from depositional history; these are usually irregular and spaced farther apart than shell growth lines. Additionally, calcite/travertine contains foreign inclusions and/or cavities with a very different pattern from shell.

Jet and Other Black Minerals

Black minerals posed another problem. Some black shales are hard and resemble bituminous coal or lignite. The term "jet" is usually used to describe lignite, but it also covers black marble. Various black shales and other materials are often classified under this name. Because shales come in a variety of colors, some are easy to classify, but black shales are more difficult to identify unless a detailed analysis of the artifact is performed. Because this study was non-destructive and performed without the aid of a microscope, there is a possibility of misidentification.

A review of some of the terms indicates the extent of the problem. Brand (1937:55-62) provides definitions for several black minerals under consideration. The following are taken from his work:

Cannel coal is commonly considered to be a compact variety of bituminous coal, although it averages less fixed carbon and more volatile material. It possesses a dull luster and conchoidal fracture. No deposits of cannel coal have been reported from the Chaco area, but small lenses could occur in the predominant sub-bituminous seams (found in the area). Artifacts recovered from sites in Chaco Canyon indicate it was used for beads.

Carbonaceous shale is found in altered clay beds containing brownish bituminous material. It is quite common in Chaco Canyon, especially in the upper portion of the Allison member. It was used for flooring, etc., in pueblo construction, and for pot covers, ornaments, etc.

Gilsonite or Uintahite is a brittle variety of asphalt that is lustrous black in color and has a conchoidal fracture. It is probably the same as manjak. Found in Utah, western Colorado, and in veins in sandstone strata southwest of Aztec, it superficially resembles another asphalt (wurtzilite), and has frequently been confused with the jet variety of lignite. It was usually employed for ornaments, inlays, and "buttons."

Jet is a "jet black" variety of brown coal or lignite. It is a compact hydrocarbon, takes a high polish, and has a conchoidal fracture. It was used for beads, "buttons," inlays, and various other small carved items. There may be some confusion in the identification of items listed by archeologists as jet, lignite, and gilsonite. The material is probably derived from the coal seams in Chaco Canyon.

Lignite is a variable variety of coal that is ordinarily brown in color and ligneous in texture; it checks irregularly and breaks into thin slabs. The black form of lignite is known as sub-bituminous coal. This is the dominant type in the Allison and Chacra members of the Mesaverde group. Various ornaments of lignite have been recovered.

Red Minerals

Again, Brand (1937) provides several terms that cover materials that possibly were used for red beads and pendants.

Argillite is a schist or slate derived from clay. In the Chaco area, it is probably derived from argillaceous shale beds in the Allison member or from the Lewis or Kirtland shales.

Reddle is a clay and red ochre mixture resembling argillite, but softer. It was found as beads at Tseh So and probably was obtained from local shales.

Other Colored Minerals

Additionally, Brand (1937) discusses several other materials that were used to make ornaments.

Clay is an earthy material that is plastic when wet and composed chiefly of hydrous aluminous silicates. Most of the clays in Chaco Canyon are recent alluvial (in the valley fill) and argillaceous shales. Found principally in the upper portion of the Allison member, and to a minor extent in the Chacra sandstone, are thin stringers of hard white clay interbedded with lignite and sandstone. The sandy alluvial clay or adobe found exposed in the Chaco channel walls was used for plaster, mortar, and wall fill. Beads and other ornaments were likewise made from clay.

Shale is a soft sedimentary rock, normally with a thinly laminated structure that is formed by the consolidation of beds of mud, clay, or silt. In the Chaco area, the shales are only less important than the sandstones. Gray, green, brown, and black shales are most common, the black to gray carbonaceous shales being preponderant. Shale was used as floor material, for beads and other ornaments, olla lids or covers, tablets and palettes, etc. Archeological reports normally do not differentiate among the shales, but some reports list specific types: argillaceous shale, green shale, carbonaceous shale, ferruginous shale, and siltstone. Siltstone is a fine-grained clastic rock that is included in shale.

In addition to the above, the following definitions from Webster's New Collegiate Dictionary (1951, second edition) add to our comprehension of the problem.

Schist covers any metamorphic crystalline rock having a foliated structure and readily split into slabs or sheets.

Slate is a dense, fine-grained rock produced by the compression (metamorphism) of clays, shales, etc., so as to develop a characteristic cleavage.

To resolve the mineral identification problem for this study, it was assumed that all shales were of local origin. The Allison member of the Mesaverde group, the Chacra member, and the Lewis shales are part of the rocks exposed along the Chaco Wash to some extent from Pueblo Pintado to the junction of the Chaco Wash with the Escavada.

Argillite is the term that was used to identify all red shale-like ornaments in this report. Some red material was often called red dog shale by the archeologists who worked on the project. Yet, there were darker and harder artifacts that were referred to as red shale. As a result, a brief reconnaissance of Chaco Canyon was made. Outcrops of the fine-grained red material are found along the south and west end of Chacra Mesa—in view of Fajada Butte. The shale beds or layers also include some pieces that are both red and gray, which indicates the extent of the burn area. Layers above and below range in color from a pinkish shade to near maroon. In the area just south of the old monument fence, near site 29SJ 1337, there are layers that are yellowish. Along the south side of South Mesa and West Mesa are other outcrops of red shale. The westernmost of these outcrops are not as fine-grained and more closely match Brand's description of reddle. During the survey of Chaco Canyon, numerous sites in the area were noted to have artifacts of this material on the surface. Those that were collected by the survey crews were examined and resemble material from the nearby source locations (Mathien 1994). In 1995, a collection of material from five source areas and 25 artifacts from several sites was sent to James N. Gunderson and Lillian Pollach at Wichita State University for more detailed study. Until their results are available, for purposes of this study, all ornaments were called argillite.

Gray and lighter brown shale objects posed no problems. They are called shale and a color was associated with the material identification.

Black objects posed the greatest problem. They ranged in appearance from dull to polished, and from soft to hard. Extremely soft pieces were identified as lignite; the layers were usually visible. The hard, well-polished artifacts, usually discoid beads, ranged from brownish-black to dark black. There was no way to determine whether some pieces were gilsonite, jet, or shale. All were classified as shale, black, except for a very few ornaments that were classified as jet because they were much harder, e.g., a ring from 29SJ 1360.

As a result, there are probably some incorrect identifications of materials called argillite and shale. The questions about source areas utilized, however, are probably not greatly affected by these determinations.

Mica-muscovite versus Shaved Selenite

Another mineral identification problem surfaced several years after the analyses were completed and some site reports published (Mathien 1987, 1988). The material identified as mica-muscovite throughout this analysis may, in some cases, be thin shaven pieces of selenite. Dodge (1990) prepared pieces of selenite for a class display; they very much resembled the items listed as mica in this report. Obvious pieces of selenite were identified as such in this report; the thin leaves that were originally classified as mica were not changed because Love had suggested this term during the study. Selenite is abundant in Chaco Canyon; mica is available in the San Juan Basin. The number of items classified as mica are few; therefore, imports would have been few if this material was misidentified.

Source Area Identification

Brand (1937) describes the natural landscape in the Chaco area as follows:

> The Allison member is made up of interbedded sandstones and carbonaceous shales, with stringers of white clay, argillaceous shale, selenite, and coal. In the vicinity of Casa Rinconada the coal seams are thin, and the coal varies from lignite to subbituminous. Progressing westward the seams increase in thickness, and the quality of the coal improves (Brand 1937:40).

Two fossils (casts of Halymenites major and shells of Inoceramus barabini) are also found locally, as are sharks teeth.

Within 15 miles (ca. 24 km) to the northeast of Chaco Canyon are numerous outcrops of the Lewis and Kirtland shales. The latter contains barite, gypsum, aragonite, siderite, and petrified wood. The Ojo Alamo sandstone contains silicified logs, pebbles of red jaspery quartz, brown and gray chert, vein quartz, pink and white quartzite, rhyolite, andesite, felsite, porphyrite, granite, gneiss, schist, obsidian, lignitized wood, manganese concretions, and limonitic concretions. The Puerco and Torrejon formations contain calcite crystals, chert, and quartz. Thus, within a 15-mile (24 km) radius, there are numerous minerals available for use by the inhabitants of Chaco Canyon (Brand 1937). Love (Appendix 3A of this report) provides additional information on stone sources.

Identification of source areas also relied heavily on Northrop (1959) for minerals and Keen (1971) for Pacific Coast shells (Tables 10.1 and 10.2).

Turquoise, one material that was used in abundance by the Chaco Anasazi, comes from many sources, and it was important to try to identify which sources were mined for the thousands of turquoise ornaments and pieces that were found in Chaco Canyon sites. In an attempt to discover the turquoise source deposits, 218 specimens from 16 archeological sites were taken to local traders for possible identification of mining localities. J. C. Zachary, Jr. and his brother have been in the turquoise jewelry business (Zachary Bros. Indian Jewelry and Zachary Turquoise Inc.) in Albuquerque for many years. They kindly agreed to look at some artifacts. Although the Zachary brothers were able to suggest possible source areas for the bulk of the material examined, they were not able to identify a specific source.

There are two reasons why the prehistoric turquoise looks different from modern turquoise; thus, source identification is difficult. First, minerals obtained prehistorically were likely to have come from veins that have been exhausted, and, second, turquoise changes color as it is handled and worn. The effect of discard, burial, etc., in archeological sites is not known. The colors revealed by a fresh break in an artifact are often different from the exterior surfaces. These two factors, combined with the knowledge that turquoise from the same vein varies in color, and that turquoise from different areas within a vein or from different veins within the same deposit varies in element composition, makes it very difficult to indicate prehistoric sources from visual analysis alone. The Zachary brothers did suggest three possibilities as the most common sources: the King mine in Colorado, the Cerrillos District southeast of Santa Fe, NM, and a mine in Nevada (Mathien 1980).

Several investigators have used trace element analyses in an attempt to identify the source(s) of turquoise artifacts. Sigleo (1970) used arc emission spectrometry to analyze 80 source samples collected from 25 mines and 8 artifacts. Her results indicated that turquoise from Chaco Anasazi sites came from Mineral Park, AZ, Mine 16 at Cripple Creek, CO., and possibly from Crescent Peak, NV.

In an attempt to obtain a more definitive answer, and especially to evaluate the Cerrillos Mining District in New Mexico (an area that has been suggested as a source of Chacoan turquoise for many years [e.g., Judd 1954]), neutron activation was considered because studies using this technique

Table 10.1. Material types found in Chacoan archeological sites during the 1971-1978 excavations.

	Source Location			
Material Type	Chaco	San Juan Basin	Other	References and Comments
Aragonite	X	X	X	Aragonite is found in local Kirtland-Fruitland formations (Brand 1937:40-41, 55; Warren 1967, 1979). Northrop (1959:116-118) identifies deposits in 15 New Mexican counties. Special deposit is found on the mesa west of Los Lunas, NM.
Argillite	X	X	X	Argillaceous shale is found in the local Allison member (Brand 1937:40, 55). Love (personal communication, 1979) and Warren (personal communication, 1979) found argillite in gravels at Chaco Canyon, also in the Zuni, San Juan, and Nacimiento Mountains.
Azurite	-	X	-	Brand (1937:55-56) suggests a source in the Zuni Mountains. Warren (1967) notes it is found in the Zuni, San Juan, and Nacimiento Mountains. Love (personal communication, 1979) found it in the area around Cuba, NM. Northrop (1959:129-131) found deposits in 21 counties, including the Zuni Mountains.
Calcite	X	X	-	Love (personal communication, 1979) and Warren (personal communication, 1979) note calcite in the Upper Cretaceous beds in the San Juan Basin. Northrop (1959:154-160) locates calcite in 23 counties and are undoubtedly present in every county of the state. The travertine form is "widespread as deposits in mineral spring waters..."
Calcite, crystal	X	X	-	Calcite crystals are found in the Puerco formation, just north of Chaco Canyon (Brand 1937:50). Love (personal communication, 1979) and Warren (personal communication, 1979) found crystals in the Upper Cretaceous beds in the San Juan Basin.
Chert	X	X	X	Brand 1937:56-57) indicates gray, brown, and black cherts are found locally, but suggests Cerro Pedernal as the source for much material. Love (personal communication, 1979) and Warren (personal communication, 1979). See Cameron (this volume) for more details on the use of chert for chipped stone implements and their possible source areas.
Chert, green	?	X	-	Love (personal communication, 1979) and Warren (personal communication, 1979) found green chert in the Four Corners area and Red Mesa Valley, NM.
Clay	X	-	-	Brand (1937:57); Love (personal communication, 1979).
Claystone	X	-	-	Love (personal communication, 1979) and Warren (1979). Red claystones are found in local Kirtland-Fruitland formations.
Coal	X	-	-	Coal seams are visible in the canyon walls (Brand 1937:40).
Copper	-	?	X	Brand (1937:57) indicates sources of native copper in the Zuni Mountains and in Rio Arriba County, but there is no indication of prehistoric mining in these areas. Northrop (1959).
Crystal, quartz	-	X	X	Love (personal communication, 1979) and Warren (1967) note there are various sources, but none are local. Some have been found near Gallup.
Crystal, calcite	X	X	-	See calcite, crystal.
Crystal, feldspar	?	X	-	Brand (1937:40-41) indicates that felsite is found in the Ojo Alamo sandstones just north of Chaco Canyon. Northrop (1959:234-235) found it in 17 counties, including the Grants District of McKinley county.
Galena	-	X	X	Brand (1937:58) suggests the Zuni Mountains and Rio Arriba County as the nearest sources, and Northrop (1959:246-249) found galena in 20 counties, including the Grants District of McKinley county.

Table 10.1. (continued)

Material Type	Source Location: Chaco	San Juan Basin	Other	References and Comments
Garnet	-	X	X	Brand (1937:58) indicates sources near Fort Defiance, AZ, and in Buell Park and Garnet Ridge on the Utah-Arizona state line. Love (personal communication, 1979) found garnets in Buell Park area near the Arizona border. Northrop (1959:249-256) found pyrope in Buell Park area, northwestern part of McKinley County, near Fort Defiance. W. Reiter (personal communication, 1980) found garnets in the Jemez Mountains. R. Bice (personal communication, 1980) notes that garnet is found in the Taos area.
Gilsonite	-	X	-	Brand (1937:58) documents gilsonite in Utah, western Colorado, and southwest of Aztec, NM. See also Northrop (1959:257) who reports it is found in the sandstone southwest of Aztec, NM.
Geothite	X	-	-	Brand (1937:58) suggests a local source. Love (personal communication, 1979) and Northrop (1959:259-260) note geothite is found in 8 counties. Probably much limonite was misclassified and should be geothite.
Gypsite	X	-	-	Northrop (1959:268-274) indicates that gypsite is probably abundant in the Chaco area.
Gypsum	X	-	-	Brand (1937:58) indicates it is local; and Northrop (1959:268-274) indicates gypsum is found in 24 counties and is abundant in the Chaco area.
Hematite	X	X	X	Brand (1937:58) documents a local source. Warren (1967) indicates that hematite is found in the Chaco Canyon Cliff House formation. Northrop (1959:282-286) found it in 24 counties; it is an exceedingly common and widespread mineral. It is found in the Grants District of McKinley county.
Iron	X	-	-	Brand (1937:59) indicates iron pyrites occur sporadically in local coal seams. Love (personal communication, 1979) and Warren (1979) note that iron pigments are found in the Kirtland-Fruitland formations.
Jet	X	X	-	See lignite or gilsonite. Brand (1937:59) and Northrop (1959:323-324) indicate a variety of brown coal or lignite that is found locally was used for ornaments.
Lead	-	-	X	Love (personal communication, 1979) and Northrop (1959:323-324) note lead occurs rarely; it is found in the Magdalena Mountains. Warren (personal communication, 1979) found it in the Cerrillos Hills, southeast of Santa Fe.
Lignite	X	X	-	Brand (1937:59) documents a local source.
Limonite	X	X	-	Brand (1937:60) found limonite in Chaco Canyon. Northrop (1959:329-333) discredits limonite as a mineral type; it should be geothite, but it can also be a variety of hematite, jarosite. It is found in 26 counties, including the Grants and Gallup Districts of McKinley county. It is abundant in the Mesa Verde and Fruitland formations.
Limonitic sandstone	X	X	-	Warren (personal communication, 1979) documents limonitic sandstone in the Cliff House formation at Chaco Canyon.
Malachite	-	X	X	Brand (1937:60) suggests the Zuni Mountains as a source. Warren (1967) locates malachite in the Zuni, San Juan, and Nacimiento Mountains around the San Juan Basin and in Colorado. Northrop (1959:367-374) notes it in the Grants District of McKinley county. The Haystack area has small quantities.
Mica-muscovite	-	X	X	Brand (1937:60) suggests it is probably found in Rio Arriba County. Northrop (1959:367-374) indicates its presence in the Grants District of McKinley county.
Ocher, unidentified	X	-	-	Brand (1937:60) notes a local occurrence. Love (personal communication, 1979) and Northrop (1959:329-333) indicate ocher is present in 25 counties.
Opal	-	X	-	Northrop (1959:384-387) indicates opal is available in the Chuska Mountains.

Table 10.1. (continued)

Material Type	Source Location: Chaco	Source Location: San Juan Basin	Source Location: Other	References and Comments
Pyrite	-	?	X	Love (personal communication, 1979) and Northrop (1959:412-414) locate pyrite in 25 counties. It is in the Morrison formation sandstone ores, in the Grants District of McKinley county.
Quartz crystal	-	X	X	Northrop (1959:420-437) found crystals in 4 counties. Quartz is a "ubiquitous mineral occurs in every district and every county in the state." Crystals are found near Gallup.
Quartz, green with sandstone	X	-	-	Love (personal communication, 1979) noted presence depends on conditions. Warren (personal communication, 1979) indicated there were various sources.
Quartzite	X	-	-	Brand (1937:61) documents its presence in the Ojo Alamo sandstone. Love (personal communication, 1979) and Warren (personal communication, 1976) found quartzite in Chaco area gravels.
Sandstone	X	-	-	Brand (1937:40) describes the local sandstone formations.
Schist	X	-	-	Brand (1937:41) documents schist within 15 miles (24 km) of Chaco Canyon. Love (personal communication, 1979) and Warren (personal communication, 1979) found it coming out of gravel beds.
Selenite	X	-	-	Brand (1937:41, 61), Love (personal communication, 1979) and Warren (personal communication, 1979) found selenite in the Mesa Verde group, Kirtland shale formation. Northrop (1959:268-274) notes it is abundant in coal strata, with especially good crystals in Chaco Canyon.
Sepiolite	-	X	X	Love (personal communication, 1979) and Northrop (1959:454-458) indicate that sepiolite is found in fractures at Green Knoles, northeast of Red Lake in McKinley. It is also present in Grant County, north of Silver City on Sapillo Creek (a tributary to the Gila River).
Serpentine	-	X	X	Brand (1937:61) documents its presence in northern Arizona, and Rio Arriba or Catron counties, NM. Love (personal communication, 1979) and Northrop (1959:458-462) indicate serpentine is found in McKinley county near Buell Park along with periodite and garnet. In San Juan County, it is found in the rocks of the Chuska Mountains.
Shale	X	X	-	Carbonaceous shale is common in the Allison member in Chaco Canyon (Brand 1937:56), as are green, brown, and black shales (Brand 1937:62). Warren (personal communication, 1979) indicates Menefee shale is part of the local formation. Baked shales are present in the Kirtland-Fruitland formations. Mancos shale is found around the peripheries of the San Juan Basin to the east, south and north (see Geologic Map of New Mexico by Carle and Bachman 1971, USGS G-63272).
Slate	X	-	-	Love (personal communication, 1979).
Sulphur	X	X	-	Brand (1937:62) and Northrop (1959:493-495) indicate sulphur is found in the shales and coal seams in Chaco Canyon as well as in 7 counties—in the Gallup District of McKinley County.
Talc (steatite, soapstone)	-	X	-	Brand (1937:62) indicates that green talc may possibly be found in the Garnet Ridge area of Utah and Arizona. Northrop (1959:498) indicates microscopic amounts are found in the Buell Park area of McKinley County.
Turquoise	-	-	X	Northrop (1959:520-535) indicates turquoise is found in 6 counties. The closest source to Chaco Canyon is in the Cerrillos Hills, southeast of Santa Fe; but other mining areas are present to the south (Hachita and Burro Mountains), southeast (Orogrande), and west in Arizona, Nevada, and California. There are several sources in northwestern Mexico (Mathien 1981:Appendix C).

Table 10.1. (continued)

Material Type	Source Location: Chaco	San Juan Basin	Other	References and Comments
Other:				
Bone	-	-	-	Not all species were identified.
Ceramics	-	-	-	
Feather	-	-	-	Species unidemified.
Fossil shell	-	-	-	Shell types unknown.
Glass	-	-	-	Historic artifacts, origin not discussed.
Seed	-	-	-	
Shell	-	-	-	See Table 10.2.
Wood, petrified	X	-	-	Love (personal communication, 1979).

Table 10.2. Shells identified by H. DuShane, based on Keen (1971).

No. of Pieces	Type of Shell	Range of Present-day Distribution
	GASTROPODA (Snails)	
26	Haliotus cracherodii Leach, 1817	Coos Bay, Oregon to Cabo San Lucas, Baja California Sur, Mexico. Does not occur in Panamic province except in transitional zone, Cedros Island to Cabo San Lucas, although one small species is endemic to the Galapagos Islands, Ecuador. Common on rocks at low tide. Does not occur in the Gulf of California.
2	Episcynia medialis Keen, 1971	Guaymas, Sonora, Mexico south to Banderas Bay, Nayarit-Jalisco, Mexico. These shells probably were found adhering to a larger shell.
1	Turitella leucostoma Valenciennes, 1832	Cedros Island, Baja California Norte; throughout the Gulf of California, Mexico to Panama.
1	Serpulorbis oryzata (Morch, 1862)	Guaymas, Sonora, Mexico to Acapulco, Guerrero, Mexico.
1	Cerithium sp.	No Panamic species is at present considered to be assignable to Cerithium sp.
2	Cerithidea albondosa Gould & Carpenter, 1957	Northern part of the Gulf of California, Mexico on tidal flats.
2	Strombus galeatus Swainson, 1823	Throughout the entire Gulf of California, Mexico to Ecuador.
3	Melangonia patula (Broderip & Sowerby, 1829)	Northern Gulf of California, Mexico south to Panama. On sand and mud flats.
2	Nassarius sp.	Large range from Gulf of California to Panama. Without species, difficult to pinpoint area.
4	Oliva sp.	Gulf of California.
8	Oliva incrassata [Lightfoot, 1786]	Throughout the Gulf of California, south to Peru, on sand beaches.
152	Olivella dama (Wood, 1828, ex Mawe MS)	Head of Gulf of California, Mexico south to Panama.
2	Conus perplexus Sowerby, 1857	Gulf of California, Mexico south to Ecuador, on sand beaches.
1	Lymnaea species	Freshwater gastropod. If there is slow moving water, it could live in area.
2	Lymnaea bulemoides Lea Keep, 1935	
1	Unidentified snail.	
	PELECYPODA (Clams)	
1	Lyropectin subnodosus (Sowerby, 1835)	Scammons Lagoon, Baja California Sur; Gulf of California, Mexico to Peru.
351	Glycymeris gigantea (Reeve, 1843)	Bahia Magdalena, Baja California Sur to Acapulco and in Gulf of California north to approximately Mulege, Baja California Sur. On West coast of Mexico only beach valves are found north of Mazatlan, Sinaloa, Mexico.
3	Glycymeris maculata (Broderip, 1932)	Northern part of Gulf of California, Mexico south to Peru.
2	Choromytilus palliopunctatus (Carpenter, 1857)	Confined to exposed-coast intertidal areas where mussels live fastened to rocks. Magdalena Bay, Baja California Sur to Panama.
2	Argopectin circularis (Sowerby, 1935)	Cedros Island, Baja California Norte, throughout the Gulf of California and south to Peru. Common on sand mud flats.

Table. 10.2. (continued)

No. of Pieces	Type of Shell	Range of Present-day Distribution
*	Spondylus calcifer Carpenter, 1857	Gulf of California, Mexico to Ecuador.
4	Spondylus princeps unicolor Sowerby, 1947	Cedros Island, Baja California Norte; Concepcion Bay, Gulf of California to Jalisco, Mexico. Taken only by divers, but not at great depths.
21	Chama echinata Broderip, 1835	Southern Gulf of California to Panama. Mazatlan is the northern point where it can easily be found.
1	Trachycardium species	
1	Trachycardium species, possibly Trachycardium panamense (Sowerby, 1933)	Throughout the Gulf of California south to Costa Rica (in spite of its name).
3	Laevicardium elatum (Sowerby, 1933)	Southern California to Panama. Most common on mud flats in Gulf of California.
2	Freshwater clam, possibly Rabdotus Schiedeanus	
2	Freshwater clam	
3	Freshwater clam, possibly Anodonta species	Requires year-round water supply. Possibly the San Juan River?
1	Bivalve, unidentified	
22	Too small to identify	
22	Fossil shell impressions	

were well underway (Weigand et al. 1977). A sample of 150 turquoise artifacts from 10 Chaco Canyon archeological sites was forwarded to Brookhaven National Laboratory in 1978, and preliminary results were received (Bishop 1979; Mathien 1981). Although neutron activation tests indicated that the turquoise was remarkably homogeneous with quite consistent copper values, much like what one would expect if it was procured from a fairly restricted source, no source area was identified. There were two clusters, however, that indicated some relationship between artifacts from Chaco Canyon sites and the sites of Guasave in northern Sinaloa and Snaketown in Arizona.

In addition to the turquoise artifacts, source specimens from the Cerrillos Mining District had been collected during a survey of the southern part of that district (Warren and Mathien 1985) and forwarded to Brookhaven, but the results of comparisons of these specimens with Chaco Canyon artifacts were not then available. An informal discussion with Phil C. Weigand (personal communication, 1983), indicated that continued research on the problem did not provide more definitive answers as of that date. Recently, however, Harbottle and Weigand (1992; Weigand and Harbottle 1992) indicate that the Cerrillos Mining District, where there is much evidence of prehistoric and historic turquoise mining (Levine and Goodman 1990, Levine et al. 1991; Warren and Mathien 1985), is a probable source for Chaco Canyon turquoise artifacts. Additionally, Wiseman and Darling (1986) have documented several sites in the area that have mining tools as well as sherds similar to those found in the San Juan Basin; these authors suggest some contact and trade took place. Recently Harbottle and Weigand (1992:84; Weigand 1994:29) presented schematic maps of turquoise trade routes; they show turquoise flowing into Chaco Canyon from sources in Colorado and Nevada, as well as Cerrillos.

As a result of these preliminary studies on a limited number of specimens (less than 400 out of 100,000+), it is difficult to specify how much turquoise in Chaco Canyon came from which source areas or when. The only inference made herein is that turquoise is not available from within the San Juan Basin and must have been imported to Chaco Canyon from one or several mines located throughout the western United States and northwestern Mexico. Additional study is needed to determine the exact source or sources for the many turquoise artifacts recovered from Chaco Canyon sites.

Assignment of General Procurement Areas

Once the problems in material identification were addressed and probable source areas located, the materials were assigned to one of three general procurement areas. "Local" indicates that a material could be found in and around Chaco Canyon. "Basin" indicates that it could be found outside the larger Chaco Canyon area but within the San Juan Basin. "External" was assigned to those materials imported from sources located outside of the San Juan Basin. Tables 10.1 and 10.2 list the source areas for mineral and shell types.

Assignment to Time

During the analyses of artifacts, a general method of comparing proveniences at various sites across space and time was needed. Although not ideal, a time-space matrix was devised, based on absolute dates, architecture, and ceramic data (Cameron 1985:6; see Chapter 3). At that time, the dominant ceramics from excavated sites had been divided into 24 distinct periods, some of which overlapped. Three 100-year time ranges for the Bonito Phase were defined: the Early Bonito Phase (A.D. 920 to 1020), the Classic Bonito Phase (A.D. 1020 to 1120), and the Late Bonito Phase (A.D. 1120 to 1220) (Toll, Windes and McKenna 1980:96-97). These dating categories were used in this study as well.

In several site reports, however, the principal investigators have used more detailed time frames, and Windes (1987:Volume III, Table I.2) provides an update to the original dating sequences, based on recent studies. (See Chapter 1 for a correlation of dating periods.)

Artifact Classes

Based on a review of the literature, 20 ornament types were defined. These (and the abbreviations) include bulk mineral, unmodified; bulk mineral, modified; bead; bead blank; pendant (Pend.); inlay; effigy, human (Eff.); zoomorphic effigy, animal (Zoom.); strand dividers; debris (Deb.); other; unidentified (Unid.); pendant blank (PB, Pend. bl.); bracelet (Brac.); ring; noseplug (NP); gaming piece

(Gam. pc.); button; bell (copper); and tinkler (Tink.).

Only beads and bead blanks need further clarification. A bead need not be whole; its condition was noted under a separate category and those beads that were nearly complete were listed under this classification (particularly several specimens from 29SJ 629) rather than as bead blanks which were not nearly as complete. A bead blank is generally a specimen that is roughly discoid. It may have slight evidence of an attempt to make a perforation, but generally the perforation did not go through. Usually, the edges were not ground smoothly.

Results

Based on the classification system for minerals, their sources, time frame, evidence of manufacturing, and functional type (Mathien 1985) information was evaluated by time under four topical headings: procurement, production, distribution, and consumption, as well as compared with data from other excavations in Chaco Canyon, the San Juan Basin, and to a limited extent, other Anasazi areas.

A variety of minerals, shells, seeds, and ceramics were utilized as ornaments by the Chaco Anasazi through time (Table 10.3). For some periods, there are few sites with ornaments and minerals. As a result, several of the periods were grouped as follows for purposes of discussion: Archaic-Basketmaker II (pre A.D. 500), Basketmaker III-Pueblo I (A.D. 500 to 900); Pueblo II-Pueblo III (A.D. 900 to 1250), and Navajo. The Pueblo II-Pueblo III period, however, was broken down into several shorter segments for the Chaco Project excavations (e.g., the Bonito Phase: Early—A.D. 920 to 1020, Classic—A.D. 1020 to 1120, and Late—A.D. 1120 to 1220), and the Mesa Verde Phase—A.D. 1220 to 1320. When data from other excavated Anasazi sites are evaluated, however, they are discussed under larger time segments.

Archaic-Basketmaker II (pre A.D. 500)

Hayes (1981:21) defines the Early Archaic-Basketmaker II period in Chaco Canyon "from roughly 5000 B.C. to shortly after the time of Christ." Five sites assigned to this period were excavated (at least in part) and provide some information on the use of minerals and other materials:

1) 29SJ 126. Probably the oldest site in the group; it had evidence of a Jay point and an indicator date of 3730 B.C.

2) 29SJ 1156 (Atlatl Cave). Two separate occupations were identified. A San Jose point and a C^{14} date of 2900 $\pm$ 136 would place the northwest midden in the Archaic period, but the C^{14} dates of 950 to 910 B.C. for the midden in the central section of the cave suggest a later Archaic occupation.

3) 29SJ 1157 (Sleeping Dune and Ant Hill Dune). Located just in front of the entrance to Atlatl Cave, Mathews and Neller (1979) associated this site with the utilization of Atlatl Cave. A single C^{14} date of A.D. 40 from a hearth on Ant Hill Dune, however, indicates that these were not contemporaneous occupations.

4) 29SJ 116. Originally classified as an Archaic site, the single C^{14} date of A.D. 690 and the presence of sherds ranging from Basketmaker III through Pueblo III indicate a later occupation than the Archaic points found on the site. This site will be discussed under Basketmaker III, even though Windes (personal communication, 1987) would not assign it to one specific period.

5) 29SJ 1118. This is a quarry site that contained no ornamental artifacts.

Based on the above, only the material recovered from sites 29SJ 126, 29SJ 1156, and 29SJ 1157 will be considered in this section.

Procurement

Table 10.4 summarizes data on ornaments and minerals from the Archaic-Basketmaker II sites. Only malachite and shell would have been imported; shale could have been obtained locally or from areas within the San Juan Basin. The shell is a freshwater species that could have been found in the San Juan Basin. The malachite was available around the peripheries of the San Juan Basin. Based on evidence from these three sites alone, there is little reason to suspect any long-distance trade networks; however, the entire San Juan Basin and its peripheries probably provided materials for the Archaic people who used Chaco Canyon.

Table 10.3. Material types by sites by time frame.[a]

	Time Frame in A.D.											
Material Type	Arch.	BMII	500-600	500-700	600-700	600-820	750-800	700-820	700-1020	820-920	800-1020	820-1220
Aragonite	-	1157	-	-	-	-	-	-	-	-	-	-
Argillite	126	1157	-	-	-	628 116	724	628 1360	-	-	-	-
Azurite	-	-	-	1659	299	628	-	1360	-	629	-	-
Calcite	-	-	423	1659	299	628	724	-	-	-	-	630
Chert, green	-	-	-	-	-	-	-	-	-	-	-	-
Coal	-	-	-	-	-	-	-	-	-	-	-	-
Copper	-	-	-	-	-	-	-	-	-	-	-	-
Crystal, calcite	-	-	423	-	-	-	-	-	-	-	-	-
Crystal, feldspar	-	-	-	-	-	-	-	-	-	-	-	-
Crystal, quartz	-	-	-	1659	-	-	-	-	-	-	-	-
Evaporite	-	-	-	-	-	-	-	-	-	627	-	-
Galena	-	-	-	-	-	-	-	-	628	-	-	-
Garnet	-	-	-	-	-	116	-	-	-	-	-	-
Geothite	-	-	-	-	-	-	-	-	-	-	-	-
Gypsite	-	1156	423	1659	299	628	724	721	-	627	-	-
Gypsum	-	-	-	1659	-	628	724	1360	-	-	-	-
Hematite	1156 126	1156 1157	423	1659	299	628 116	724	1360	628	629	629	-
Iron	-	-	-	-	-	628	-	-	-	-	-	-
Jasper	-	-	-	1659	-	-	-	-	-	-	-	-
Jet	-	-	-	-	-	-	-	-	-	-	-	-
Lead	-	-	-	-	-	-	-	-	-	-	-	-
Lignite	-	1156	-	1659	299	628	724	721	628	627 1360	-	-
Limonite	1156	1156 1157	423	1659	299	628 116	724	628 721 1360	628	627 629 1360	629	-
Limonitic sandstone	-	-	-	-	-	116	-	-	-	-	-	-

Table 10.3. (continued)

	Time Frame in A.D.											
Material Type	900-1000	900-1050	920-1020	920-1000	920-1120	920-1220	1000-1050	1020-1120	1020-1220	1120-1220	1200-1300	Navajo	Not Dated
Aragonite	627	-	1360	-	-	389	-	-	-	389	-	-	-
Argillite	627	-	389 629 1360	-	627 629	389 629	627	389	389	389 391 633	633	-	389 629
Azurite	627	-	389 625 628 629 1360	-	627 629	389	627	389 423	389 391	389 391 633	-	-	389
Calcite	627	-	299 389 391 628 629 1360	-	391 627 629	389	627	389 423 721	389 391	389 391	-	1613	389 627 721
Chert, green	-	-	-	-	627	-	-	423	-	-	-	-	389
Coal	-	-	-	-	-	-	-	-	-	389	-	-	-
Copper	627	-	-	-	-	389	-	389	-	-	633	-	-
Crystal, calcite	-	-	-	-	-	-	-	423	-	-	-	-	-
Crystal, feldspar	-	-	1360	-	-	-	-	-	-	-	-	-	-
C[illegible]quartz	627	-	389	-	-	-	627	-	-	-	-	-	-
Evaporite	-	-	-	-	-	-	-	-	-	-	-	-	-
Galena	627	-	389 629	-	-	-	-	-	389	-	-	-	-
Garnet	-	-	-	-	-	-	-	-	-	-	-	-	-
Geothite	-	-	-	-	-	-	627	389	-	-	-	-	-
Gypsite	627	-	389 629 1360	-	627	389	627	389	-	389 633	633	-	-
Gypsum	627	-	629 1360	-	627	389	627	-	-	633	633	1613	389 627 721
Hematite	627	-	389 391 628 629 1360	-	389 627 629	389 629	627	389 423	389	389 633	633	1613	-
Iron	-	-	-	-	-	-	-	-	-	-	-	1613	-
Jasper	-	-	-	-	-	-	-	-	-	-	-	-	-
Jet	-	-	629 1360	-	627	389 629	627	-	-	391	-	-	-
Lead	-	-	-	-	-	-	-	423	-	-	-	-	-
Lignite	627	-	389 625 629 1360	-	629	389	627	389 423	389	389	633	-	-
Li[illegible]	627	-	299 391 629 1360	-	389 391 627 629	389 629	627	389 423	389	389 633	633	-	627
Limonitic sandstone	627	-	-	-	-	-	-	423	-	-	-	-	-

Table 10.3. (continued)

Material Type	Time Frame in A.D. Arch.	BMII	500-600	500-700	600-700	600-820	750-800	700-820	700-1020	820-920	800-1020	820-1220
Malachite	-	1157	423	-	299	628	724	1360	-	-	-	-
Mica-muscovite	-	-	-	-	-	-	-	-	-	-	-	-
Ocher, unidentified	-	-	-	1659	-	-	-	-	-	-	-	-
Opal	-	-	-	-	-	-	-	-	-	-	-	-
Quartz, green with sandstone	-	-	-	-	-	-	-	-	-	-	-	-
Quartzite	126	-	-	-	-	116	-	-	-	-	-	-
Sandstone	-	-	423	1659	-	628 116	-	-	628	-	-	-
Schist	-	-	-	-	-	628	-	-	-	-	-	-
Selenite	-	-	423	1659	299	628	724	299 628 721 1360	628	627 629 1360	629	-
Sepiolite	-	-	-	-	-	-	-	-	628	-	-	-
Serpentine	-	-	-	-	-	628	-	-	-	-	-	-
Shale	-	1156	-	-	-	-	724	-	628	1360	-	-
Shark's tooth	-	-	-	-	-	-	-	-	-	-	-	-
Slate	-	-	-	-	-	-	-	-	-	-	-	-
Specularite	-	-	-	-	-	-	-	-	-	-	-	-
Steatite-soapstone	-	-	-	-	-	-	-	-	-	-	-	-
Sulphur	-	-	-	-	-	628	-	-	-	-	-	-
Turquoise	-	-	423	1659	299	628	724	299 1360	628	627 629 1360	629	-
[illegible]	[illegible]	1156	423	1659	299	628 116	-	-	628	627	-	-
[illegible]	-	[illegible]	-	[illegible]	299	-	-	-	-	-	-	-
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-	-	-	-	-
[illegible]	-	[illegible]	-	[illegible]	[illegible]	-	-	-	-	-	-	-
[illegible]	[illegible]	-	[illegible]	-	-	-	-	-	-	-	-	-
Seed	-	1156	-	-	-	-	-	-	-	-	-	-
Wood, some petrified	-	1156	-	-	-	-	-	-	-	-	-	-
Glycymeris gigantea	-	-	-	1659	-	628	724	-	-	-	-	-
Choromytilus palliopunctatus	-	-	-	-	-	-	-	-	-	-	-	-

Table 10.3. (continued)

	Time Frame in A.D.												
Material Type	900-1000	900-1050	920-1020	920-1000	920-1120	920-1220	1000-1050	1020-1120	1020-1220	1120-1220	1200-1300	Navajo	Not Dated
Malachite	627	627	391 629 1360	-	391 627	389	627	389 423	389 391	389 633	633	-	423 627
Mica-muscovite	-	-	-	627	-	389	-	389	-	389	-	-	389
Ocher, unidentified	-	-	-	-	-	-	-	-	-	633	-	-	-
Opal	-	-	-	-	-	389	-	-	-	-	-	-	-
Quartz, green with sandstone	-	-	1360	-	-	-	-	423	-	-	-	1613	-
Quartzite	-	-	389	-	-	-	-	-	391	-	-	-	-
Sandstone	627	-	-	-	627	389	627	389 391	-	-	633	-	-
Schist	-	-	-	-	-	-	-	-	-	-	-	1613	-
Selenite	627	-	299 389 391 628 629 1360	-	389 391 627 629	389 629	627	389 423	389 391	389 391 633	633	-	627 721
Sepiolite	-	-	-	-	629	-	-	-	-	-	-	-	-
Serpentine	-	-	628 1360	-	-	389	-	-	-	-	-	-	-
Shale	-	-	389 391 629 1360	-	389 391 627 629	389	627	389 423	389	389	633	-	389 627
Shark's tooth	-	-	389	-	-	389	-	389	-	-	633	-	-
Slate	-	-	-	-	-	-	-	-	-	-	-	-	-
Specularite	-	-	-	-	-	-	-	-	-	-	-	-	627
Steatite-soapstone	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulphur	-	-	1360	-	627	-	627	-	-	-	-	-	-
Turquoise	627	627	389 391 625 628 629 1360	-	391 627 629	389 629	627	389 391 423	389 391	389 391 629 633	633	1613	189 627 629
Bone	-	627	389 625 629	-	627 629	389	627	389 423	-	389	-	1613	-
Ceramic	-	-	389	-	-	-	-	389	-	-	-	-	-
Clay	-	-	629	-	-	-	-	-	-	-	-	-	-
Claystone	-	-	-	-	-	-	-	-	-	-	633	-	-
Glass	-	-	-	-	-	-	-	-	-	-	-	1613	-
Seed	-	-	-	-	-	-	-	-	-	-	-	-	-
Wood, some petrified	-	-	1360	-	-	-	-	-	-	-	-	-	-
Glycymeris gigantea	627	627	389 391 629 1360	-	627 629	389	627	389 391 423	389	389 391 633	633	-	627
Choromytilus palliopunctatus	-	-	-	-	-	-	-	389	-	-	-	-	-

Table 10.3. (continued)

Material Type	Arch.	BMII	500-600	500-700	600-700	600-820	750-800	700-820	700-1020	820-920	800-1020	820-1220
	Time Frame in A.D.											
Argopectin circularis	-	-	-	-	-	-	-	-	-	-	-	-
Spondylus calcifer	-	-	-	-	-	-	-	-	-	-	-	-
Spondylus princeps unicolor	-	-	-	-	-	-	-	-	-	-	-	-
Chama echinata	-	-	-	-	-	-	-	-	-	-	-	-
Trachycardium sp.	-	-	-	-	-	-	-	-	-	-	-	-
Trachycardium panamense	-	-	-	-	-	-	-	-	-	-	-	-
Haliotus cracherodii	-	-	-	-	-	628	-	-	-	-	-	-
Episcynia medialus	-	-	-	-	-	-	-	-	-	-	-	-
Turitella leucostoma	-	-	-	-	-	-	-	-	-	-	-	-
Cerithidea albondosa	-	-	-	-	-	-	-	-	-	-	-	-
Strombus galeatus	-	-	-	-	-	-	-	-	-	-	-	-
Oliva sp.	-	-	-	-	-	-	-	-	-	-	-	-
Oliva incrassata	-	-	-	-	-	-	-	-	-	-	-	-
Olivella dama	-	-	423	1659	-	116	724	299	-	-	-	-
Conus perplexus	-	-	-	-	-	-	-	-	-	-	-	-
Lymnaea sp.	-	-	-	-	-	-	-	-	-	-	-	-
Lymnaea bulemoides Lea	-	-	-	-	-	-	-	-	-	-	-	-
Freshwater clam	126	-	-	1659	-	-	-	-	-	-	-	-
Anodonta sp.	126	-	-	-	-	-	-	-	-	-	-	-
Unidentified shell	-	-	423	-	299	-	724	-	-	-	-	-
Fossil shell	-	-	-	-	-	-	-	-	-	-	-	-
Fossil shell impressions	-	1157	423	-	-	-	-	-	-	-	-	-
Fossil, other	-	-	423	-	-	-	-	-	-	-	-	-

[a] Site numbers presented in abbreviated form; 29SJ omitted.

Table 10.3. (continued)

Material Type	900-1000	900-1050	920-1020	920-1000	920-1120	920-1220	1000-1050	1020-1120	1020-1220	1120-1220	1200-1300	Navajo	Not Dated
Argopectin circularis	-	-	389	-	-	-	-	-	-	-	-	-	627
Spondylus calcifer	-	-	389	-	-	-	-	-	-	-	-	-	-
Spondylus princeps unicolor	-	-	-	-	-	389	-	-	-	-	-	-	-
Chama echinata	-	-	389	-	629	389	-	389	-	389	-	-	-
Trachycardium sp.	627	-	-	-	-	-	-	-	-	-	-	-	-
Trachycardium panamense	-	-	-	-	-	-	627	-	-	-	-	-	-
Haliotus cracherodii	627	-	-	-	-	389	627	423	389	391 633	-	-	627
Episcynia medialus	627	-	-	-	-	-	-	-	-	-	-	-	-
Turitella leucostoma	-	-	-	-	-	-	-	-	-	-	-	-	627
Cerithidea albondosa	-	-	-	-	627	-	-	-	-	-	-	-	-
Strombus galeatus	-	-	-	-	-	-	627	-	-	-	-	-	-
Oliva sp.	-	-	629	-	-	-	-	-	-	-	-	-	-
Oliva incrassata	-	-	629	-	-	389	-	-	-	-	-	-	-
Olivella dama	627	-	391 629	-	-	389	627	389 423	389	389 633	-	-	423
Conus perplexus	-	-	299	-	-	-	-	-	-	-	-	-	-
Lymnaea sp.	-	-	-	-	-	-	-	-	-	-	633	-	-
Lymnaea bulemoides Lea	-	-	-	-	627	389	-	-	-	-	-	-	-
Freshwater clam	-	-	389 629	-	627	-	-	-	-	-	-	-	-
Anodonta sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Unidentified shell	627	-	-	-	-	389	627	-	-	391 633	633	-	627
Fossil shell	-	-	-	-	-	-	-	-	-	-	-	-	-
Fossil shell impressions	-	-	389	-	-	389	-	389	-	-	-	-	-
Fossil, other	-	-	629	-	-	389	-	-	-	-	-	-	-

Table 10.4. Archaic-Basketmaker II ornament and mineral materials.

Material Type	29SJ 126 (open)	29SJ 1156 Middle	29SJ 1156 (shelter) Late	29SJ 1157 (open) Ca. A.D. 40	Total
Aragonite	-	-	-	1 Bead	1
Argillite	1 Flake	-	-	1 Modified	2
Bone	-	-	10 Beads	-	10
Gypsite	-	-	90 Pieces	-	90
Hematite	1 Modified	23 Pieces	15 Pieces	11 Pieces	50
Lignite	-	-	1 Piece	-	1
Limonite	-	41 Pieces	25 Pieces	11 (1 Pendant)	77
Malachite	-	-	-	1 Unmodified	1
Quartzite	16 Flakes	-	-	-	16
Seed	-	-	1 Bead	-	1
Shale	-	-	1 Bead	-	1
Shell (Anodanta)	1 Pendant	-	-	-	1
Fossil shell impressions	-	-	-	12	12
Wood	-	-	1 Bead		1
No. of materials	4	2	8	6	14
Total items	19	64	144	37	264
Ornaments	1 (5.2%)	0	13 (9.0%)	2 (5.4%)	16 (6.1%)
Soft minerals (pigments)	1 (5.2%)	64 (100%)	130 (90.3%)	23 (62.2%)	218 (82.6%)

The wood bead and the seed bead, both from 29SJ 1156, lend additional evidence of use of a variety of materials for ornaments during this period.

Production

At 29SJ 1157, one aragonite bead and one limonite pendant were recovered. Aragonite has a hardness of 3 1/2-4 on the Moh's scale and limonite 4 1/2-5 (Northrop 1959). As noted in the ornament report for this site (Mathien 1985), the formation of this pendant could be attributed to natural forces. It was probably an unusual piece that was strung and used by the inhabitants of this site.

The ten bone beads, the seed bead, shale bead, and wood bead from 29SJ 1156 probably were no more difficult to make than the aragonite bead from 29SJ 1157. The freshwater shell (possibly Anodonta sp.) at 29SJ 126 had been fashioned into a pendant, but its presence there may or may not reflect a Basketmaker II occupational use because there are sherds of the Pueblo sequences at this site. Shell has a hardness of 3 1/2-4 on the Moh's scale (Feathers 1989:580-581).

Minerals that probably had been used for pigments include gypsite, hematite, and limonite. Pictographs at 29SJ 1156 include a limonitic yellow animal, hematitic red hands, and dark red human figures as well as some white figures. The lack of evidence of later occupation at this site may indicate that these figures could be associated with the 950 to 910 B.C. midden, but there are difficulties with this assumption. Although the presence of pigments that match colors in the rock shelter is suggestive, the human figures are similar to those attributed to Basketmaker people (Guernsey and Kidder 1921:34). At present, however, there is no way to date with certainty any of the rock art at 29SJ 1156.

Based on these data, it is suggested that the inhabitants of Chaco Canyon were making or using some ornaments (beads and pendants) by 950 to 910 B.C. (at 29SJ 1156) and that by the time of Christ they were able to work with materials in the range of hardness of 3 1/2-4 or 5 on the Moh's scale. Manufacture of the bone beads included cutting and grinding of two ends. No tools for ornament manufacture were found at any of these sites; therefore, no information is available on where or how these ornaments were made. (For more information on bone bead manufacturing, see the discussion at the end of this chapter.) The simplicity of manufacture of the bone beads and the limonite pendant suggest that the technology was not highly sophisticated, but probably consisted of using tools that were available for other daily activities, e.g., butchering, cutting, drilling, etc. No particular skills were needed, and the work could have been done by a hunter-gatherer while sitting at a camp or resting during his or her daily activities. This lack of sophistication, however, was not true for all Anasazi during Basketmaker II (see discussion under Basketmaker III-Pueblo I).

Distribution and Consumption

The limited number of ornaments (14 beads and 2 pendants) at these three sites provide insufficient information to make inferences about distribution or consumption in Chaco Canyon during this early period. As it is difficult to estimate the number of people utilizing any of the sites excavated and discussed, it is impossible to do more than suggest their use of ornaments and minerals by these early inhabitants.

Comparisons

One tubular bone bead was recovered in Sheep Camp Shelter, located just outside Chaco Culture National Historical Park (Gillespie 1984:80). This bead is probably Late Archaic as it was found near the surface of Area B, which was radiocarbon dated at 2830 $\pm$ 130 and 3030 $\pm$ 130 B.P. (Gillespie 1984:68). Review of reports on Archaic sites located just north of Chaco Canyon indicates that a number of recent excavations have recovered no ornamental artifacts in Archaic open air sites (Simmons 1982).

Comparative data from other sites in the San Juan Basin are scarce. Data from the Navajo Indian Irrigation Project (NIIP) near Bloomfield, NM, indicate that although numerous open Archaic sites have been found and a number of them excavated, no ornaments or minerals were recovered (Elyea et al. 1979; Sessions 1979). Nine sites discussed by Kirkpatrick (1980) had neither ornaments nor minerals among the recovered artifacts. Discussion with Al Simmons (personal communication, February 1982) revealed no information on ornaments at sites from the Archaic period, neither in his surveys nor literature search. Ruth Henderson (personal communication, April 1982), however, excavated a Basketmaker II pithouse complex on the Gallegos Wash as part of the NIIP. This site had four structures in which a few bone and stone beads were recovered; all materials were available within the San Juan Basin.

In an attempt to make comparisons within the larger Anasazi area, Jernigan's (1978) data and summaries were used as a baseline. He had reviewed the literature for the American Southwest and discussed only items for which he thought he had good temporal control. His reviews of "Big Game Hunters" and the "Desert Tradition" cover much of the earlier part of Hayes' Archaic period, as used here. In the Anasazi sequence, Jernigan (1978:151-196) dated Basketmaker II from 300 B.C. to A.D. 450, which falls within the latter part of Hayes' Archaic-Basketmaker II Period.

Jernigan (1978:7-9) found very little evidence for the use of jewelry among the "Big Game Hunters;" he listed only bone items from the Levi site and the Lindenmeier site and stated that these may not have been jewelry items. During the "Desert Tradition," however, a number of material types had been fashioned into ornaments (Jernigan 1978:9-19). These include animal teeth, claws, and horns used as pendants; bone pendants, pectorals, tubes, discs, beads, and nasal ornaments; a calcium carbonate bead; a mica disc or ring; selenite; green slate discs and pendants; a green schist bead; steatite pendants; a serpentine ring; white marble/dolomite pendants; several species of shell (Olivella, Abalone, Laevicardium elatum, and freshwater mussel, all unworked except as necessary to string, and Glycymeris bracelet); cane tube beads; oak and bark pendants; gourd pendants; and leather discs. These ornaments were recovered from sites throughout the Southwest but were not from the Anasazi area. He discounted the evidence of use of one Glycymeris shell that he thought more accurately should be classified as an artifact of Mogollon sedentary occupation. The freshwater mussel might suggest that the freshwater shell pendant found at the Chaco site, 29SJ 126, may not be out of place temporally, but Jernigan's comments on the lack of purposeful working of shell (other than grinding off the top in order to string it) suggest that the extensive working would place the Chaco pendant into a later time frame. The grinding technology, on the other hand, must have been developed fairly early because Jernigan did list calcium carbonate and white marble-dolomite beads, materials of approximately the same hardness as shell.

For the Basketmaker II period, Jernigan (1978:Tables 70-90) indicates a number of materials that were fashioned into a variety of beads, pendants, necklaces, pins, inlay, and mosaic pieces. These are summarized in Table 10.5.

Among the Anasazi in the Kayenta area, many people were buried with beads of some type. Personal ornaments found in Cave I at Kinboko:

> Necklaces of various kinds were evidently much worn, as almost every undisturbed Basket Maker skeleton yet found by us was provided with one. We are inclined to believe, indeed, that the Cists of Cave I were plundered primarily for the beads accompanying the internments in them (Kidder and Guernsey 1919:161).

The technology available during the early Basketmaker period was sufficiently advanced to allow the Anasazi to make fine jewelry. The lignite beads are numerous and particularly striking; some were highly polished and still retain their luster.

> There are two kinds of beads: the cylindrical and the hemispherical. The former are all made of black albatite, a phase of asphaltic shale; they are less than three-sixteenths inch [0.48 cm] in diameter, with fine straight bores with not more than one thirty-second inch [0.079 cm] across. They vary somewhat in length, but are of uniform diameter and cylindrical in form.
>
> Hemispherical stone beads are much larger, averaging seven-sixteenths inch [1.11 cm] in diameter . . . Hematite and serpentine are the commonest materials, though the minerals mentioned above all occur.
>
> Most of the shell beads were made from olivellas by simply cutting off the end of the spire (Kidder and Guernsey 1919:164).

The lack of modification on shell may have been a stylistic preference because Kidder and Guernsey (1919:162-164) report that Haliotus shell pendants (which have a particular type of luster) were common and that other materials of probably comparable hardness were made into beads; these include lignite, limestone, serpentine, picrolite, hematite, albatite (shale), and calcareous tufa. A few hemispherical bone beads were also noted. If the distance to a source area indicated either greater access to unusual items by some traders or travelers, or if shells had a special meaning, retention of their significant characteristics could have been a visual marker for this concept in the society.

In addition to ornaments listed with specific burials, Kidder and Guernsey (1919) noted the presence of a necklace of Pyrimidula strigosa var. cooperi (snail shells) and ear ornaments of lignite in Cave I at Kinboko and pendants of actinolitic schist, red jasper, and satin spar from Sayodneeche.

At White Dog Cave, Guernsey and Kidder (1921:47) recovered one necklace of 71 lignite and limestone beads in a graduated form ranging from 3/8 to 5/8 inch [0.95-1.58 cm] in size. Another necklace of shell beads included 18 Olivella shells incised with zigzag decoration. They also commented on the use of a hard black seed very similar to albatite after it had been cut down during manufacture, as well as two other types of seed beads: Onosmodium occidentale and a brown bead similar to Melia azederach. Quartz and alabaster were added to the material type list (Guernsey and Kidder 1921:48); these are also harder materials and testify to the ability of the early Anasazi to work minerals given their Stone Age technology.

Description of a shell pendant from Broken Roof Cave indicates it was a "carelessly cut section of abalone shell, roughly triangular in shape and measuring 1 3/4 by 3/8 inches" [4.45 by 0.95 cm] (Guernsey 1931:68). It was found in Cist 1.

Additionally, feathers were commonly used for ornamental purposes. Guernsey (1931:69) describes a number of them.

Other excavated sites in the Kayenta area provide additional evidence of the use of ornaments.

Haury (1945) reports on a Basketmaker II circular structure (20 ft [6.096 m] in diameter) and several small cists in Painted Cave, northeastern

Table 10.5. Basketmaker II ornaments taken from Jernigan (1978).

Figure	Type	Material	Additional Comments
70-71	Beads	Stone Seed Shell (Abalone) Bone Shale	Disks, subspherical and tubular Disk, saucer
72-78	Pendants	Stone Turquoise Shell Whole shell Haliotus Bone Stone Jet Horn	Tabular. Pg. 160 stone was gypsum and hematite; pg. 162 Glycymeris used from BMII on but never common until Pueblo IV. Glycymeris, Conus, Olivella Round sunburst and oval-shaped. Square and rectangular. Diamond, elongate, trapezoidal, triangular.
83-85	Necklaces	Stone Seed Shell Stone Jet Limestone	Necklaces of single elements. Seeds included juniper and acorn cups. Olivella, snail, and bone.
86	Misc.	Cord/lime Olivella/shell disk Jet/shell	
87	Bone pins		On wood cord and feathers.
89	Bone tubes		
90	Inlay Mosaic	Turquoise	Date on this is questioned in text.

Arizona. He removed three barrel-shaped beads made of compact mud rocks that were pink, gray, and pale green, with biconical perforations. Their diameters were 5/8, 7/16, and 1/2 inches [1.59, 1.11, and 1.27 cm] respectively. Haury said they were similar to beads from the Basketmaker II sites reported by Kidder and Guernsey.

A disturbed Basketmaker II burial site in the Tsegi Canyon area near Rainbow Bridge, Monument Valley, was reported by Lockett and Hargrave (1953). There was a green pendant in with the burial in Cist 7.

Gaumer (1937) reported on a child burial that probably dates to Basketmaker II in Desolation Canyon, Utah. There were 2,771 beads in eight coils (for a length of 11 feet [3.35 m]) found near the head of the burial. The beads were slate and white bone, with a single red stone bead.

In DuPont Cave (Kane County, Utah), Nusbaum (1922:29-30) recovered a number of ornaments as follows: Cist 4 contents included a two-strand necklace of polished seeds and serpentine beads, and several sections of a string of seed beads. Later in the text, Nusbaum (1922:80-81) describes two necklaces recovered from Cist 30. The first consisted of two strings (26 inches long [0.66 m]) of brown Ephedra seeds (243 in all) that were held together by six large greenstone discoidal beads. The second necklace was a 55-foot [16.76 m] long string of Ephedra beads. Nusbaum also recovered a land snail shell bead and a saucer-shaped shell bead, presumed to be Olivella, in loose fill.

Further east and 13 km north of Durango, CO, Morris and Burgh (1954) excavated the Talus Village (Ignacio 7:101), a Basketmaker II house with at least seven floors. Floors 1, 2, and 3 dated by tree-rings to the period from approximately A.D. 180 to 330. There were six cists in the pithouse, several with burials. Of a total of 34 burials found in the cists and crevice at this site, several were accompanied by grave goods.

At the nearby North Shelter site (Ignacio 7:2A), a total of 47 burials were recovered during excavation of nine floors. In some instances, these burials were badly preserved as only four were found in cists. This site was tree-ring dated between A.D. 46-260+. In their descriptions of the artifacts, Morris and Burgh (1954:57) reported they recovered five obsidian, seven quartzite, and 54 chalcedony drills at this site.

> Not more than a dozen drills in the lot are slender enough for making even the largest perforations in the hundreds of beads collected. The two pipes..., some pieces of perforated shell..., and a few other objects show the use of a drill, but such instances seem too few to account for the large number of implements. We suspect that the drill found its most frequent use in some industry of which evidence has not been recovered.

Thus, a few stone drills may have been used in the manufacture of beads, but there is no certain proof. Morris and Burgh (1954:60) also suggested that five of their abraders may have been used for making ornaments. These abraders were of a grayish-black material and were variable in shape.

Examination of 897 gaming pieces from this site indicated that there were three sets, and that a craftsman made each set. Gaming pieces tended to be scored on one side and were circular, rectangular, and lenticular in shape.

A total of 31 bone tubes, used as beads and whistles, were generally ground on the severed ends. They were seldom square cut and neatly finished.

Vegetal material included two necklaces of Juniperus monosperma seeds, plus hundreds of other isolated beads. Originally light brown in color, these seed beads turned black with luster after they had been worn.

A variety of shells had been used. Most numerous were Olivella. In many cases, the spire had been either ground or hammered off, and the opposite end had been removed as well. In a few, only the spires had been removed sufficiently to allow stringing. Other shell genera that were identifiable include Abalone and Conus, but these were few in number.

Among the minerals used for beads and pendants, lignite was the most predominant. Gray, pink, light green, and dark green stone beads were recovered. The pink and gray were identified as shale. In their discussion of the necklace with 107 stone beads that accompanied Burial 29, Morris and Burgh (1954:72) note the sizes graded from small to large. Measurements of the lignite beads ranged from 8.5 to 14 mm in diameter, and 5-5.5 mm in height, with thicknesses of 4-9 mm. Gray/pink beads ranged from 1-1.8 cm in diameter. All perforations were biconical and ranged from 4-4.5 mm in diameter at the face of the stone.

Other Basketmaker II sites dating to the Los Pinos Phase include LA 2605, a village on a tributary of the Pine River (Fenega and Wendorf 1956), where Olivella and Haliotus shells, bird bone beads, and powdered hematite were recovered. In the same general area south of Durango, Eddy and Dickey (1961) found a bird bone bead and evidence of red and light green stains (probably hematite and malachite) on a paint palette. Southwest of Montrose, Hurst (1942) recovered a red and white sandstone bead blank, tubular bone beads, and seed beads in Tabeguache Cave.

Conclusions

Review of the literature provides a broader perspective on use of ornaments and minerals than did the limited data from Chaco Canyon and the San Juan Basin. Several inferences can be made.

The earliest inhabitants of the American Southwest used very little jewelry. According to Jernigan (1978), only bone items were utilized by "big game hunters."

During the Archaic Period, however, a number of materials were fashioned into beads, pendants, discs, and rings. Included among the materials were marine shells available in the Gulf of California; these were transported inland to sites in Arizona and Nevada. Green ornaments (slate and schist) were also made by hunter-gatherers; the significance of the color, however, is not determined. Technology was sufficient to fashion beads and pendants from materials as hard as dolomite; however, shells and bones were not extensively shaped. Distribution of ornaments, based on the available data, indicates some differences between sites in Arizona and Nevada versus those in New Mexico. In Chaco Canyon and the San Juan Basin, Middle Archaic sites had only bone beads, and a possible freshwater shell pendant. Not until the Late Archaic do seed, shale, and wood beads appear in the archeological record. Soft minerals were utilized, possibly as pigments.

By Basketmaker II, a number of additional material types were utilized in what would later be the Kayenta and Mesa Verde Anasazi areas, including the first evidence of turquoise (Table 10.5). The technology in northeastern Arizona and southwestern Colorado had been developed to a point that allowed creation of small lignite beads. There may have been part-time specialists based on evidence from Ignacio 7.2A; Morris and Burgh (1954) suggest that three sets (a total of 897 gaming pieces) were made by three craftsmen. The burials at sites from these two areas suggest that everyone had access to some ornaments; however, where sex and age were reported, the necklaces found with females and children may indicate differential use based, in part, on age or sex.

Data from the San Juan Basin and Chaco Canyon do not provide information for similar production and distribution. Here, few material types were used and few ornaments were found during Basketmaker II. There may be two explanations for this. First, the majority of the excavated sites from the San Juan Basin are open rather than cave or house sites. These sites are less likely to have been used for habitation or long-term camps. No burials have been found. The differences could be due to sampling. Second, there may be a cultural difference between areas. Scheick (1983a, 1983b) notes that the area around Gallup, NM, has evidence of mixed archeological cultural remains that span the entire time sequence from Archaic through Pueblo III. Differences between the Oshara-Cochise of the Archaic, and the later Mogollon-Anaszai may be part of a continuum that separates Zuni-Rio Grande pueblo peoples today. This possibility of a long-standing interface between different groups needs much further investigation.

Basketmaker III-Pueblo I

Excavations were carried out at nine sites in Chaco Canyon that have components dating between A.D. 500 and 920 and from which some ornaments were recovered (Table 10.6). Because the dates overlap in this Basketmaker III-Pueblo I continuum, there are few data for each discrete period. Periods are lumped into the broader categories for comparative purposes. Three sites had components that fell within Basketmaker III, two within the Basketmaker III-Pueblo I transition, and six within Pueblo I. Data on material types by site and time are summarized in Table 10.6.

Basketmaker III

Three excavated pithouse villages that had components dating ca A.D. 400/500 to 725/750 were assigned to this period:

1) 29SJ 423: Material from the great kiva, trash area 2, and the central pit of Pithouse A was assigned to the A.D. 500s (McKenna 1986; Windes 1975a).

2) 29SJ 1659 (Shabik'eshchee Village): This site, excavated by Roberts (1928, 1929) and re-excavated in part by Hayes (1975) during the Chaco Project, produced ornaments and minerals that can be dated between A.D. 500 and 700. Material from the court, kiva and associated Pithouse C, and Pithouse X, however, falls within the Pueblo I period (McKenna 1986). Truell (1986:218) states that based on architecture, House C and the Protokiva house date to the late A.D. 700s to 800s. Her House C complex includes the court and Bins 12-15. Bullard (1962) also assigned House C to the Pueblo I period. Thus, six alabaster beads, one turquoise pendant, and six turquoise mosaic pieces may be later, but these ornaments are not out of place in Basketmaker III (e.g., compare types of turquoise objects with those from 29SJ 423 [Table 10.6]).

3) 29SJ 299: Pithouse A and Pithouse D had ornaments that were dated to the A.D. 600s (Loose 1979; Windes 1976a).

Procurement: Comparison of Table 10.6 with Table 10.4 reveals that quartz and calcite crystals, jasper, sandstone, selenite, talc, and turquoise, plus new species of shell are being collected and used by Basketmaker III people in Chaco Canyon. Several of these materials (jasper, Olivella, and possibly Glycymeris) were documented by Jernigan (1978) for earlier inhabitants of the American Southwest, but had not appeared in excavated Chaco sites until

Table 10.6. Basketmaker III-Pueblo I ornament and mineral materials.

Period	A.D. 500s	A.D. 500-700	A.D. 600s	A.D. 600-800		A.D. 700-820				A.D. 800-920		
Material	29SJ 423	29SJ 1659	29SJ 299	29SJ 628	29SJ 116	29SJ 299	29SJ 724	29SJ 1360	29SJ 628	29SJ 627	29SJ 629	29SJ 1360
Argillite	-	-	-	1 Bead 1 Pendant	3 Beads 1 Pendant 1 Modified 251 Unmod.	-	1 Pendant 1 Pend.bl. 1 Bead	1 Modif.	1 Modif.	-	-	-
Azurite	-	1 Unmod. 3 Modif.	2 Modif.	1 Ball 10 Modif.	-	-	-	2 Modif.	-	-	1 Modif.	-
Calcite	4 Unmod.	6 Beads* 1 Other	2 Pend. bl. 2 Unmod.	1 Bead	-	-	1 Bead 1 Unmod.	-	-	-	-	-
Crystal, calcite	1 Unmod.	-	-	-	-	-	-	-	-	-	-	-
Evaporite	-	-	-	-	-	-	-	-	-	1 Unmod.	-	-
Garnet	-	-	-	-	1 Other	-	-	-	-	-	-	-
Gypsite	2 Unmod.	4 Unmod.	2 Modif. 5 Unmod.	1 Unmod.	-	-	2 Modif. 5 Unmod.	-	-	1 Unmod.	-	-
Gypsum	-	1 Pendant	-	2 Pendant	-	-	2 Pend.	2 Unmod.	-	-	-	-
Hematite	12 Unmod. 1 Modif.	1 Pendant 6 Unmod. 3 Modif.	8 Modif. 24 Unmod.	1 Paint. 1 Pendant 249 Unmod.	1 Other 30 Modif.	-	3 Modif. 1 Unmod.	1 Modif. 9 Unmod.	-	-	1 Unmod.	-
Iron	-	-	1 Unmod.	-	-	-	-	-	-	-	-	-
Jasper	-	1 Other	-	-	-	-	-	-	-	-	-	-
Lignite	-	1 Bead 1 Other - Frags.	12 Modif.	1 Unmod.	-	-	1 Modif.	-	-	1 Modif.	-	1 Unmod.
Limonite	13 Unmod. 1 Other	17 Unmod. 5 Modif.	2 Unmod.	7 Modif. 23 Unmod.	1 Disk 61 Unmod.	-	6 Modif. 6 Unmod.	1 Modif.	1 Modif. 32 Unmod.	1 Modif. 7 Unmod.	3 Unmod.	1 Effigy
Limonitic sandstone	-	-	-	-	1 Ball	-	-	-	-	-	-	-
Malachite	1 Unmod.	-	1 Pend. bl. 2 Unmod.	2 Modif. 5 Unmod.	-	-	2 Unmod.	1 Unmod.	-	-	-	-
Ocher, unident.	-	8 Modif.	-	-	-	-	-	-	-	-	-	-
Quartz crystal	-	1 Other	-	-	-	-	-	-	-	-	-	-
Quartzite	-	-	-	-	1 Disk	-	-	-	-	-	-	-

Table 10.6. (continued)

Period	A.D. 500s	A.D. 500-700	A.D. 600s	A.D. 600-800		A.D. 700-820				A.D. 800-920		
Material	29SJ 423	29SJ 1659	29SJ 299	29SJ 628	29SJ 116	29SJ 299	29SJ 724	29SJ 1360	29SJ 628	29SJ 627	29SJ 629	29SJ 1360
Sandstone	1 Other	1 Other	-	1 Unmod.	2 Disks 1 Ball	-	-	-	-	-	-	-
Schist	-	-	-	1 Pendant	-	-	-	-	-	-	-	-
Selenite	1 Unmod.	67 Unmod. 1 Modif. 1 Other	6 Modif. 16 Unmod.	3 Modif. 300 Unmod.	-	1 Unmod.	4 Modif. 28 Unmod.	1 Modif. 59 Unmod.	2 Unmod.	66 Unmod. 4 Modif.	18 Unmod.	1 Modif. 1 Unmod.
Serpentine	-	-	-	1 Bead 1 Modif.	-	-	-	-	-	-	-	-
Shale	-	-	-	-	-	-	2 Beads 1 Other 1 Modif.	-	-	-	-	1 Modif.
Sulphur	-	-	-	1 Modif. 1 Unmod.	-	-	-	-	-	-	-	-
Talc	-	1 Other	-	-	-	-	-	-	-	-	-	-
Turquoise	2 Beads 4 Inlay 3 Modif. 3 Unmod. 1 Frag.	2 Pend.[a] 6 Inlay[a] 3 Modif.	1 Modif.	1 Modified 1 Unident.	-	4 Unmod.	1 Unmod.	1 Unmod. 1 Pendant 1 Bead 2 Modif.	-	1 Modif. 1 Debris	2 Modif. 1 Other	1 Pendant
Bone	2 Beads 1 Disk 1 Other	16 Beads 1 Gm. pc.	18 Beads 1 Gam. pc.	1 Bead	2 Beads 1 Other	-	-	-	-	-	1 Bead	-
Ceramic	-	-	-	-	-	1 Pendant 1 Pend. bl.	-	-	-	-	-	-
Glycymeris gigantea	-	1 Brac. fr. 1 Pendant	-	1 Br. fr.	-	-	1 Br. fr.	-	-	-	-	-
Haliotus cracherodii	-	-	-	1 Pendant - Frags.	-	-	-	-	-	-	-	-
Olivella dama	3 Beads	3 Beads - Frags.	-	-	3 Beads	1 Bead	2 Beads	-	-	-	-	-
Freshwater clam	-	3 Pendant 1 Disk	-	-	-	-	-	-	-	-	-	-
Unident. shell	1 Bead 1 Uniden.	-	1 Unident.	-	-	-	1 Bead 1 Uniden.	-	-	-	-	-
Fossil shell impression	1 Unmod.	-	-	-	-	-	-	-	-	-	-	-

Table 10.6. (continued)

Period	A.D. 500s	A.D. 500-700	A.D. 600s	A.D. 600-800		A.D. 700-820				A.D. 800-920		
Material	29SJ 423	29SJ 1659	29SJ 299	29SJ 628	29SJ 116	29SJ 299	29SJ 724	29SJ 1360	29SJ 628	29SJ 627	29SJ 629	29SJ 1360
Fossil, other	1 Unmod.	-	-	-	-	-	-	-	-	-	-	-
No. of materials	14	18	12	18	9	4	14	8	3	6	6	5
Total items	62	168	106	620	360	8	77	82	36	83	27	6
Ornaments	16 (25.8%)	50 (29.8%)	22 (20.8%)	12 (1.9%)	18 (5.0%)	3 (37.5%)	14 (18.2%)	2 (2.4%)	-	-	2 (7.4%)	2 (33.3%)
Soft minerals (pigments)	31 (50.0%)	116 (69.0%)	67 (63.2%)	590 (95.2%)	92 (25.6%)	1 (12.5%)	55 (71.4%)	76 (92.6%)	35 (97.2%)	79 (95.2%)	23 (85.2%)	2 (33.3%)

[a] The six alabaster/calcite beads, six turquoise inlay and one turquoise pendant are from the second occupation that is Pueblo I.

Basketmaker III. There was an increase in the number of material types brought from other areas of the San Juan Basin (azurite, quartz crystal, talc/soapstone). This may indicate increased interaction among the inhabitants of the basin, expressed though economic exchange networks, or it may represent increased search for and use of pigments and ornaments by residents of the canyon for either ritual or decorative purposes. The presence of turquoise indicates that procurement networks had been extended beyond the San Juan Basin, and the two shell species indicate procurement networks reached the Gulf of California. This suggests that by Basketmaker III, the Chaco Anasazi were part of the long-distance trade networks that provided shell to Basketmaker II Anasazi in northwestern Arizona and southwestern Colorado.

Production: The artifact types that were found during Basketmaker III include bracelet fragments, possibly mosaic inlays, gaming pieces, and other worked forms, in addition to the beads and pendants found during earlier periods (Figure 10.1). Most of the beads are still made from bone; a group of bone beads from 29SJ 299 and those at 29SJ 1659 show that most of the ends were cut evenly rather than jaggedly, which suggests more care in their manufacture (for a more complete discussion of bone bead manufacturing, see discussion at the end of this chapter). The Olivella dama shells at 29SJ 423 were ground to various degrees, indicating more than expedient grinding alone. Discoid beads made from several materials (calcite, turquoise, lignite) appear in the Chaco area and are the standard form. The two turquoise beads from site 29SJ 299 were not exceptional; one was crudely made, and both were made from greenish turquoise (5 G 8/1 on the Munsell chart). The descriptions of the calcite and lignite discoid beads from 29SJ 1659 were not detailed, but Roberts' illustration (1929:Plate 30) shows that the manufacturing of calcite-alabaster beads was well done. The lignite tube bead (Roberts 1929:Plate 30) has rough ends and does not indicate superior craftsmanship.

Bracelet fragments indicate these ornaments were nicely cut from Glycymeris shells. There is no evidence of etching or design work, a contrast to the well-known Hohokam decorating techniques already present by the Colonial Period, A.D. 550 to 900 (Jernigan 1978:63, Figure 20). Who made these bracelets is uncertain; they may have been imported as complete bracelets because no workshop areas or tools have yet been discovered in Chaco Canyon.

Pendants and pendant blanks are generally tabular pieces; their shapes vary from rectangular with rounded corners to trapezoidal and oval (e.g., at 29SJ 1659). One unusual non-tabular triangular malachite piece from 29SJ 299 had a notch/groove and numerous striations (Figure 10.1[l]).

A single disk was found on the surface of 29SJ 1659; due to the greater number found after A.D. 700, it may be a Pueblo I artifact, as there are discoid objects found during that time period in other Chaco Canyon sites.

The gaming piece from 29SJ 299 was flat, long and narrow; one edge was straight and one rounded; there were numerous linear marks on it. The gaming piece from 29SJ 1659 was also a flat, oval piece that had striations on its surface.

Tesserae or inlay tended to be rectangular. At 29SJ 423, the three turquoise pieces varied in size but were about 0.13-0.15 cm thick. This may reflect the thickness of the turquoise veins from which they were cut; many of the veins still visible at the Cerrillos Mining District are very similar.

One unusual piece of bone was recovered at 29SJ 423. It was flat, rectangular and saw-toothed on the two side edges with a groove running up and down the middle (Figure 10.1[k]). The saw-tooth pattern was found on a horn pendant at White Dog Cave (Jernigan 1978:171, Figure 78) during Basketmaker II, but here there were numerous teeth that were not deeply notched. The piece from 29SJ 423 has four and five notches on the sides and does not resemble any artifacts described or drawn by Jernigan.

A broken tabular piece of sandstone from 29SJ 423 that had been notched on one short side has no known function (Figure 10.1[j]).

The materials that were fashioned into ornaments required more energy expenditure than the bone and limonite found during the Archaic-Basketmaker II period. If one assumes, however, that the aragonite and shell items found in sites dating to the earlier period are correctly classified in the chronological sequence, the increase in energy

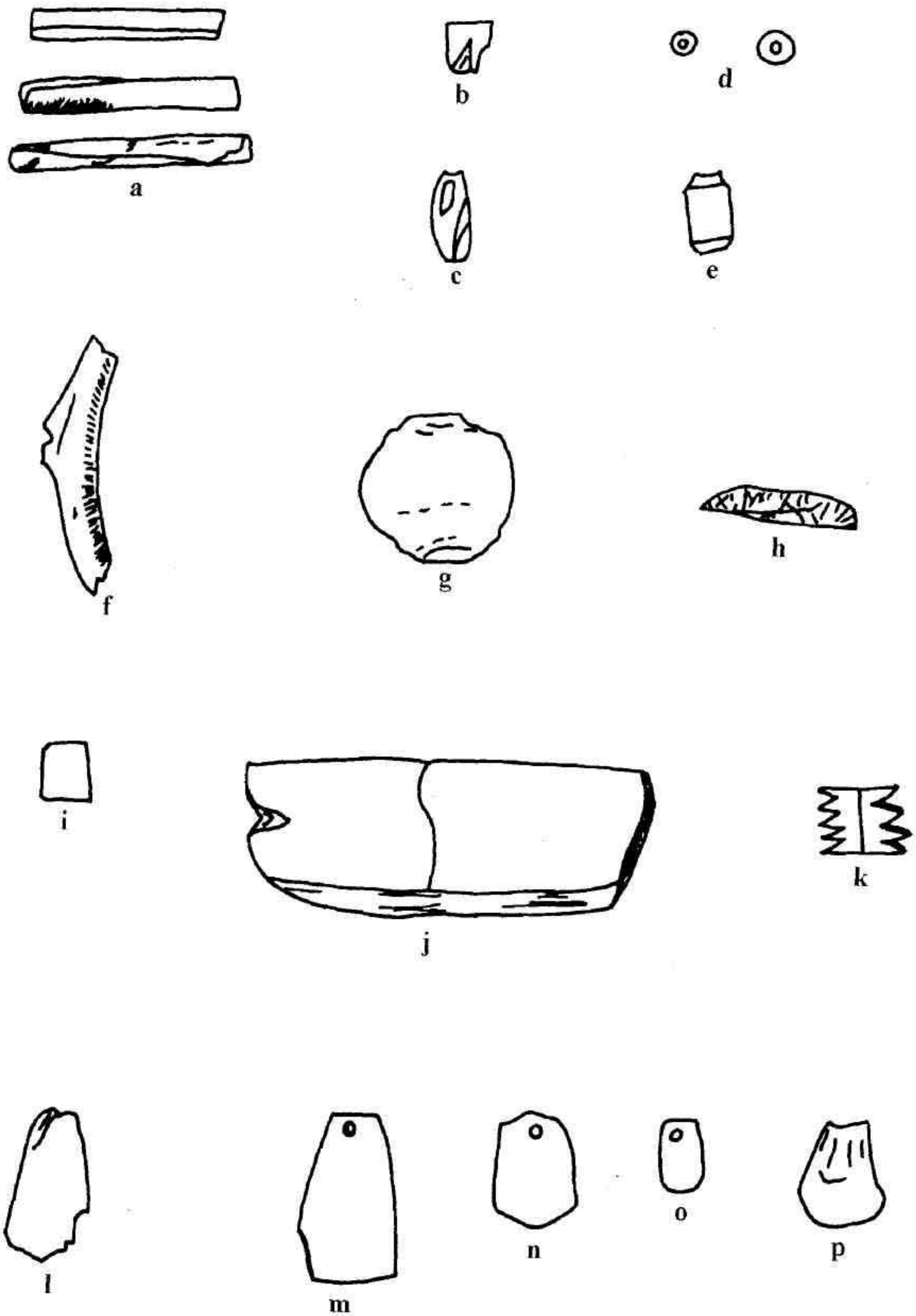
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Figure 10.1. Ornament types from Basketmaker III-Pueblo I sites in Chaco Canyon.

a) Bone beads from 29SJ 299 (FS 173A).
b) Olivella dama bead from 29SJ 423 (FS 417).
c) Olivella dama bead from 29SJ 1659, Shabik'eshchee Village (USNM 340823).
d) Calcite/alabaster beads from 29SJ 1659, Shabik'eshchee Village (USNM 40875).
e) Lignite bead from 29SJ 1659, Shabik'eshchee Village (USNM 340840).
f) Glycymeris bracelet fragment from 29SJ 1659, Shabik'eshchee Village (USNM 340856).
g) Freshwater mussel disk from 29SJ 1659, Shabik'eshchee Village (USNM 340867).
h) Bone gaming piece from 29SJ 299 (FS 173B).
i) Haliotus cracherodii inlay from 29SJ 423 (FS 57).
j) Sandstone piece from 29SJ 423 (FS 124).
k) Bone piece from 29SJ 423 (FS 213).
l) Malachite pendant from 29SJ 299 (FS 396).
m) Haliotus pendant from 29SJ 1659, Shabik'eshchee Village (USNM 340803).
n) Turquoise pendant from 29SJ 1659, Shabik'eshchee Village (USNM 340833).
o) Turquoise pendant from 29SJ 1659, Shabik'eshchee Village (USNM 340805, 74 04 75).
p) Freshwater shell pendant from 29SJ 1659, Shabik'eshchee Village (USNM 340814).

FS numbers indicate artifact is part of the National Park Service collections; USNM number indicates this belongs to the U.S. National Museum, Smithsonian Institution).

expenditure is not large. Of the materials made into an ornament during this period, turquoise was the hardest at 5-6 on the Moh's scale and would have required the most time to manufacture into ornaments. The remainder of the ornaments were made from materials which ranged from 1 1/2-4 on Moh's scale, the latter being the same range noted for the Archaic-Basketmaker II period.

At none of these sites is there any indication that ornaments were made within the areas where found. The manufacturer may have been someone outside the canyon, or our sample may be biased. With limited data, it is not possible to specify where production was carried out; but the two calcite and one malachite pendant blanks at 29SJ 299 and the few pieces of turquoise that were slightly modified at 29SJ 299, 29SJ 423, and 29SJ 1659 suggest that inhabitants may have made their own pieces if we assume that the presence of modified and unmodified pieces relate to manufacturing rather than placement of offerings, lost material, etc. The variation in quality of workmanship seen on these ornaments suggests more than one maker.

Distribution and Consumption. Due to the few ornaments present in the Basketmaker III components of these three sites, no inferences are made about their use during this period. Some jewelry was made and used but little was found in a context that points to how it was used by the population. Roberts (1929:143-144) noted that only three of 14 burials at Shabik'eshchee Village were accompanied by grave goods, e.g., ceramics. In one burial, a bowl was found in the rubbish from houses with three pieces of rubbed azurite and six pieces of rubbed red ocher. Two bone tubes were the only ornaments that appeared with one of the skeletons that was buried on the knoll just northwest of the main site. Roberts attributes the structures on this knoll (the protokiva and House X) to the second phase of occupation of this site, which Bullard (1962) and Truell (1986) place in the Pueblo I period.

At 29SJ 423, three turquoise pieces were found in Posthole A, the roof support for the great kiva. Between the benches were two turquoise and three shell pieces; below the lower bench were two turquoise and two shell pieces. These artifacts may indicate the beginning of a custom of placing offerings in kivas during construction or remodeling. Excavations at Pueblo Bonito (Judd 1954; Pepper 1920; catalog cards from the American Museum of Natural History and the U.S. National Museum) and at Chetro Ketl (Hewett 1936; W. Reiter 1933; J. Woods 1934) revealed numerous caches or offerings of shell, turquoise and other materials in kivas and great kivas in similar proveniences during the Classic Bonito Phase (A.D. 1020 to 1120).

Basketmaker III-Pueblo I Transition

Two sites assigned to the Basketmaker III-Pueblo I transition period were excavated during the Chaco Project:

1) 29SJ 628. Some material from six pithouses and two cists was dated to the period A.D. 600 to 820 (Truell 1976).

2) 29SJ 116. This open site was basically a lithic scatter with material from several periods. Because a single radiocarbon date indicated the use of Hearth 1 at about A.D. 690, the minerals and ornaments were dated within the time period A.D. 600 to 800. All the materials in this study, except a single garnet, were similar to those found in other Basketmaker III-Pueblo I sites. Windes (personal communication 1985) considers all but the hearth to be Archaic in date. Yet the garnet is more indicative of later use (see below).

Procurement. As might be expected when one compares an open site with an architectural site, there are some differences in the types of materials found. There is a greater variety of material at 29SJ 628 than at 29SJ 116, but each site revealed materials that were not present at the other. Table 10.4 and Table 10.6 indicate that the only new materials recovered in Chaco Canyon sites were garnet, schist, serpentine, sulphur, and Haliotus cracherodii. The garnet from 29SJ 116 may be from a later period, as other garnets are not found at Chaco Canyon sites until a later date, e.g., at Pueblo Bonito (Mathien 1985:Appendix C, Tables 23a and 23 b; Judd 1954). Although the schist, serpentine, and Haliotus from 29SJ 628 are new to the list of materials found in a datable context in excavated Chaco Canyon sites, these materials were found during earlier periods in other parts of the Anasazi world (see Archaic-Basketmaker II section above). To my knowledge, sulphur has not been reported previously. It can be found locally and was among the minerals recovered from Pueblo Bonito (Brand et al. 1937:62). The presence of Halitous shell indicates the ability of the Chaco Anasazi to obtain shells from the Pacific Coast and not just from the Gulf of California. Other Basketmaker III people at Prayer Rock (Morris 1980) were also using Haliotus shell for pendants.

Production. Neither of these sites provide evidence of definitive workshop areas for the manufacture of ornaments. At sites 29SJ 628, however, we find the first evidence of fashioning argillite into an ornamental form. Although argillite was found earlier on Archaic-Basketmaker II sites, sites where we have better time control suggest an A.D. 720 to 820 date for its use as a decorative material. If the 251 flakes found across the trenches at 29SJ 116 represent waste material, this open-air site may have been a processing area for this material; however, the lack of abraders or other tools associated with manufacturing of ornaments limits our interpretation of the processing activity.

Balls and disks are the new artifact forms that were recovered at these two sites. Balls were fashioned from azurite, limonitic sandstone, and sandstone and show little evidence of work other than shaping. Limonite, quartzite, and sandstone were fashioned into flat disks; only the quartzite piece and one limonite disk at 29SJ 116 were finely shaped, the other sandstone ones were crudely shaped. An earlier freshwater clam disk had been recovered between A.D. 500 and 700 at 29SJ 1659 by Roberts (1929).

The single garnet found at 29SJ 116 may be an anomaly. There had been several attempts at drilling this artifact, but none were successful. Garnet is harder than turquoise, 6 1/2-7 1/2 on Moh's scale versus 5-6 for turquoise, which may indicate the limits of the Anasazi drilling technology or their unwillingness to invest the additional labor needed to complete the work of modifying this material.

Distribution and Consumption. There is too little available information to make inferences about distribution and consumption.

Pueblo I

Six of the excavated sites had components specific to this period.

1) 29SJ 299: Four rooms (Room 12, Room 13, Room 14, and Room 15), a ramada, and the floor and floor fill of Pithouse E are assigned to the A.D. 700 to 820 period. Windes (1976a, personal communication, 1986) dates them at A.D. 800.

2) 29SJ 628. A limited amount of material from Pithouse F and Pithouse G was assigned to the A.D. 700 to 820 period (Truell 1976).

3) 29SJ 724. Limited material from Pithouse A and Pithouse C was deposited in the A.D. 700 to 920 period (Windes 1976b).

4) 29SJ 1360. Room 2 and Room 3 of House 1, the bench of Kiva C of House 2, the trash mound, and Level 3 of the test trench provided material from A.D. 700 to 820. House 1, Room 4, and Level 3 of the test trench contain material from A.D. 820 to 920 (McKenna 1984).

5) 29SJ 627. Pithouse C, Layer F, and Room 9, Subfloor 3, and Floor 4, provided material dated A.D. 820 to 920 (Truell 1992).

6) 29SJ 629. Trash in "Room 4;" Trash Mound Layer 1; Grids 59, Layers 1-2; Grid 64, Level 3; Grid 65, Levels 4-6; and Test 99, Level 1 north of Room 1-3, provided material from the A.D. 820 to 920 period. Windes (1993, personal communication 1986) places the dates closer to A.D. 900.

Although Pueblo I occupations were reported for House C at 29SJ 1659 (Bullard 1962) and at 29Mc 184 (only test pits were excavated in 1975 by T. C. Windes), no ornaments or minerals were recovered from these proveniences. In the court and kiva areas at Shabik'eshchee Village (29SJ 1659), however, Roberts (1929) recovered six alabaster-calcite beads, one turquoise pendant, and six turquoise mosaic pieces. These probably fall within the late A.D 700s to 800s (Truell 1986).

Procurement. No new materials are found from the components dated to this period. There are no shell ornaments and only a few pieces of turquoise among the artifacts recovered. This could be attributable to the small sample. All but the azurite and turquoise were available from the local Chaco Canyon area.

Production. Most of the unmodified or partially modified material was soft and may have been used for pigment (except for turquoise, shale, and bone). One effigy figure was recovered at 29SJ 1360. Made of limonite, it was anthropomorphic in shape and relatively large (7.41 cm high)(McKenna 1984:303, Figure 5.15). No new artifact forms were recovered.

Distribution and Consumption. The scarcity of artifacts found on house floors or with burials precludes statements on these topics.

Comparisons

Other excavated sites in Chaco Canyon that provide data on ornaments and minerals for the period A.D. 500 to 900 are few. And in most cases, few artifacts were recovered.

At 29SJ 1657 (Half House), an eroded pithouse below 29SJ 1659 (Shabik'eshchee Village), Adams (1951) reports a bracelet fragment from the fill and some pieces of lignite in a rectangular pit and a subfloor firepit. It is doubtful the lignite recovered in this site was used for ornamental purposes. The site is dated to the A.D. 700s.

Judd (1924) excavated two pithouses located along the Chaco Wash in the main part of the canyon. In Pithouse 1, dated as Basketmaker III-Pueblo I and located just east of Casa Rinconada, no ornaments or minerals were reported. From Pithouse 2 (29SJ 1678), a mile east of Pueblo Bonito, only one Glycymeris shell bracelet fragment was recovered in the material that had fallen into the wash. Although Roberts (1938) suggests it was occupied ca. A.D. 777, Windes (personal communication, 1980) places it in the A.D. 820 to 920 period.

Another possible A.D. 820 to 1020 component is Pithouse A at Bc 51 (29SJ 395). Here, four Glycymeris bracelet fragments, a shale bead, five turquoise, three azurite-malachite, and one quartz crystal piece were reported and/or found among the collections (Kluckhohn and Reiter 1939).

Based on this review, there seems to be little evidence of jewelry use by the inhabitants of Chaco Canyon prior to the A.D. 900s. Although materials such as turquoise and shell indicate participation in a trade network that extends far beyond the San Juan Basin, there is no evidence to suggest who made jewelry or if there were any jewelry-making specialists.

A brief examination of some of the published literature from elsewhere in the Anasazi world was not comprehensive, but it does provide some information on the use of ornaments during the Basketmaker III-Pueblo I period.

Whitten (1982) presents data on the Crawford site, a Basketmaker III-Pueblo I site with two pithouses and several features, located on the southwestern edge of the Muddy Water community near Crownpoint. The site was dated between A.D. 500 and 800, probably mid 700s, and no ornaments were reported.

Near Tohatchi, Bullard and Cassidy (1956) and Olson and Wasley (1956) excavated part of an extensive Basketmaker III-Pueblo I settlement as part of a pipeline route. At LA 2507, only one tubular bone bead was found on the floor of Pithouse A. Two other bone beads were reported, but exact proveniences were not given. They were probably from other structures that were excavated. No ornaments were reported with the burials recovered.

Further south in the Red Mesa Valley, Gladwin (1945) reports the only ornaments found during the White Mound Phase (ca. A.D. 730 to 900) were three single turquoise pendants (Plate XVII) and a stone bird effigy.

At Window Rock, Fehr et al. (1982) excavated AZ-P-24-1, a Pueblo I-II site. One red shale pendant in "typical bird representation" was recovered in a small circular basin-shaped pit located several feet from any of the structures.

In the Whitewater District, near Allantown, AZ, Roberts (1939, 1940) excavated a number of structures in the vicinity of a later Chacoan structure. Unit 2 was a surface structure with six rooms, several shelters, and a subterranean chamber or kiva. Room 10, which Roberts considered a storage room, had many beads on the floor in a single group. All were shell—some pink, white, and red, with a few orange. Most were discoid, but some were figure-eight-shaped. Roberts estimated a total of about 9,000 beads or 37'4" when strung. A few pieces of azurite and malachite and a few turquoise fragments were also recovered. Unit 2 was considered to be an early Developmental Pueblo village; however, as Roberts has commented, there is considerable Chaco influence in this area during the Developmental Period, and these ornaments (plus the burial material) may relate to the Bonito Phase of Chaco rather than the Basketmaker III-Pueblo I Phases under discussion in this section.

In the Petrified Forest, at Twin Butte site, Burial 2 of 8 found in Test Trench 2 had 376 pieces of worked turquoise and nine pieces of red sandstone or argillite, along with several hundred strung shell beads and an abalone pendant (Wendorf 1953:138, 155). Wendorf thought Burial 2 may represent a craftsman rather than a high status individual. This is the earliest evidence I have found to suggest a craftsperson who worked with ornaments. Between burials 5A and 6 in Test Trench 1, only one turquoise pendant was recovered.

At Site 264 in the Awatovi District, Woodbury (1954:147) records three pieces of turquoise mosaic inlay dating to Basketmaker III-Pueblo I. One was from Room 8; two were from Room 16, one was on the floor and one was on the lower bench, both at the west side of the room. Lacking perforations, they were similar in size to turquoise used for inlay. All three were a poor grade of turquoise. A turquoise pendant was also recovered; no provenience was given. A creamy white limestone pendant fragment was also found on the bench of Room 16. Woodbury (1954:149) notes that pendants of stone seem to be more abundant at sites where shell was scarce, "probably because stone was a less convenient material to work into ornaments, and was not much used if shell was available. The commonest pendant shapes are rectangular or subrectangular, round or oval and trapezoidal. All three are reported from Basket Maker III."

In Canyon de Chelly, Morris (1933) reports on burials from Tseahatso Cave, which is dated to Basketmaker III. Three burials were described. Here necklaces and bracelets of shell, stone, and turquoise were found, as well as turquoise inlay. In Mummy Cave, Morris (1925) found two child burials out of over 14 with white bead bracelets interspersed with abalone shells. Other cave burials in the area had turquoise mosaic pendants. One male also had a bracelet of shell beads. Other burials had pendants of shell, as well as wood and yucca seed bead ornaments.

In the Prayer Rock District, Morris (1980) found additional burials in a number of caves that are Basketmaker in age. In Broken Flute Cave, Burial 5, an adult male had a bracelet of 12 Olivella shells and white discoid beads around the neck; Burial 3 had a bracelet of Olivella and white shell beads, as well as a necklace of Olivella and white discoid beads. In Cave 2, a baby was buried with an Olivella shell bracelet and a strand of discoid pink and white stone beads around the neck. Material from structures attributed to this period, however, was not as abundant as that with burials. In Pithouse 1 of Ram's Horn Cave were three stone pendants and eight stone beads, along with a stone drill, fossil shell, and lumps of red and yellow pigment. There was no inference as to whether this represents workshop material. Pithouse 4 in this cave had an incomplete pendant and a stone bead. In Pocket Cave, Pithouse 3 contained only one stone pendant. Other ornaments from this area included pendants of selenite, turquoise, and fine-grained rock, beads of lignite, fine-grained rock, red and white variegated stone, turquoise, effigy pieces of lignite and shell, and a variety of discs. Identified shell taxa included Haliotus, Agaronis testacae, Spondylus, Conus, Pyrene, Turitella, Glycymeris, Oliva, and Olivella (Morris 1980). These data are consistent with those reviewed under the earlier Basketmaker II section above, in that children are buried with jewelry and that adults receive varying amounts. Remains in living/storage structures are sparser.

In western Utah, Steward (1936) reports on several sites that may reflect a Basketmaker III-Pueblo I occupation. Among these were ten turquoise pendants from at least six different proveniences at four different locations. A stone bead, and a few lignite, slate, and stone pendants were the only other ornaments reported.

A considerable amount of excavation has taken place in the Mesa Verde area and a few Basketmaker III sites had some ornaments.

> Archeologists working in the Mesa Verde area are often impressed by the fact that few articles classifiable as ornaments are encountered in excavation. To all intents and purposes the former inhabitants of this region were 'poverty struck' as regards possession of items for personal adornment. It is not often that ornaments are found interred with the dead and, considering Pueblo Indian burial customs in general, this factor alone is indicative of their actual scarcity. A review of items reportedly taken from the Cliff dwellings in the early days shows that jewelry rarely was found (Lancaster and Pinkley 1954:66).

Table 10.7 summarizes the excavations dated to Basketmaker III-Pueblo I. The excavations since Lancaster and Pinkley's 1954 statement certainly conform to it.

Review of publications resulting from the Dolores Archaeological Project indicates a similar pattern. Tests at Hanging Rock Hamlet recovered a trapezoidal turquoise pendant dating to the late A.D. 800s from Pitstructure 2 (Gross 1986:66) and two bone gaming pieces from a pre A.D. 600 Archaic Basketmaker II site, Cougar Springs Cave (Gross 1986:95). Nelson (1986:Table 8A.4, 783) reports a bead (PL 136) from the floor of Pitstructure 1 at Pozo Hamlet, which dates between A.D. 600 to 780. At Kin Tl'iish, Dohm and Gould (1986:668-669) found a jet ornament fragment (PL 363) that was broken during manufacture on the bench surface in Pitstructure 1; they also found one other unspecified ornament in another unit. Sebastian (1986) lists an ornament from Prince Hamlet, Area 3; this site is dated A.D. 720 to 840. At LeMoc Shelter, Hogan (1986:Table 4D.8) reports that a total of 11 bone ornaments were recovered in proveniences that span the period A.D. 750 to 950. At Grass Mesa Village, two ornaments were recovered from the Dos Casas Subphase (A.D. 760 to 850), 10 from the Periman Subphase (A.D. 850 to 900) and three from the Great Mesa Subphase (A.D. 880 to 925) (Phagan 1988:Table 14.5). At McPhee Village, Phagan and Hruby (1988:Table 15.8) report three shell ornaments were recovered from areas dated between A.D. 850 to 900.

Reed et al. (1981) report no ornaments from 5 MT 5834, a Basketmaker III pithouse near Dolores, CO. In the La Plata District, Morris (1939) found a cache of four Olivella shells and two white disk beads at Site 23, which was dated Basketmaker III. In Site 18, there was a calcite pendant in Building I, Area 5, that is attributed to a Pueblo I occupation, as was an Olivella bead from a pit in Protokiva 1. Laurel Wallace (personal communication, 1993) reports that some ornaments were recovered from Basketmaker III-Pueblo I sites along the LaPlata highway, but, again, these were relatively few in number.

In the Piedra District of southwestern Colorado, in villages that he attributed to Pueblo I, Roberts (1930) recovered some ornaments. Among the pieces he reported were two bone tube beads, three gaming

Table 10.7. Basketmaker III-Pueblo I sites/ornaments from Mesa Verde.

Site and Provenience	Artifacts	Date	Reference
MV-145:			
Pithouse I	No ornaments	A.D. 600s	O'Bryan (1950)
Pithouse II, floor	Pendant and pendant blank, fine-grained red or white stone		
SE bin	*Oliva* shell		
Earth Lodge B		Late A.D. 600s	Lancaster and Watson (1954)
Pithouse, fill	One stone pendant		
MV-1924-71	No ornaments		Nordby and Breternitz (1972)
Site 1060	No ornaments	Basketmaker III	Hallisy (1972)
Badger House Community			
Pithouse A	No ornaments	A.D. 600s	Hayes and Lancaster (1975)
Pithouse B	No ornaments	A.D. 600s	
Pithouse C	No ornaments	A.D. 600s	
House 3 and Protokiva C			
Rooms 6, 8 and 9, fill	Red shale pendant blank	ca. A.D. 725	
House 2	No ornaments	ca. A.D. 775	
House 6	No ornaments	ca. A.D. 800	
House 7	No ornaments	ca. A.D. 800	
House 4 and Protokiva E			
Room 3, fill	Chapin Gray pendant blank	ca. A.D. 860	
Room 7	Red shale pendant blank		
Room 9, fill	Jet bird effigy pendant		
Room 13, fill	Bluff Black-on-red pendant blank		
House 5			
Room 1, Bins/banquette	2 Chapin Gray bird effigies	ca. A.D. 860	
Protokiva D, level 1	Red shale pendant blank		
MV-1940			
Pithouse, main room, Cist 1	Bone bead	A.D. 680-725	Birkedal (1976)
antechamber, Bin 1	Bone bead		
antechamber, Bin 2	Bone bead		
MV-1937			
Structure 3, main room, Lev. 1	Gaming piece or ornament	ca. A.D. 640	Birkedal (1976)

pieces, four shell bracelets on a skeleton, and bits of copper ore and a few turquoise.

> Only a few ornaments were recovered and most of them were made from stone. The most favored material, judging from the number of fragments and whole specimens, was a ferruginous shale of black-red hue. Pendants of various forms were made from it. The bird (plate 53, a) is an unusual type, but the disk, b, is a characteristic form. Pieces from many broken pendants of this type were found, but the illustrated example is the only whole specimen. The pendant, c, is a hard greenish stone whose exact character cannot be determined without destroying the ornament. The so-called southwestern form of alabaster furnished the material from which it was made.
>
> The four flat beads were made from gray shale. The latter is very abundant in the region. For some reason or other beads were not plentiful. Even counting the broken ones, there were not enough in number recovered to make two medium-length necklaces. Why there was a lack of such objects for personal adornment is not known. At most sites beads of one kind or another generally are quite abundant.
>
> Turquoise was so rare that it might well be considered as non-existent. Only two small pieces, presumably from an inlay or mosaic, were found. Both were lying on the surface of the ground and may well have come from a later horizon. No traces of this unusually popular stone were present in an unquestioned relationship to the period represented (Roberts 1930:153-154).

In the Navajo Reservoir District, Eddy (1968) found some ornaments at various sites. The most abundant were found at LA 4169, where 71 shell discoid beads and five Olivella shells were recovered with Burial 12. Most of the ornaments were found with burials.

In the Rio Grande Valley, several sites with Basketmaker III-Pueblo I material have been excavated. Table 10.8 summarizes these data. Again, there are few ornaments at most sites except the Artificial Leg-Basketmaker site where more recent excavations under the direction of Matthew Schmader (1994) revealed a burial with about 100 pieces of turquoise in chunks, partially worked beads, and pendants. Freshwater mussel, Olivella beads, Spondylus shell, and abalone were also present. Other material recovered at the site includes slate hishi, two smoky quartz crystals, an effigy-shaped slate pendant, as well as other minerals.

In summary, the material types used in Chaco Canyon reflect participation in a long-distance trade network extending as far as the Pacific Ocean. Production was probably occurring in several places and a few individuals may have been better jewelry-makers than others. Only one suggestion of a craftsperson's burial was recorded—at the Twin Butte site in the Petrified Forest (Wendorf 1953).

Regarding distribution and consumption, there is generally very little ornamental material recovered from structures dating to the Basketmaker III-Pueblo I period in any part of the Anasazi world, so the material recovered from the sites in Chaco Canyon fits the pattern well. The material from the Whitewater District of eastern Arizona, near Allantown, may contradict this as the storage room (Room 10 of Unit 2) had over 9,000 shell beads, but again this may be slightly later in time. The Artificial Leg-Basketmaker Site in the Rio Grande Valley reported by Frisbie (1967) and Schmader (personal communication, 1992) also had an unusual amount of turquoise and other objects. It may also be slightly later, in part; Schmader (1994) would place his excavations up to A.D. 1000 at the very latest, but they ranged from A.D. 650 to 900 overall.

Burial goods reflect differences in the number of ornaments recovered. Those burials with the greatest number of grave goods have been found in the Canyon de Chelly, the Prayer Rock District, with one man at the Twin Butte site in the Petrified Forest, and at the Artifical Leg-Basketmaker site. These are not as rich in grave goods as those discussed under the Archaic-Basketmaker II section. It may be that the introduction or use of jewelry co-occurred along with some type of horticulture and at least seasonal settlement and construction of habitation structures. Although ornaments were still used in the Basket-

Table 10.8. Basketmaker III-Pueblo I sites/ornaments from the Rio Grande Valley.

Site and Provenience	Artifacts	Date	Reference
St. Joseph's site, 1 pithouse	No ornaments	A.D. 600-800	Schorsch (1962)
Denison site			
Pithouse 3	No ornaments	A.D. 675-750	Vivian and Clendenen (1965)
Near Zia Pueblo			Vytlacil and Brody (1958)
Pithouse 1, burial	One galena, 3 Olivella beads, one other bead, 46 red berry seed beads	A.D. 750-800	
Sedillo site		A.D. 750-800	Skinner (1965)
Pithouse 6, floor	Piece of limonite, piece of hematite		
Artificial Leg-Basketmaker site[a]			
Site I (3 excavated pithouses)			
Pithouse 1, backdirt	3 shell pendants	Basketmaker III-Pueblo I	Frisbie (1967)
surface	1 slate disk bead, 1 Olivella shell		Schmader (1994)
Site II (4 excavated pithouses)			
Site surface	1 bivalve fragment, 1 limonite nodule		
Pithouse 2, fill	2 bivalve shell pendants		
depression 3	4 specular iron specimens		
Pithouse 3, Cist I, fill	1 ea. selenite, malachite, limonite		
Cist II, fill	1 yellow iron oxide, 3 malachite, 1 limonite		
Cist IV, fill	1 malachite		
Cist XI, fill	1 gaming piece, 1 snail shell		
Pithouse 4, fill	1 worked turquoise, 1 Olivella shell		
	4 bivalve pendants, 2 other, 1 Haliotus pendant, 1 freshwater snail, 2 malachite, 3 hematite, 2 selenite		
	4 unworked turquoise, 1 malachite		
Site III (5 pithouses), surface	1 turquoise bead fragment, 1 worked bivalve, 2 mica schist fragments		
Pithouse 1, fill	1 Olivella bead, 1 unworked turquoise		
floor fill	1 ea. Olivella, selenite		
floor	1 bivalve		
vent shaft	3 bivalves		
subfloor Cist I			

[a] Recently Matt Schmader (1994) excavated a number of pithouses that are part of this village. They contained a quantity of ornaments and other materials that are unusual for this period, but combined with Frisbie's material suggest that the Artifical Leg-Basketmaker site on the West Mesa near Albuquerque has a very unusual amount of material.

maker III-Pueblo I period, the number of finely made beads found with burials decreased (Gaumer 1937; Guernsey and Kidder 1921; Kidder and Guernsey 1919; Morris and Burgh 1954).

In conclusion, the material types from Chaco Canyon do not vary substantially from those found in the rest of the Anasazi world during Basketmaker III-Pueblo I. Very few burials were recovered from this period in Chaco Canyon, and none had ornaments. The material from structures is sparse as it is in most, but not all, other Anasazi sites.

The Bonito Phase

Because the accepted Basketmaker-Pueblo chronology established by Kidder (1962) was inadequate to describe the chronology in Chaco Canyon, and because there has been much confusion due to the introduction of terms such as Bonito Phase, Hosta Butte Phase, and McElmo Phase, Toll, Windes, and McKenna (1980) defined a Bonito Phase sequence for use in analysis of the Chaco Project. It has been used for the ornament analysis; the only deviation is at 29SJ 627, where Marcia Truell was able to see a distinction ca. A.D. 1050 rather than between the A.D. 920 to 1020 and 1020 to 1120 or Early and Classic Bonito Phases (Windes has now revised his dates, see Chapter 1). Therefore, this section will cover what Hayes (1981) called the Late Pueblo II-Early Pueblo III and will be discussed as Early, Classic, and Late Bonito Phases, the latter covering the A.D. 1120 to 1220 period. Data from 29SJ 627 for A.D. 1000 to 1050 will be discussed with the Early Bonito Phase.

Early Bonito Phase (A.D. 920 to 1020)

Table 10.9 presents data from eight sites that have material dating from A.D. 900 to 1050. (At 29SJ 627, Truell [1992] used A.D. 1000 and 1050 as time divisions; her data from A.D. 900 to 1000 and A.D. 900 to 1050 are lumped together as there were no differences in material types found.) These sites are as follows:

1) 29SJ 299. Kiva B (Pithouse B) and Pithouse E alluvial fill were dated A.D. 920 to 1020 (Loose 1979; Windes 1976a).

2) 29SJ 389 (Pueblo Alto). Room 139, Floor 2; Room 142, Floor 2; Room 143, Floor 8; Room 146, Floors 2-5; Kiva 3 probably a pilaster base; Plaza 1, Grid 8, Floors 4-9; Trash Mound, Grid 70, SC 1, Grid 71 and Grid 136 were all dated to this period (Windes 1987). Most ornaments were from the early A.D. 1000s (Mathien 1987).

3) 29SJ 391 (Una Vida). Room 23, Floor 2, is dated to the A.D. 900s (Akins and Gillespie 1979).

4) 29SJ 625 (Three C Site). Very little material was recovered at this small site that was previously excavated by Vivian (1965) and reexamined by Windes in 1976 (field notes).

5) 29SJ 627. Some fill from Pithouse B and Pithouse C; Room 3 below Floor 1, Room 4 below Floor 1, Room 5 below Floor 1; Room 6, Floor 3; Room 7 below Floor 1; Room 8 below Floor 1 to Floor 3; Room 10 below Floor 1; Room 12 below Floor 1; Room 16, Floor 4, firepit; Room 22 below Floor 1 to Floor 3; Room 23; Room 25; Kiva F, Level 5 of fill to floor; Burial 3 in Test Trench 10; and parts of the Trash Mound were all dated A.D. 900 to 1050 (Truell 1992). Proveniences dated A.D. 1000 to 1040/1050 include Room 1, Room 4, Room 5, Room 6, Room 7, Room 10, Room 13, Room 15, Room 19, Room 11 fill to Floor 1; Room 8 and Room 8 to Floor 2; Room 11 and Room 16 to Floor 3; part of the ramada; Kiva D and Kiva G; the Trash Mound, Grids IL-1, JL-1, KL-1, KL-2, and KX (Truell 1992).

6) 29SJ 628. Only some surface material was assigned to this period (Truell 1976).

7) 29SJ 629. Fill and floor of Pithouse 2 and Pithouse 3; Rooms 6-8; some material from Pitstructure A; Plaza Grid 9, especially Other Pit 1, Other Pit 9, Other Pit 14, and Other Pit 6; Plaza Grids 15, 16, 20, 21, and 202; anthills in Plaza Grids 31 and 41; and Trash Mound Grids 76 and 82 (Windes 1993).

8) 29SJ 1360. House 1, Rooms 7, 9, and 11, and Kiva B; House 2, Rooms 1-2, surface Kiva A; and Plaza Areas 1, 2, 3 and 5 (McKenna 1984).

Because there is so little data from four of these sites, most of the discussion that follows relies on sites with larger databases for primary observations. The others, however, do reaffirm the use of some materials at other sites.

Table 10.9. Early Bonito Phase (A.D. 920-1020) ornament and mineral materials.

Period	A.D. 900-1050	A.D. 1000-1050	A.D. 900-1020	A.D. 920-1020					
Material	**29SJ 627**	**29SJ 627**	**29SJ 625**	**29SJ 628**	**29SJ 629**	**29SJ 299**	**29SJ 389**	**29SJ 391**	**29SJ 1360**
Aragonite	1 Debris	-	-	-	-	-	-	-	2 Modified
Argillite	1 Pendant 2 Zoomorph. 4 Modified	1 Disk 2 Modified 1 Unmodified 1 Pendant 1 Flake	1 Modified	-	1 Modified 1 Bead	-	1 Bead 1 Inlay 1 Pend. fr. 2 Unmodif.	-	2 Beads
Azurite	5 Unmodified 2 Modified 20 Debris	9 Unmodified 2 Modified	-	1 Unmodif.	8 Unmodif. 1 Zoomorph. 2 Debris	-	2 Unmodif.	-	5 Unmodif.
Calcite	6 Beads 2 Modified 1 Unmodified	8 Beads 1 Bead/disk 1 Pendant 1 Unmodified	-	1 Bead	1 Unidified	1 Unmodif.	26 Beads 3 Unmodif.	1 Unmodif.	9 Beads 1 Unmodif.
Copper	1 Unmodified	-	-	-	-	-	-	-	-
Crystal, feldspar	-	-	-	-	-	-	-	-	1 Modified
Crystal, quartz	1 Unmodified	1 Unmodified	-	-	-	-	1 Pendant	-	-
Galena	1 Unmodified	-	-	-	21 Debris	-	1 Modified 1 Unmodif.	-	-
Geothite	-	1 Modified	-	-	-	-	-	-	-
Gypsite	22 Unmodified	6 Unmodified	-	-	1 Unmodif.	-	3 Beads 89 Unmodif. 3 Pendants	-	6 Unmodif.
Gypsum	5 Unmodified	4 Unmodified	-	-	2 Unmodif.	-	-	-	2 Modified 2 Unmodif.
Hematite	2 Modified 10 Unmodified	1 Paintstone 9 Unmodified 1 Modified	-	1 Unmodif.	7 Unmodif. 3 Modified 1 -	-	3 Modified 11 Unmodif. 1 Unknown	1 Modified	1 Modified 18 Unmodif.
Jet	-	1 Unidified	-	-	1 Pendant 1 Unmodif.	-	-	-	1 Ring
Lignite	1 Modified	1 Button 2 Unmodified 1 Modified	2 Unknown	-	2 Modified 2 Unmodif.	-	13 Unmodif. 1 Unknown	-	1 Pendant 1 Unmodif.
Limonite	49 Unmodified	16 Unmodified 1 Gaming pc. 2 Modified	-	-	22 Unmodif. 10 Modified 1 Unknown	1 Modified	10 Modified 26 Unmodif.	-	3 Modified 9 Modified

Table 10.9. (continued)

Period	A.D. 900-1050	A.D. 1000-1050	A.D. 900-1020	A.D. 920-1020					
Material	29SJ 627	29SJ 627	29SJ 625	29SJ 628	29SJ 629	29SJ 299	29SJ 389	29SJ 391	29SJ 1360
Limonitic sandstone	1 Unmodified	-	-	-	-	-	-	-	-
Malachite	5 Unmodified 1 Modified	1 Unmodified 1 Modified	-	-	1 Unmodif.	-	-	1 Unmodif.	1 Unmod. 1 Debris
Mica-muscovite\ (selenite)	1 Modified	-	-	-	-	-	-	-	-
Quartz, green with sandstone	-	-	-	-	-	-	-	-	1 Other
Quartzite	-	-	-	-	-	-	9 Unmodif.	-	-
Sandstone	1 Unmodified	1 Unmodified	-	-	-	-	-	-	-
Selenite	285 Unmodified 6 Modified 1 Debris	181 Unmodif. 3 Modified 2 Debris	-	12 Unmodif.	490 Unmodif. 1 Other 1 Zoomorph.	1 Unmodif.	6 Modified 51 Unmodif. 1 Zoomorph. 8 Unknown	2 Modified 4 Unmodif.	1 Modified 88 Unmodif.
Serpentine	-	-	-	1 Bead	-	-	-	-	8 Beads
Shale	-	34 Beads	-	-	2 Modified 1 Bead bl. 1 Unmodif. 2 Beads	-	91 Beads 1 Inlay 1 Unmodif.	1 Bead	3,976 Beads
Shark's teeth	-	-	-	-	-	-	10 Unknown	-	-
Sulphur	-	1 Unmodified	-	-	-	-	-	-	1 Unmodif.
Turquoise	3 Pendant bl. 3 Beads 5 Bead blank 3 Inlay 35 Modified 1 Unmodified 14 Debris 1 Mod/other 1 Button 1 Mod/pend. bl. 3 Pendant 6 Unknown	25 Bead bl. 22 Debris 19 Modified 3 Unmodified 6 Pendants 4 Pendant bl. 6 Inlay 1 Other 1 Unidified 18 Beads	2 Modified	1 Modified	5 Pendants 230 Modified 202 Unmodif. 12 Beads 46 Bead bl. 1,702 Debris 3 Other 3 Inlay 4 Pend. bl. 3 Unidified 1 Unknown	-	3 Beads 17 Debris 36 Modified 28 Unmodif.	1 Modified 1 Debris	25 Debris 15 Unmodif. 6 Pend. bl. 3 Pendant 2 Unident. 1 Inlay 5 Bead bl. 1 Bead 49 Unmodif. 3 Other 3 Unknown
Bone	1 Bead 2 Gaming piece	1 Other 3 Beads 1 Gaming pc.	2 Gam. pc. 1 Tube	-	1 Gaming pc. 1 Bead 1 Ring fr.	-	1 Bead 1 Gaming pc.	-	-
Ceramic	-	-	-	-	-	-	1 Pendant	-	-

Table 10.9. *(continued)*

Period	A.D. 900-1050	A.D. 1000-1050	A.D. 900-1020	A.D. 920-1020					
Material	29SJ 627	29SJ 627	29SJ 625	29SJ 628	29SJ 629	29SJ 299	29SJ 389	29SJ 391	29SJ 1360
Clay	-	-	-	-	1 Pendant	-	-	-	-
Wood	-	-	-	-	-	-	-	-	1 Other
Glycymeris gigantea	2 Beads 5 Pendant 13 Bracelet frag.	12 Brac. frag.	-	-	2 Brac/pend. 5 Brac. frag.	-	4 Beads 19 Brac. frags.	1 Brac. frag.	5 Brac. frag. 1 Other
Argopectin circularis	-	-	-	-	-	-	1 Unmodif.	-	-
Spondylus calcifer	-	-	-	-	-	-	1 Bead	-	-
Chama echinata	-	-	-	-	-	-	2 Beads 1 Pendant	-	-
Trachycardium sp.	1 Pendant	-	-	-	-	-	-	-	-
Trachycardium panamense	-	1 Pendant	-	-	-	-	-	-	-
Haliotus cracherodii	2 Pendants	1 Pendant	-	-	-	-	-	-	-
Epyscinia medialis	1 Unmodified	-	-	-	-	-	-	-	-
Oliva sp.	-	-	-	-	1 Ring	-	-	-	-
Oliva incrassata	-	-	-	-	1 Pendant	-	-	-	-
Olivella dama	18 Beads	2 Beads 3 Unidentified	-	-	4 Beads	-	-	1 Bead	-
Conus perplexus	-	-	-	-	-	1 Other	-	-	-
Strombus galeatus	-	1 Pendant	-	-	-	-	-	-	-
Freshwater clam	-	-	-	-	1 Inlay	-	1 Unidentified 1 Modified	-	-
Unidentified shell	2 Unknown	1 Pend. frag.	-	-	-	-	-	-	-
Fossil shell impression	-	-	-	-	-	-	1 Unknown	-	-
Fossil, other	-	-	-	-	1 Unknown	-	-	-	-
No. of materials	25	24	4	6	22	4	22	8	20
Total items	553	430	8	17	2,817	4	495	14	4,261

Table 10.9. *(continued)*

Period	A.D. 900-1050	A.D. 1000-1050	A.D. 900-1020	A.D. 920-1020					
Material	29SJ 627	29SJ 627	29SJ 625	29SJ 628	29SJ 629	29SJ 299	29SJ 389	29SJ 391	29SJ 1360
Ornaments	71 (12.9%)	129 (30.3%)	-	2 (11.8%)	98 (3.5%)	1 (25%)	161 (32.5%)	3 (21.4%)	4,019 (94.3%)
Soft minerals	413 (74.7%)	238 (55.3%)	-	14 (82.4%)	551 (19.6%)	2 (50%)	207 (41.9%)	11 (78.6%)	137 (3.2%)

Procurement. Comparison of Table 10.9 with Tables 10.4 and 10.6 indicates the presence of several new minerals and shell species in excavated sites. Although a piece of unmodified copper was recovered at 29SJ 627, its unworked state leads me to suspect that it was collected as a curiosity. Similarly, mica-muscovite appears but is not shaped into a recognizable form.

The increased number of shell taxa during this period is important. Species that appear for the first time in a dated context include Trachycardium sp., Episcynea medialis, Argopectin circularis, Spondylus calcifer, Chama echinata, Oliva sp., Oliva incrassata, and Conus perplexus. Based on Truell's ability to segregate some of site 29SJ 627 from A.D. 1000 to 1050/1050 and the presence of two new shell species within those time parameters, plus the presence of two other new shell species, Trachydarcium, probably T. panamensis and Strombus galeatus, I suspect that these new shell species probably fall within the later part of the Early Bonito Phase. The increased number of shell species at small sites such as 29SJ 627 and 29SJ 629, as well as increased importation of turquoise at the small and large sites during this period, indicates more intensive interaction with people outside of the San Juan Basin, and especially with those to the west who supplied the shells. Because we do not know the source of turquoise used by the Chaco Anasazi, and neutron activation tests performed by Brookhaven National Laboratory (Bishop 1979, Mathien 1981) indicate there is a similarity between artifacts from Chaco Canyon and Guasave, Mexico, I also suspect much of this material may have been flowing into Chaco Canyon from a west or southwesterly direction. Harbottle and Weigand (1992; Weigand 1994; Weigand and Harbottle 1992) outline several trade networks from turquoise sources to sites throughout the greater Southwest; the few pieces from Chaco Canyon that have been analyzed do not limit sources of Chaco Canyon turquoise to the Cerrillos Mining District (Mathien 1992a; Mathien and Olinger 1992).

Production. When compared to the ornaments recovered in earlier time segments, argillite, calcite, jet/lignite, shale, turquoise, bone, and ceramic ornaments are much more abundant in the excavated Chaco Canyon sites dated to Early Classic Phase. This, plus the increased number of shell species, suggests increased use of ornaments for adornment, ceremonial purposes, or status symbols. If these needs truly increased, it is expected that craft specialization may have begun.

Although data from the excavated Chaco Canyon sites do not clarify the question of part-time versus full-time specialization, there is evidence for manufacturing of turquoise ornaments at canyon locations (Mathien 1984a). Workshop areas have been identified in Kiva B and Plaza Area 5 at 29SJ 1360 (McKenna 1984), and in Pithouse 2 and the plaza at 29SJ 629 (Windes 1993). Debris, probably from a work area elsewhere in the site, appeared in a pit in Plaza 1, Grid 8, at 29SJ 389 (Pueblo Alto)(Mathien 1987). Turquoise pieces that included bead blanks, broken beads, modified and unmodified pieces, and a pendant blank were recovered in the early trash at Kin Nahasbas (Mathien and Windes 1988:266); these suggest jewelry-making at this site, as does material recovered from anthills located farther downslope, which included shell, calcite, and shale. Turquoise artifacts and debris were found in the fill of Pitstructures 1 and 2 at 29SJ 626 (Mathien 1990a); Windes (personal communication, 1986) thinks jewelry was made at this site, but Mathien (1990a) notes that there are several other possible explanations for the scatterings of turquoise throughout the fill of these two structures. In Kiva B at 29SJ 1360 and in Other Pit 1 of the plaza at 29SJ 629, active and passive abraders, probably used for jewelry manufacturing, were identified by Akins (1980, Chapter 5 of this report); one active abrader was also found in the pit at 29SJ 389, adding strength to the identificaton of these areas as production locations or debris from such locations. At 29SJ 629, Cameron (1993, Chapter 3 of this volume) and Lekson (personal communicaton, 1982, and Chapter 4 of this volume) have identified a number of small drills made from chalcedonic silicified wood (material type #1040) that may have been used to make perforations in some turquoise beads.

Most of the turquoise beads and some bead blanks recovered from this site were drilled from both sides and tended to be from 0.06-0.19 cm in size. Beads and bead blanks were from 0.09-0.21 cm with only one at 0.32 cm in thickness so that a very pointed and narrow stone drill tip approximately 0.05 cm at its tip could have produced the beads. Gillespie (1993) suggested that porcupine quill drills could have been used, based on their presence at 29SJ 629 in conjunction with the abraders and turquoise debris. At Pueblo Bonito and a few other sites, some extremely tiny finely made turquoise beads have been recovered. These stone drills would have been too large, and perhaps as Haury (1931) suggests, cactus spines were used because the perforations are almost needle thin. Morris (1928:100) also comments on the probable use of a cactus thorn, but found no objective proof this material was used for drilling ornaments. Hodge (1921:13) discovered a number of small turquoise beads during his excavations at Hawikuh; he suggests an obsidian flake was probably used as a drill rather than a thorn, grass stem, wood splinter, etc.

Haury (1931) also experimented with production of a fine-grained pelitic red rock similar to archeological specimens found in the Arizona State Museum collections. The drilling alone took over 15 minutes using an Echinocactus wislizini Engleman spine on one side. Given that he is not an experienced bead-maker, perhaps an estimate of 15 minutes per bead for the entire process would not be unreasonable. Crotty (1983:33) has drawn on Haury's experiment and the techniques discussed by Jernigan (1978:199) to estimate production of six beads per hour for black and red argillite beads. Using the estimate of 3,976 shale beads in the necklace found with the female at 29SJ 1360, this indicates over 662 hours of work just to produce one necklace. Because the red shales are softer than many of the turquoise artifacts found, the number of hours spent in the production of turquoise ornaments, even in locations where very little scrap or unfinished ornaments are recovered, must have been large.

How much a little bit of turquoise scrap represents was discussed with Theodore Frisbie (personal communication, August 1984), who has been doing ethnographic research at Zuni Pueblo for over two decades. He observed that jewelry-makers have a very high regard for turquoise and attempt to gather up even the finest flakes to be saved and used in conjunction with prayer meal in ceremonial activities. Although it is not possible to draw a perfect analogy between twentieth century Zuni and tenth century Chaco Canyon Anasazi, Judd (1954) noted the use of scraps of turquoise as offerings in kiva pilasters at Pueblo Bonito, which suggests there may have been a long-standing antecedent for the Zuni custom. Hodge (1921) indicates that the late prehistoric inhabitants of Hawikuh used turquoise as offerings; again, some of the material was not good quality. Also, Windes found turquoise in Chaco Anasazi shrines as well as in anthills to the east of the Chaco East (Kin Bulldozer) Community (Windes, personal communication, 1985; 1993). Frisbie also thought the turquoise artifacts found in Other Pit 1 of the plaza at 29SJ 629 were intentional offerings. Interestingly, only turquoise fragments and debris were found; if red shale were being utilized in the same workshops, small red flakes would be expected to appear in the archeological record. None were found. Black and white debris would be harder to find; thus, manufacturing of jet/lignite/shale and calcite ornaments might not be as easily detected. Windes looked carefully and found none at 29SJ 392 (Kin Nahasbas) and 29SJ 626, and Powers searched for these traces at Pueblo Alto (Windes 1987). Windes believes his extra care would have revealed the black and white specks. It is thus inferred that only turquoise ornaments were being processed in these workshop areas.

With regard to the types and shapes of ornaments from this period, there are several new forms found among the excavated Chaco Canyon artifacts. These include buttons, rings, zoomorphic shapes, and some unusual shell pendants. Figure 10.2 illustrates some of these in schematic form. In general, these ornaments tend to be fairly well-made. The rough edges noted in both the Archaic-Basketmaker II and Basketmaker III-Pueblo I sections of this report were not seen. These ornaments, however, are not as smoothly finished as some from later proveniences.

Both the workshop data and the better made artifacts suggest greater labor investment in the manufacturing process. Based on the data from site 29SJ 629, where two floors in the same room and a plaza area both had evidence of workshop debris, there may have been certain artisans who were skilled in this field and who did this type of work over many years. It may have been a family occupation. Whether or not it was the only occupation they engaged in cannot be determined; there may have been time alloted to both agriculture and jewelry-making.

Distribution and Consumption. Pieces of turquoise, shell, and other jewelry items are scattered among the proveniences classified as fill and are found on almost all floors of rooms, kivas, or plazas of this period at the four sites where the most careful data collections were made. In contrast, very few were reported at 29SJ 625 (Three C site), a site

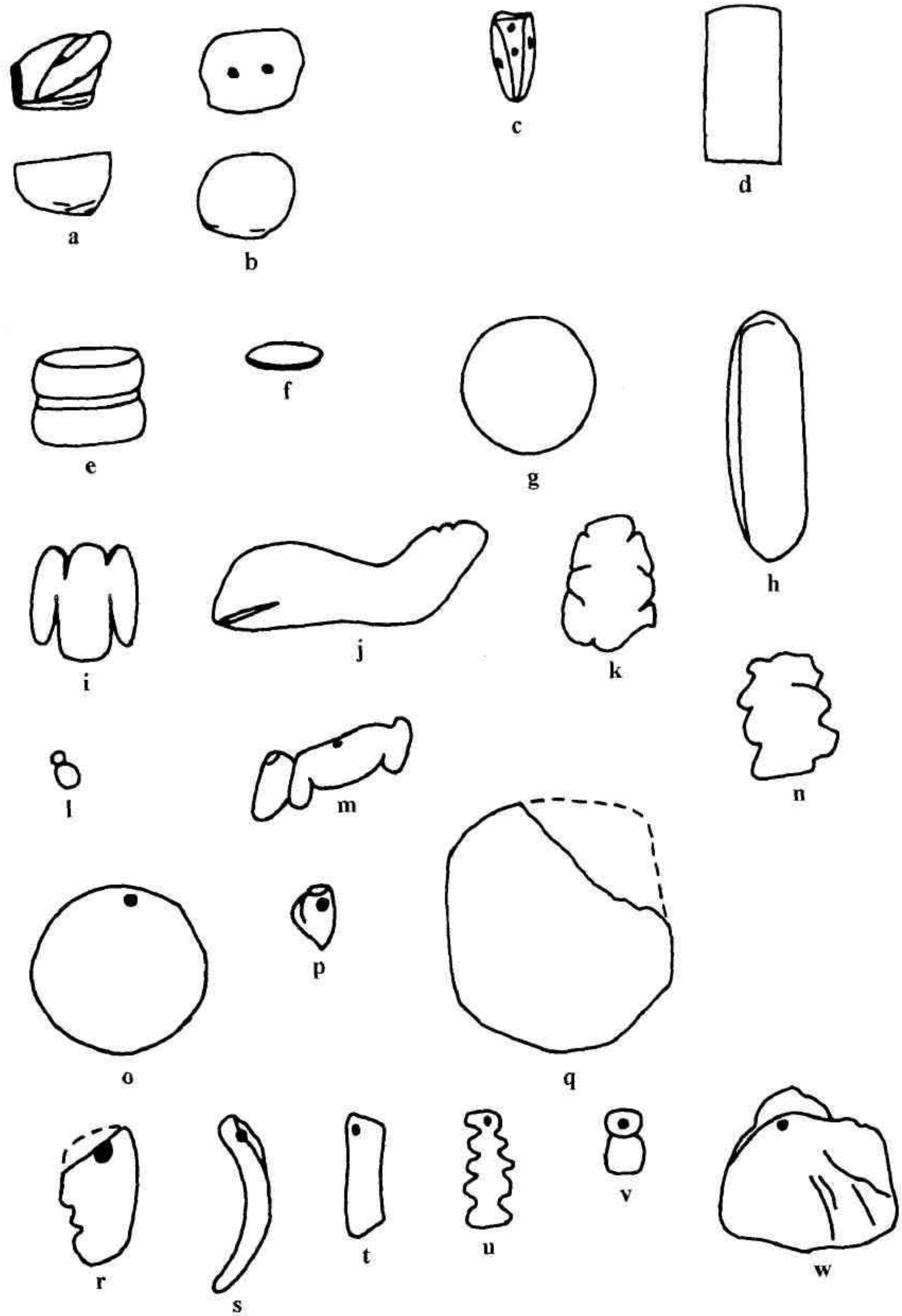
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Figure 10.2. Ornament types from the Early Bonito Phase sites in Chaco Canyon.

a) Turquoise button from 29SJ 627 (FS 5580).
b) Jet/lignite button from 29SJ 627 (FS 576).
c) Jet piece from 29SJ 627 (FS 1610).
d) Bone piece from 29SJ 627 (FS 153).
e) Olivella ring from 29SJ 629 (FS 2516).
f) Jet ring from 29SJ 1360 (FS 302).
g) Argillite disk from 29SJ 627 (FS 190).
h) Limonite gaming piece (?) from 29SJ 627 (FS 141).
i) Argillite zoomorphic from 29SJ 627 (FS 1378).
j) Argillite zoomorphic from 29SJ 627 (FS 1848).
k) Argillite zoomorphic from 29SJ 627 (FS 4387).
l) Azurite zoomorphic from 29SJ 629 (FS 719).
m) Clay zoomorphic/pendant from 29SJ 629 (FS 2805).
n) Selenite zoomorphic from 29SJ 629 (FS 2409).
o) Argillite pendant from 29SJ 627 (FS 1118).
p) Chama echinata pendant from 29SJ 389, Pueblo Alto (FS 6073).
q) Argillite pendant from 29SJ 627 (FS 2286).
r) Haliotus cracherodii pendant from 29SJ 627 (FS 2802).
s) Glycymeris gigantea pendant from 29SJ 627 (FS 5956).
t) Glycymeris gigantea pendant from 29SJ 627 (FS 5077).
u) Argopectin circularis pendant from 29SJ 627 (FS 666).
v) Trachycardium sp. pendant from 29SJ 627 (FS 1829).
w) Strombus galeatus pendant from 29SJ 627 (FS 1609).

salvaged using different excavation techniques. Although the numbers in any one provenience at any site are few, one to several ornaments on the floor indicates that distribution is widespread within sites in Chaco Canyon. Nancy Akins has examined grave goods from Chaco burials (Akins 1986:85-88) and notes that very few burials at small sites had any grave goods at all. This contrasts with several burials found at Pueblo Bonito. This does not preclude the use of ornaments by inhabitants of the small sites, however. Burial 2, found on the floor of Kiva B at 29SJ 1360, was a woman about 35-39. She wore a necklace at the time of death. In contrast, Burial 1, a slightly older female, had no ornaments. None of the three children found with these women wore ornaments. These individuals were not intentionally buried; their presence is the result of asphyxiation (McKenna 1984:353-362).

The question of ceremonial use of turquoise was raised above. As noted, Judd (1954) found turquoise debris and often poorer quality turquoise pieces in kiva pilasters at Pueblo Bonito. Review of the catalog cards of the U.S. National Museum/ Smithsonian Institution for Pueblo Bonito and Pueblo del Arroyo revealed that ornaments of other material types were also included in the pilaster offerings; some were complete, some were fragments. Mathien (1985:Appendix C) provides lists of materials from these sites. Not all the details for these offerings were available, but not all kivas had pilaster offerings. Whether there is a difference between kiva construction groups and/or behavior of the Chaco Anasazi or whether this is a result of deterioration of buildings and/or archeological field methods has not been evaluated.

Additional offerings in kivas were documented for earlier sites. At 29SJ 423, the great kiva had turquoise pieces under the posts (Mathien 1985; Windes 1975a). Bonito Phase offerings in the bench and floors of the great kiva at Chetro Ketl were also recovered (Mathien 1985:Appendix C; Woods 1934, n.d.). During excavation of a trench at Pueblo Alto, a small pocket in Kiva 3 was discovered; it may represent a pilaster offering, dating ca. A.D. 1040 to 1050, and would suggest use of beads, pendants, and debris as offerings in the Early Bonito Phase. At 29SJ 627, the ventilator tunnel of Kiva G, dating ca. A.D. 1000 to 1050, also contained what looked like the remains from a turquoise workshop, plus shell beads and fragments. The site excavator, Marcia

Truell (1992), thought these pieces may represent a ceremonial offering. If so, we then have evidence to suggest that kiva offerings were placed in a variety of places and were found at both small and large sites.

Based on the above, I suggest that during the Early Bonito Phase the Chaco Anasazi had established new procurement, production, distribution, and consumption patterns that differed somewhat from those seen earlier in Chaco Canyon and the entire Anasazi area. Ornaments continued to be used and necklaces were worn by some women; however, a pattern of ceremonial offerings was established in structures similar to those used by modern pueblos for ceremonial and community functions that may have been introduced in the A.D. 500s. The presence of such an offering at small sites in smaller kivas, as well as large ones, suggests the tradition in this time period was not an exclusive property of the inhabitants of larger sites. The presence of turquoise workshop material at 29SJ 627, 29SJ 1360, 29SJ 626, 29SJ 392 (Kin Nahasbas), and 29SJ 389 (Pueblo Alto) prior to the major growth period for the system reinforces the possiblity of little differentiation among inhabitants of the various sites in Chaco Canyon at this time. Although these inferences are based on limited data, they do provide ideas that need further exploration.

Classic Bonito Phase (A.D. 1020 to 1120)

Although much material from sites excavated by the Chaco Project was probably from this time frame, ornaments and minerals from proveniences limited strictly to this time span came from only four sites.

1) 29SJ 389 (Pueblo Alto). Room 103, Floors 1-4; Room 110, fill and Floor 1; Room 112, Floor 2; Room 138, Floor 1; Room 143, Floors 1-6; Room 236, Floor 4; Plaza 1, Grid 35; Plaza 2, Grid 201; Plaza Feature 1, Room 4, Floors 3 and 4; and the Trash Mound (Windes 1987).

2) 29SJ 391 (Una Vida). Room 19, Floor; Room 45, roof-fall and floor; Rooms 46-47, backdirt; Room 47, fill above Floor 1 (Akins and Gillespie 1979).

3) 29SJ 423. Pithouse A, surface and fill; Pithouse B, fill, shrine area. Windes (1975a) thinks most of the material from the shrine area covered Pithouses A and B, as the Classic Bonito shrine overlays these earlier structures.

4) 29SJ 721. An unfinished kiva was dated to this period. It had very little in the way of ornaments or minerals in it (Windes 1975b).

Table 10.10 summarizes the data from this period. Because only two sites have sufficient data and because 29SJ 423 is a shrine rather than an occupational site, the information from this period is difficult to evaluate; however, certain inferences can be made.

Procurement. One new shell species, Choromytilus palliopunctatus, a clam from the Gulf of California, was recovered. The earliest dated copper bell was found in the plaza at Pueblo Alto, again indicating some type of trade with inhabitants of northern Mexico. The copper bell is type IIA/a (DiPeso 1974, Vol. 7:510) or type IC1a (Pendergast 1962) and similar to those Judd (1954:Figure 28 c or e) recovered at Pueblo Bonito. This is the most widespread style found in sites throughout the Southwest. A macaw, also an import from the south, dating A.D. 920 to 1020, was recovered in the overburden of Pithouse B at 29SJ 1360 (McKenna 1984:321). Whether or not importation of this macaw correlates with the importation of copper bells from northern Mexico is difficult to determine.

Production. No workshop scrap or turquoise debris were recovered from the Classic Bonito Phase material at Pueblo Alto. Some recovered ornaments and worked minerals indicate fine workmanship, however. An excellent example is an effigy made of a hard, dark stone classified as goethite that was found in the trash mound (Figure 10.3[a]). Other shapes, also in Figure 10.3 [b and c] include two jet/lignite pieces that are deteriorating, but it is possible to see the care put into their manufacture. The selenite piece with minimal grinding (Figure 10.3[d]) is much rougher, as are the two selenite pendants (Figure 10.3 [e and f]). The quartz crystal (Figure 10.3[g]), however, exhibits a very small perforation and excellent shape. I question whether the selenite, being a more fragile material, may have deteriorated through natural causes over the years or whether it was made by a less experienced worker who started his career working with abundant local materials.

Table 10.10. Classic Bonito Phase (A.D. 1020 to 1120) ornament and mineral materials.

Material	29SJ 389	29SJ 391	29SJ 423	29SJ 721
Argillite	1 Bead 1 Disk 1 Mod. 1 Other 1 Unmod.	-	-	-
Azurite	2 Mod. 41 Unmod.	-	3 Unmod.	-
Calcite	31 Beads 2 Mod. 1 Inlay	-	1 Bead 1 Unmod.	1 Mod.
Chert, green	-	-	1 Mod. 2 Unmod.	-
Copper	1 Bell	-	-	-
Crystal, calcite	-	-	2 Unmod.	-
Goethite	1 Zoomorph.	-	-	-
Gypsite	1 Mod. 1,218 Unmod. 1 Bead 4 Unknown	-	-	-
Hematite	31 Debris 5 Mod. 54 Unmod.	-	5 Unmod.	-
Lead	-	-	1 Other	-
Lignite	1 Mod. 5 Unmod. 2 Zoomorph.	-	2 Mod.	-
Limonite	1 Gam. pc. 20 Mod. 49 Unmod.	-	14 Unmod. 1 Other	-
Limonitic sandstone	-	-	1 Unmod.	-
Malachite	2 Unmod.	-	1 Unmod.	-
Mica-muscovite selenite	2 Unmod.	-	-	-
Quartz, green with sandstone	-	-	4 Beads 1 Mod. 1 Unmod.	-
Sandstone	1 Unmod.	1 Disk	-	-
Selenite	1 Bead 13 Mod. 2 Pend. 182 Unmod. 1 Zoomorph. 1 -	-	4 Unmod.	-
Shale	34 Beads 1 Other 1 Ring	-	1 Bead	-
Shark's tooth	1	-	-	-
Turquoise	6 Beads 5 Debris 4 Inlay 10 Mod. 4 Pend. 3 Pend. bl. 3 Unmod.	5 Beads 3 Mod. 1 Unmod. 1 Pend. bl.	226 Beads 2 Pend. bl. 69 Mod. 49 Unmod. 19 Debris 1 Frag.	-

Table 10.10. (continued)

Material	29SJ 389	29SJ 391	29SJ 423	29SJ 721
Bone	1 Bead 4 Bead bl. 4 Gam. pc.	-	1 Bead	-
Ceramic	1 Ball	-	-	-
Glycymeris gigantea	8 Brac. frags.	6 Brac. frags.	1 Bracelet	-
Choromytilus palliopunctatus	1 Unmod.	-	-	-
Chama echinata	1 Pend.	-	-	-
Haliotus cracherodii	-	-	1 Pend. bl. 2 Inlay 2 Unid.	-
Olivella dama	12 Beads 1 Unid.	-	3 Beads	-
Fossil shell impression	2	-	-	-
No. of materials	23	3	18	1
Total items	1,789	17	422	1
Ornaments	126 (7.0%)	12 (70.6%)	244 (57.8%)	-
Soft minerals (pigments)	1,623 (90.7%)	-	23 (5.5%)	-

Distribution and Consumption. The one outstanding example of use of ornaments for ceremonial purposes is the data from 29SJ 423. The Pueblo III material is from the shrine, a stone receptacle containing over 150 pieces of turquoise; additionally, numerous other turquoise and shell pieces were scattered about (Hayes and Windes 1975). Beads, pendant blanks, inlay, modified, and unmodified turquoise were recovered. Although most of the beads were well-made, they tended to be larger (ca. 0.30-0.57 cm in diameter). None of the smaller beads were recovered at this site. These beads were also greener than the inlay discovered in Room 142 of Pueblo Alto or the turquoise necklaces found in Pueblo Bonito by Pepper (1909) and Judd (1954). This may reflect the choice of less desirable pieces as offerings.

At Pueblo Alto, room floors had from none to five pieces of turquoise, as they did during the Early Bonito Phase. The trash (either from the trash mound or the lower fill in Kiva 10 which may be slightly later) dating to the Classic Bonito Phase did not contain much turquoise at all, and certainly no indication of disposal of workshop material.

Late Bonito Phase (A.D. 1120 to 1220)

Three sites had material that was recovered from proveniences dating to this phase (Table 10.11).

1) 29SJ 389 (Pueblo Alto). Kivas 8, 9, 16, upper levels of Kiva 10, and floor of 15; the circular structures (1 and 2) in the plaza; Plaza 1, Grid 114; and Other Structure 4 had just a few ornaments, not enough for comparative purposes (Mathien 1987; Windes 1987).

2) 29SJ 391 (Una Vida). Room 23, fill; Room 64; Room 83, floor, are also poor candidates for comparative purposes (Akins and Gillespie 1979).

3) 29SJ 633. Room 7 fill below Floors 1 and 2; and Room 8, fill below Floor 1 (Mathien 1991).

After reviewing the discrete areas of these three sites, only the material from 29SJ 389 and 29SJ 633 provide data for any type of speculation about changes in ornament use. The data from 29SJ 391 (Una Vida), Room 23, were from an area re-excavated during the Chaco Project; ornament

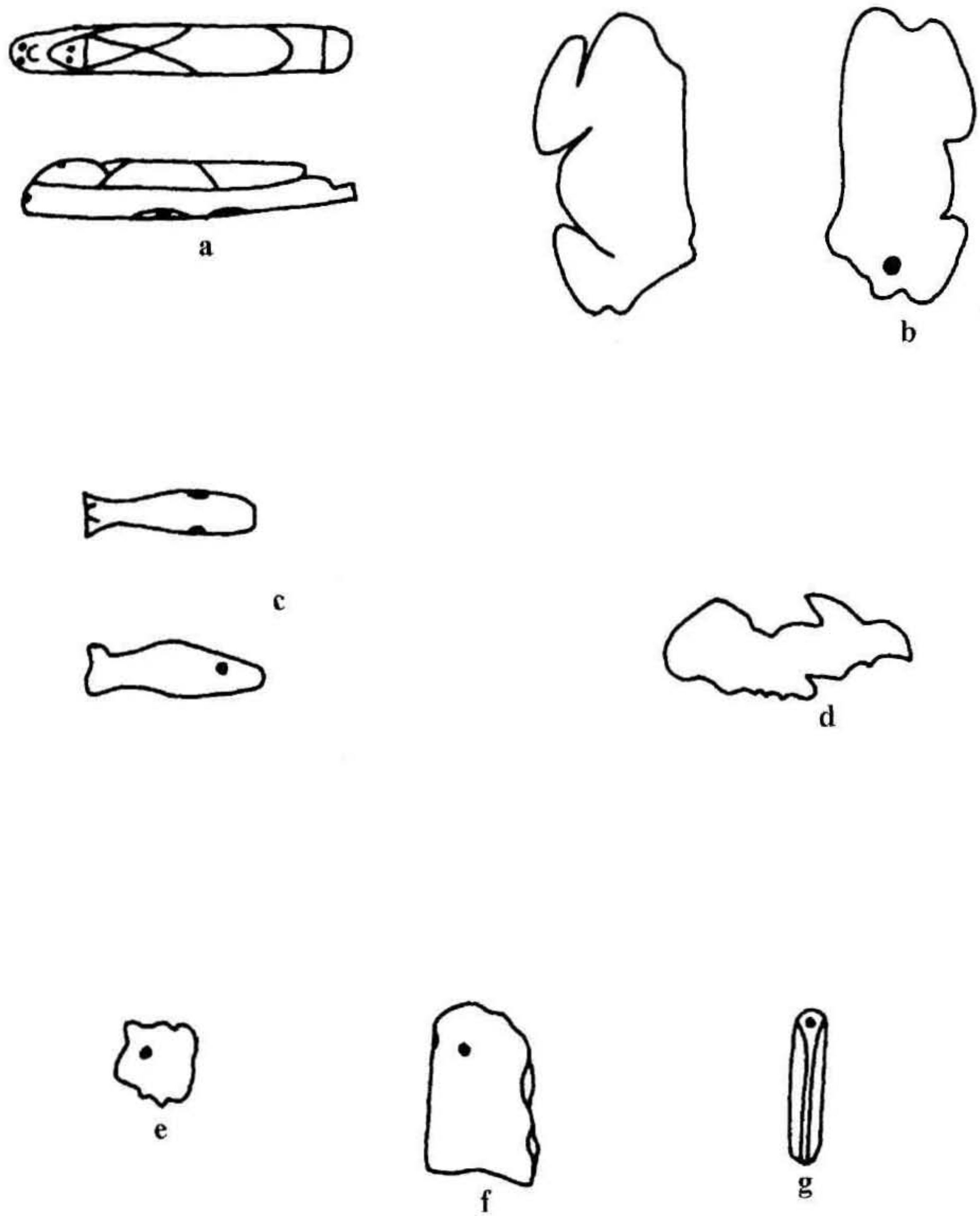
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Figure 10.3. Ornament types from the Classic Bonito Phase sites in Chaco Canyon.

a) Geothite zoomorphic pendant from 29SJ 389, Pueblo Alto (FS 4781).
b) Jet/lignite zoomorphic from 29SJ 389, Pueblo Alto (FS 4644).
c) Jet/lignite zoomorphic from 29SJ 389, Pueblo Alto (FS 4822).
d) Selenite zoomorphic from 29SJ 389, Pueblo Alto (FS 1173).
e) Selenite pendant from 29SJ 389, Pueblo Alto (FS 5467).
f) Selenite pendant from 29SJ 389, Pueblo Alto (FS 4545).
g) Quartz crystal pendant from 29SJ 389, Pueblo Alto (FS 4347).

materials were either in the fill (100 turquoise bits) from above Floor 1, which was removed by Vivian during stabilization, or from a small depression found by Akins and Gillespie (1979). Although there is a suggestion of a possible workshop here, the validity of the inference is difficult to substantiate.

Procurement. The sample is small, especially at 29SJ 633. The variety of materials from these three sites suggests there may have been fewer materials used during this period; the sample also may be skewed. At 29SJ 633, turquoise and shell were still imported, but the amounts are lower than those found in the Classic Bonito Phase.

Production. Although there are beads, pendants, an effigy, inlay, and bracelet fragments among the ornaments recovered, there are no workshop areas except for the possible material from Room 23 at Una Vida (Mathien 1984a, 1985). That identification was tentative and may be erroneous, as it is based on assumptions rather than concrete evidence.

Distribution and Consumption. None of the living floors contain a wealth of material, except the upper one in Room 23/64 of Una Vida. The few scattered pieces at 29SJ 633 resemble those from the floors of other house sites where no offerings or workshop debris were found.

Comparisons

Data from other excavated sites in Chaco Canyon that can be placed within a narrow time frame are limited (Tables 10.12, 10.13, and 10.14). Although there are numerous ornaments made from a variety of materials at sites, it is difficult to make statements about the artifacts recovered. Catalogs often have different names for the same material, or students were vague in their descriptions of what was found. These problems affect the comparisons to some extent, but they do not prohibit a statement about ornaments within a broader framework of the entire Bonito Phase (A.D. 920 to 1220, see below).

Procurement. After about A.D. 1000, a greater variety of shell species and larger quantities of turquoise indicate increased trade with other groups outside the San Juan Basin. The volume of turquoise and shells found at sites in Chaco Canyon increased over that found in the previous time segments. Data from sites excavated prior to the Chaco Project do not conflict with any of the interpretations made above. Shell taxa such as Chama echinata, Nassarius, Episcynea medialus are found during the late eleventh century-early twelfth century at the previously excavated sites. I thus conclude that by the Early Bonito Phase, we see an increase in trade for these items that are procured from distances that reach the Pacific Coast and the Gulf of California. These source areas were used by Pueblo I and continue to be used throughout the entire Bonito Phase.

Production. Possible workshop materials were recognized at Pueblo del Arroyo, Kin Kletso, Bc 51, and Bc 59 (Mathien 1984a). Although some of these areas have tentative dates, it is assumed that craftsmen were working in both large and small sites throughout the entire Bonito Phase.

Distribution and Consumption. Small sites also contained a great variety of shell species and turquoise pieces (Mathien 1984a:175). The presence of numerous ornaments, scraps of turquoise and shell, in particular, and of other materials in the pilasters of kivas at Pueblo Bonito, Pueblo del Arroyo, Pueblo Alto, and in the ventilator of Kiva G at 29SJ 627, indicate that these were not only items that served as jewelry, but that they also had some ceremonial significance. In addition to the offering found in the Basketmaker III great kiva and the shrine at 29SJ 423, Windes (1975a) also recovered

Table 10.11. Late Bonito Phase (A.D. 1120 to 1220) ornament and mineral materials.

Material	29SJ 389	29SJ 391	29SJ 633
Aragonite	3 Unmod.	-	-
Argillite	1 Inlay 4 Mod.	1 Inlay	2 Unmod.
Azurite	1 Mod. 1 Unmod.	2 Frags.	2 Unmod.
Calcite	9 Mod. 2 Pend. Bl.	2 Unmod.	-
Coal	1 Unmod.	-	-
Gypsite	3 Mod.	-	10 Unmod.
Gypsum	-	-	2 Unmod.
Hematite	6 Mod. 1 Unmod.	-	13 Unmod. 1 Mod.
Jet	-	1 Effigy	-
Lignite	2 Mod. 3 Unmod.	-	-
Limonite	3 Mod. 1 Unmod.	-	9 Unmod. 1 Mod.
Malachite	134 Debris 1 Mod. 1 Unmod.	-	-
Mica-muscovite	1 Unmod.	-	-
Selenite	17 Mod. 13 Unmod. 1 Pend. 1 Pend. Bl.	1 Pend. 1 Unknown	14 Unmod.
Shale	1 Unmod. 1 Mod. 1 Pend. 1 Other	-	-
Turquoise	1 Inlay 1 Pend. 1 Unmod.	100 Bits 1 Bead 2 Inlay 9 Debris 3 Mod. 3 Unmod. 1 Pend.	1 Bead 1 Debris 1 Pend. 1 Unid.
Bone	5 Beads 1 Pend. 1 Orn.	-	-
Glycymeris gigantea	2 Brac. frags. 2 Beads	2 Brac. frags.	-
Chama echinata	1 Pend.	-	-
Haliotus cracherodii	-	2 Inlay	2 Mod.
Olivella dama	1 Bead	-	2 Beads
Unidentified shell	-	1 Pend.	-
No. of materials	18	9	10
Total items	230	132	62
Ornaments	21 (9.1%)	11 (8.3%)	4 (6.5%)
Soft minerals (pigments)	182 (79.1%)	3 (2.3%)	52 (83.9%)

Table 10.12. Early Bonito Phase (A.D. 920 to 1020) ornament and mineral materials.

Material Type	29SJ 394 Bc 50	29SJ 589 Bc 236
Bone	10 Beads	-
Shell:	1 Bead	-
Olivella dama	1 Shell	-
Glycymeris	2 Brac. frags.	-
Stone	2 Balls	-
Stone, gray	1 Pendant	-
Turquoise	1 Bead 8 Pendants	1 Pend. frag. - Fragments
No. of materials	5	1
Total items	26	1+
Ornaments	25 (96.2%)	1 (100%)
Soft minerals	-	-

Table 10.13. Classic Bonito Phase (A.D. 1020 to 1120) ornament and mineral materials.

Material	29SJ 399 Bc 59	Ferdon's Jacal Site	29SJ 1947 Pueblo del Arroyo
Bone	7 Gam. pcs. 3 Beads	-	-
Argillite	1 Disk 1 Effigy	-	-
Gilsonite/jet	1 Pendant 1 Ring 1 Mod.	-	-
Hematite	1 Object	-	-
Shell:	-	13 White beads	1 Cylinder bead 1 Fragment 2 Bead frags.
Abalone	-	-	12 Frags.
Chama echinata	-	-	1 Bead frag.
Olivella	-	-	94 Beads/frags.
Turquoise	1 Bead	-	29 Frags. 4 Pend./frags. 8 Beads 1 Tesserae 47 Chips
No. of materials	5	1	5
Total items	17	13	200
Ornaments	15 (88.2%)	13 (100%)	89 (44.5%)
Soft minerals	-	-	-

Table 10.14. Late Bonito Phase (A.D. 1120 to 1220) ornament and mineral materials.

Material	29SJ 395 Bc 51	29SJ 400 Bc 52	29SJ 397 Bc 57	29SJ 398 Bc 58	29SJ 1912 Lizard House	29SJ 589 Bc 236	29SJ 2384 Robert's Site	29SJ 1947 Pueblo del Arroyo	29SJ 393 Kin Kletso
Aragonite	1 Cylinder	-	-	-	-	-	-	-	-
Argillite	222 Beads 2 Inlay	-	-	-	-	-	-	2 Pend.	1 Pendant 1 Cylinder 1 Square
Azurite	-	-	-	-	-	-	-	-	1 Ball 5 Pieces 1 Disk
Bone	96 Beads 1 Frag.	1 Gam. pc. 2 Beads	3 Beads	2 Beads	-	5 Beads	4 Beads	-	3 Beads 3 Gam. pc.
Calcite	2 Inlay 1 Pendant 68 Beads 15 Bilob beads 2 Frags.	1 Bilob bead	-	-	-	-	-	-	13 Mod. 5 Beads 1 Chip 1 Disk
Chalk stone	-	-	-	-	-	-	-	-	1 Cylinder
Flint, pink	-	-	1 Frag.	-	-	-	-	-	-
Galena	-	-	1 Piece	-	-	-	-	-	-
Gilsonite	66 Beads 3 Inlay	-	-	-	-	-	-	-	1 Ring frag.
Gypsite	-	-	-	-	-	-	-	-	3 Pieces
Gypsum	-	-	-	3 Ring frags.	-	-	-	-	-
Hematite	-	-	-	-	-	-	-	-	2 Cylinders 5 Unknown
Jet	2 Pendants	-	-	-	-	1 Bead	-	1 Pend.	-
Lignite	1 Modified 1 Bead	-	-	-	-	-	-	-	-
Limonite	1 Disk frag. 1 Modified	-	-	-	-	-	-	-	1 Mod.
Malachite	-	-	-	-	-	-	-	-	1 Ball 1 Mod. 5 Unknown
Mica	1 Piece	-	-	-	-	-	-	-	-
Ocher, yellow	-	-	-	-	-	-	-	-	1 Cylinder ? Nodules

Table 10.14. (continued)

Material	29SJ 395 Bc 51	29SJ 400 Bc 52	29SJ 397 Bc 57	29SJ 398 Bc 58	29SJ 1912 Lizard House	29SJ 589 Bc 236	29SJ 2384 Robert's Site	29SJ 1947 Pueblo del Arroyo	29SJ 393 Kin Kletso
Quartz, rose	-	-	-	-	-	-	-	-	4 Chips
Sandstone, red	-	-	2 Beads	-	-	-	-	-	1 Ball
Shale, black/gray	309 Beads	-	-	-	-	-	-	-	287 Beads 1 Rect.
Selenite	2 Pieces 1 Frag.	-	-	-	-	1 Pend.	-	-	1 Pend. frag.
Shale, pink	-	-	-	-	-	-	-	-	1 Piece
Shell	4 Unknown	1 Unknown 1 Bead	2 Pieces	1 Pendant	-	1 Disk 2 Beads	-	-	1 Bead
<u>Chama echinata</u>	-	-	-	-	-	-	-	-	1 Pendant 1 Bead
<u>Episcynea medialis</u>	-	-	-	-	-	-	-	-	1 Shell
<u>Spondylus princeps unicolor</u>	2 Frag.	-	-	-	-	-	-	-	-
<u>Oliva incrassata</u>	1 Frag. 1 Pendant 1 Shell	-	-	-	-	-	-	-	-
<u>Glycymeris</u>	-	-	-	-	-	-	-	-	7 Beads 6 Brac. frags.
<u>Haliotus</u>	1 Inlay ? Frags.	-	-	-	-	-	-	-	1 Ellipse 3 Beads 8 Frags.
<u>Olivella dama</u>	4 Unknown	-	1 Bead	1 Bead	-	3 Beads	-	-	99 Beads
<u>Nassarius</u>	-	-	-	-	-	-	-	-	3 Beads
Schist	1 Unmodif.	-	-	-	-	-	-	-	-
Slate, red/?	-	-	-	1 Pend. bl.	-	-	-	-	14 Beads
Stone	-	1 Pendant	-	-	-	-	-	-	-
Beige	-	-	-	1 Pendant	-	-	-	-	-
Gray	-	-	1 Bead	-	-	-	-	-	-
Green	-	-	1 Piece	-	-	-	-	-	-
Red	-	-	1 Piece	2 Pend. 1 Pend. frag.	2 Ornaments	-	1 Pend. bl. -	-	-
White	-	-	-	-	-	-	-	1 Bead	-

Table 10.14. (continued)

Material	29SJ 395 Bc 51	29SJ 400 Bc 52	29SJ 397 Bc 57	29SJ 398 Bc 58	29SJ 1912 Lizard House	29SJ 589 Bc 236	29SJ 2384 Robert's Site	29SJ 1947 Pueblo del Arroyo	29SJ 393 Kin Kletso
Turquoise	39 Modified 334 Pieces 3 Pendants 4 Beads	1 Frag. 1 Bead 1 Unmodif.	9 Bits 33 Pieces 4 Modif. 1 Frag.	3 Pieces 1 Ornament 2 Whetstones 1 Chip 4 Beads	2 Unknown 1 Ornament	2 Frags. 1 Earbob	-	5 Pendants 2 Beads 2 Frags.	16 Modified 8 Mosaic 17 Beads 3 Frags. 4 Pend/frag. 7 Bead frag. 2 Pieces
Wood	-	-	-	-	-	-	-	-	2 Cylinders 1 Tube 1 Frag.
No. of materials	17	5	10	8	2	6	2	3	25
Total items	1,193	10	60	23	5	16	5	13	558
Ornaments	802 (67.2%)	7 (70%)	7 (11.7%)	13 (56.5%)	3 (60%)	14 (87.5%)	5 (100%)	11 (84.6%)	481 (86.2%)
Soft minerals	5 (0.4%)	-	1 (1.7%)	-	-	-	-	-	21 (3.8%)

similar offerings of turquoise at several other shrines located throughout the San Juan Basin. These include Hosta Butte in the south and Huerfano in the north.

The analysis of burial goods by Akins (1986) and Akins and Schelberg (1984) suggests that turquoise items occur more frequently with burials in large sites and especially from Pueblo Bonito. Akins and Schelberg infer status differentiation by the Classic Bonito Phase. Haury's (1931) and Crotty's (1983) crude estimates of time needed to produce beads would support the idea of some form of craft specialization that may have been nearly full-time to produce the thousands of items such as those found by Pepper (1909) in Room 33 of Pueblo Bonito and by the Chaco Project in various sites.

Leadership of some type and specialization is supported by other studies. Data on prehistoric roads led several investigators (Marshall et al. 1979; Powers et al. 1983; Windes 1982, 1987) to conclude that Pueblo Bonito, Pueblo Alto, and Chetro Ketl were the central node in the network that tied the inhabitants of Chaco Canyon to outliers located throughout the San Juan Basin. Lekson's (1984) studies of architecture and Schelberg's (1982) analysis of site size corroborate these conclusions. The planning of these architectural features and the correlation of the work force indicate some leadership, but the level of political sophistication was probably limited (Sebastian 1988).

Other sites throughout the San Juan Basin have been given a cursory examination to obtain some idea about the use of ornaments at Chacoan outliers that should be tied into the system. At these sites I would expect evidence of use of ornaments if high-ranking Chacoan leaders became part of local groups and directed the participation in that system.

This review will encompass data from only those Chacoan outliers or communities that have been excavated. Starting in the northwest, it will proceed in a clockwise fashion around the central node, Chaco Canyon.

Lowry Ruin. The Chacoan structure at Lowry Ruin, located west of Cahone, CO, was two stories and had about 34 rooms, three kivas, and a great kiva. It was probably occupied between A.D. 1089/90 and 1150. It was remodeled around A.D. 1120; overall ceramics are Mesa Verde Black-on-white, which indicates use around A.D. 1200. Martin (1936) reports only a few ornaments; these include one felsite bird image, two limestone pendants, one limestone ball, one trachyte pendant, one trachyte ring, two sandstone buttons, one Mancos Black-on-white sherd pendant, and one McElmo Black-on-white sherd pendant. No turquoise or shells were recorded.

Escalante. The Escalante Ruin, located on the south bank of the Dolores River, west of Dolores, CO, has about 25 rooms. Three occupational periods were noted by Nemetz (1977): a Chacoan unit pueblo dating ca. A.D. 1120 to 1130, a Mesa Verde style kiva and reuse of the site ca. A.D. 1150, and a Mesa Verde occupation ca. A.D. 1200. There was very little evidence of the Chacoan occupation other than architecture in the seven rooms and one kiva that were excavated. Hallasi (1979:298-300, 309) indicates that the following ornaments were found: From the earliest occupation, there were a lignite and turquoise pendant, a lignite circular disk, and four bone tube beads. Other artifacts included one Glycymeris shell bracelet fragment, one Olivella bead, a hematite paintstone, a piece of limonite, and a sandstone effigy block.

The Dominguez Ruin, a small-house site with four rooms and a small kiva with "McElmo-Mesa Verde" occupation dating ca. A.D. 1080 to 1200 is located nearby. Reed (1979:53-66) notes there were thousands of beads and several pendants—all well-made and mostly with Burials 1 and 2—found beneath the floor of Room 2. Only two bone beads (one in the fill of Room 3 and one in the fill of the kiva), a piece of a jet pendant (in the ash of the firepit in Room 1), and a keystone-shaped shale pendant were from the rest of the site. A rectangular red shale pendant was recovered in the fill of the kiva.

Burial 1 was a small infant accompanied by one Oliva undatella shell bead and a bilobed or "Figure-8" bead. Burial 2, an adult female, was accompanied by about 6,900 disk-shaped beads, most of which were turquoise (6:1 ratio with jet and gray shale being the others). A large frog-shaped pendant of shell and turquoise, which includes Haliotus shell, abalone, and Laevicardium was also recovered, as were two circular pendants of Haliotus inlaid with turquoise and specular hematite. Additionally, three mosaic ornaments of shell and turquoise were found in a McElmo bowl. Burials 1 and 2 were interpreted as high status burials, and both were probably post A.D. 1123. The kiva with four pilasters had no offerings.

Wallace Ruin. Part of the Lakeview Group of small ruins in the area northeast of Cortez, CO, the Wallace Ruin is in a valley 500 m south of the Ida Jean Ruin. Excavated by Bruce Bradley (1974, 1984, 1988; personal communicaton, 1981), the Wallace Ruin had four construction phases. The earliest construction phase (21 rooms) was dated ca. A.D. 1000; the second (a two-story room) ca. A.D. 1075 to 1100; the third (10 two-story rooms) ca. A.D. 1075 to 1120; and the last a Mesa Verde Phase in the mid to late A.D. 1200s. In total, there are an estimated 73 rooms and five kivas.

Ornaments from the Wallace Ruin were relatively abundant but most were recovered from proveniences that date to the latest occupation (Bradley 1988:27-29). Three turquoise pendants were from the first building phase, which is not directly tied to the Chaco Phenomenon. Two pendants were associated with burn spots in pre-floor levels and had been buried with sand prior to construction of the floor; Bradley considered these to have been buried as part of a room dedication ritual.

Ida Jean. Located about eight miles south of Escalante Ruin, the Ida Jean site was examined by Joel Brisbin (1973, personal communication to Robert Powers, 1979-80). Excavation of 13 rooms and 2-3 kivas produced a number of ornaments and minerals, mostly from the fill of rooms dating between A.D. 1050 and 1200. The earliest complete dendro-chronological sample dated A.D. 1124; this site was probably remodeled in the early A.D. 1100s by those emulating Chacoan architecture. There are other sites in the area estimated to date to Pueblo II-Pueblo III.

Ornaments recovered included nine bone tube beads, one partial gaming piece, two whole pendants, one partial turquoise pendant, half of a mother-of-pearl pendant, one black jet cylinder, one hematite gaming piece, one bilobed bead of shell, one gypsum pendant, and one other bead. These came from fill of five rooms, three work areas, and kiva pilasters; they may belong to the later occupation of this site.

Salmon Ruin. Located just above the San Juan River near Bloomfield, NM, Salmon Ruin has approximately 140 ground-floor rooms and 100 second-story rooms that were built in the Chacoan style, plus 175-200 rooms or spaces built or remodeled during the thirteenth century (Irwin-Williams and Shelley 1980). Four phases of Chacoan construction date between A.D. 1088 and 1160. The period A.D. 1130 and 1160, however, differs architecturally from the earlier Chacoan structure.

Over 2,633 ornaments and ornament related objects were recovered from Salmon Ruin (McNeil 1986:72). Of these, 633 were ornaments; 88 were assigned to the primary or Chacoan occupation, 383 to the secondary or San Juan/Mesa Verde occupation, and 192 were recovered from the plaza. McNeil divided his material types into exotics and locals. Exotics included jet, greenstone, quartz crystals, petrified wood, malachite, azurite, turquoise, serpentine, muscovite, calcite spar, fluorite, lepidolite, and shell. Locally available materials included basalt scoria, andesite, granodiorite, limestone, red shale, other shale, mudstone, siltstone, claystone, a range of sandstone, calcite, slate, schist, fine granular quartzite, fine metamorophic rock, chalcedony, agate, massive quartz, earthy and other hematites, aragonite, gypsum including selenite, kaoline, talc, calcite crystals, other mineral, ceramic, bone, and vegetal. Table 10.15 is constructed from McNeil's data as presented in several tables; information listed under category and material does not correlate well with the numbers cited above. Unfortunately, McNeil did not provide a master list of ornaments by provenience, number, material, and type, so I could not rectify these discrepancies.

Table 10.16 was devised using data from several of McNeil's tables. It provides a partial list of ornaments and ornament-related materials from the Chacoan occupation at Salmon Ruin. A total of 311 pieces are provided, but only 81 of these could be ornaments. McNeil (1986:173) indicated that turquoise, gypsum, and shell were predominant. Gypsum/selenite was the most abundant material, but because 193 pieces greatly exceed the number of ornaments (81 total), it is assumed that most of these were not ornaments. Shell was more popular than turquoise (14 versus eight pieces listed in Table 10.16).

Although it is difficult to assign specific ornaments to a Chacoan or Mesa Verdean occupation, McNeil's (1986) data do indicate that most of the beads recovered were made of bone and

Table 10.15. Ornaments from Salmon Ruin.[a]

Category	Material	Chacoan Primary Occupation	San Juan/Mesa Verde Secondary Occupation	Plaza	Not Stated	Total
Beads: 168 cylinder 120 circular 66 cone 6 rectangular 2 sphere 1 teardrop 1 square	123 shell 140 bone 48 aragonite 27 baked shale 12 turquoise 8 sandstone 7 ceramic 5 jet 1 obsidian 1 selenite 1 satin spar 1 talc 1 fluorite	47 (6 shell 1 turquoise 1 bone 12 calcite)	183 (32 shell 1 jet 1 turquoise 47 bone 16 calcite 7 baked shale 2 ceramic 1 selenite)	134	11	375
Tab beads: 47 bilob 7 rectangular 2 oval 1 trapezoid 1 square 1 hexagonal	1 andesite 10 jet 1 baked shale 1 shale-other 4 selenite 4 turquoise	2 (1 turquoise 1 jet)	42 (30 shell 7 jet 1 turquoise 1 selenite)	15	-	59
Pendants: 38 rectangle 12 oval 8 trapezoidal 5 triangle 4 circle 4 cone 1 rhomboid	12 jet 1 mud/siltstone 28 baked shale 1 claystone 1 quartz, fine 12 selenite 10 turquoise 2 ceramic 10 shell 5 bone	5 (1 selenite)	57 (3 jet 3 turquoise 2 shell 18 selenite 3 baked shale 1 mudstone 1 ceramic)	10	-	72
Tab pendants: 6 rectangle 2 square 1 triangle	1 jet 3 baked shale 5 selenite 1 bone	1 (1 turquoise)	6	2	-	9
Rings: 2 circle 1 oval	1 claystone 1 serpentine 1 bone	-	2 (1 bone)	1	-	3
Bracelets: 1 geoform 1 circle	2 shell	-	-	2	-	2
Button:	1 jet	-	-	1	-	1
Necklace:	100 aragonite beads	-	1 (100 aragonite/calcite beads)	-	-	1
Plaque	1 jet	-	-	-	1	1

Table 10.15. (continued)

Category	Material	Chacoan Primary Occupation	San Juan/Mesa Verde Secondary Occupation	Plaza	Not Stated	Total
Shaped slab: 13 rectangle 3 circle 2 oval 2 square 2 cone 1 cylinder 1 teardrop 1 triangle	12 selenite 7 baked shale 4 fine sandstone 2 turquoise	2	23 (1 turquoise 6 baked shale 3 selenite 3 satin spar 2 f. gr. sandst. 2 ceramic 1 hematite 1 gypsum, earthy 1 limestone, ear.	-	-	25
Gaming piece: 2 rectangle 1 circular 1 cabochon	3 bone 1 selenite	1	3 (1 bone)	-	-	4
Other		15 (1 fluorite 3 hematite 1 other	31 (1 quartz cry. 1 pet. wood 1 lepidolite 8 hematite 3 sandstone 2 selenite 1 granodiorite 1 f. sandstone 1 fine quartz 1 satin spar)	8	-	54
Bead blank: 2 circle 2 square 1 rectangle	3 selenite 2 baked shale	1	1 (1 turquoise)	3	-	5
Pendant blank: 6 rectangle 2 teardrop 2 rhomboid 1 circle 1 oval 1 trapezoid 1 square	12 selenite 1 baked shale 1 bone	2 (1 selenite)	8 (2 baked shale 2 selenite)	4	-	14
Earring 1 geometric	1 selenite	-	1	-	-	1
Whistle: 2 cylinder 1 oval	2 bone 1 claystone	-	2 (2 bone)	1	-	3
Inay/Mosaic: 38 rectangle 4 square 1 oval 1 rhomboid	33 turquoise 8 baked shale 4 hematite	5 (2 turquoise 1 baked shale)	23 (12 turquoise 3 baked shale 3 hematite)	17	-	45
Total ornaments		81	383	192/663		
Effigies[b]	Effigies	1	9	-	1	11

Table 10.15. (continued)

[a] From tables presented in McNeil (1986). Totals do not correlate because of the way the data were presented. Only those identified as pure Chaco or pure Mesa Verde are listed in that column.

[b] Effigies:

Chacoan:

1 from Room 33W, bird-shaped hematite.

Mesa Verdean:

2 from Room 16P, both of baked clay and human form.
1 from Room 64W, sandstone lizard.
1 from Room 67W, massive quartz bird.
1 from Room 92B, fired clay dog.
1 from Room 124A, pendant of fired clay, stylistic.
3 from Room 100W, two turquoise frogs, one fired clay female human.

Mixed:

1 from Room 62W, fired clay dog.

Table 10.16. Ornaments and ornament-related materials from the Chacoan occupation at Salmon Ruin.[a]

Provenience	No.	Material
Room 4	1	Turquoise
	20	Gypsum/selenite
	1	Hematite, earthy
Room 7	1	Gypsum/selenite
Room 30	1	Gypsum, earthy
	1	Shell
Room 31	1	Quartz crystal
	2	Shells
Room 33	1	Azurite
	9	Gypsum, earthy
	23	Gypsum/selenite
	1	Hematite, earthy
	1	Hematite, other
	1	Shale, baked
	5	Shells
Room 56	1	Calcite
	1	Gypsum/selenite
Room 62	27	Gypsum/selenite
Room 63	1	Greenstone
	1	Shell
Room 80	4	Gypsum, earthy
	6	Gypsum/selenite
Room 81	2	Gypsum/selenite
	1	Shell
Room 82	1	Turquoise
	1	Gypsum/selenite
Room 83	69	Gypsum/selenite
Room 90	9	Gypsum/selenite
Room 91	2	Turquoise
	31	Gypsum, earthy
	5	Gypsum/selenite
	2	Hematite, other
	1	Shell
Room 92	1	Turquoise
	1	Fluorite
	1	Hematite, earthy
	2	Hematite, other
	1	Shell
Room 93	1	Turquoise
	1	Azurite
	1	Gypsum, earthy
	1	Gypsum/selenite
	1	Kaolin
Room 96	1	Shale, baked
Room 97	1	Turquoise
	1	Calcite
	1	Gypsum, earthy
	9	Gypsum/selenite
Room 100	1	Calcite
	2	Gypsum/selenite
	1	Hematite, other
Room 101	1	Calcite
	1	Shell

Table 10.16. (continued)

Provenience	No.	Material
Room 102C	1 2 1	Turquoise Gypsum/selenite Hematite, earthy
Room 119	21	Gypsum, earthy
Room 121	1	Hematite, earthy
Room 129	3 15 1	Gypsum, earthy Gypsum/selenite Shell
Room 130 (Great Kiva)	1	Calcite
TOTAL	311	

[a] Taken from McNeil (1986:Tables 46-51).

shell, followed by aragonite, baked shale, turquoise, sandstone, etc. Additionally, 100 aragonite/calcite beads made up the single necklace recovered during the Mesa Verde occupation. Most of the inlay were turquoise, with some red shale and hematite, but the majority of these were found in Mesa Verdean contexts (see below).

With regard to workshop material, McNeil (1986:39) found very little evidence of ornament manufacturing. There were no specialized tools, few ornament blanks, no manufacturing debris, and no raw material caches. This did not preclude the manufacture of a few pieces; some evidence indicates that a little gypsum, shale, and bone were being worked by the inhabitants of Salmon Ruin (McNeil 1986:62-64). A quartz crystal from Room 31 also showed some use as an engraving tool (McNeil 1986:114-115). McNeil thought perhaps a few people occasionally made an ornament.

The data on ornaments are in sharp contrast to conclusions reached by Irwin-Williams (1983; and Irwin-Williams and Shelley 1980) regarding workshop areas and specialization for other items used at Salmon. Shelley's (1980) lithic analyses indicates that there was more specialization in production at this site during the Chacoan, rather than the Mesa Verdean occupations. This was seen in an examination of projectile points, metates, and milling areas (Shelley 1980:155-159). Data on ceramics presented by Franklin (1980) supported the hypothesis that there was a difference between the local inhabitants and those affiliated with Chacoan type ceramics during the Chacoan occupation. He indicated that Chacoan groups had access to a variety of nonlocally available exotic and luxury items. This uneven access to or use of exotic or rare ceramic vessels, as with other "luxury" goods, was possibly concomitant with concentrated socio-religious activity in the hands of a theocratic minority. Such activities were restricted to certain loci. There was some evidence of local manufacture of ceramic products; this was supported by the study of refired clays and the presence of tools that may have been used for ceramic manufacture, such as polishing stones and hematite pigment found associated with each other in strata that are dominated by San Juan wares (Franklin 1980:448-464).

Survey in the San Juan and La Plata Valleys (Whalley and Yingst 1978) indicates that some Chacoan sites were present in the San Juan Valley prior to A.D. 1050, but there was little evidence of Chacoan goods at the local sites until after A.D. 1050. When several large Chaco sites appear in the middle San Juan Valley, the Chacoan artifacts appear at the smaller sites too. In contrast, Whalley and Yingst's data from the lower La Plata indicated that several Chacoan outliers had exotic goods but the local sites did not. Recent data from the La Plata Highway Project, carried out by the Museum of New Mexico Office of Archaeological Studies, does not contradict these data. Laurel Wallace (personal communication, 1993) indicates that very few ornaments were found in earlier sites excavated by the project staff.

The Sterling Site. This site is located about five miles upstream from the Salmon Ruin. Erosion had destroyed part of this site at which six rooms and two kivas were excavated (Bice 1983). Evidence suggests that it was occupied by Chacoans probably as early as A.D. 950, surely by A.D. 1040, and abandoned about A.D. 1100. Later reoccupation by San Juan people was evident.

Bice's initial report only covered the architecture of the site; no ornaments were reported. Bice (personal communicaton, 1985) indicates few ornaments were found and that there was nothing remarkable about them. No final analysis of these has been done to date.

Aztec Ruins. Just north of Aztec, NM, is one of the larger Chacoan sites, a D-shaped pueblo with an estimated 405 rooms and 28 kivas. Aztec West Ruin was excavated by Morris during the period 1919 to 1928 and has two major occupations: one Chacoan ca. A.D. 1110 to 1120, and one San Juan/Mesa Verdean in the mid A.D. 1200s (Morris 1928).

Ornaments recovered with Chaco-related burials were scarce. Morris (1928:opposite page 225) listed the burials and their accompanying grave goods and cultural affiliation. Although his table lists six positive and two probable Chacoan burials, only seven were assigned to the Chacoan period in the text.

Burial 5 was an infant found in the refuse of Room 2 with a black-on-white pot. Burial 59 was an adult found in the refuse of the southeast mound. No grave goods were associated with this burial. Burial 80, a young adult found in the debris in Room 159, had matting and pottery (a large bowl inverted over its head). Burial 81 was an adolescent (possibly female) found in Room 43E in a grave (pit). A bowl containing a pitcher was found just beyond the pit. Between the bowl and the wall was a thin piece of polished black slate. Burial 103 was an adult found in the southeast refuse mound accompanied by a black-on-white bowl and part of a black-on-red pitcher. Burial 104 was an adult found in a grave in the southeast refuse mound accompanied by a black-on-white bowl that contained a corrugated pot. Burial 105, a young adult, was found near the previous two burials; it had a large and small bowl associated with it. No jewelry was found with any of these burials.

This small number of burials contrasts greatly with the number of burials from the later occupation of the site (see below). Morris (1928:224-225) considered this paucity of Chaco burials typical of what was found in other large sites of Pueblo Bonito and Chetro Ketl in Chaco Canyon. It differs markedly from the numbers of burials found in the refuse mounds at small sites throughout the San Juan Basin.

Ornaments were recovered from other proveniences at Aztec West. Room 47, which contained Chaco refuse, had two turquoise beads, one turquoise set, three shell bracelets, one shell bead, two gilsonite pendants, one selenite pendant, a shell bracelet set with turquoise, and two bird bone cylinders. Rooms 48 and 54 also had Chaco debris and bits of turquoise. Room 65, a Chacoan room, had one piece of turquoise. These data from the Chacoan occupation do not indicate major amounts of jewelry, especially when compared with the large and small sites in Chaco Canyon.

Chimney Rock. Chimney Rock is on a mesa near the Piedra River, between Pagosa Springs and Durango, CO. Four sites in this area have been excavated, including Chimney Rock Pueblo. Occupied sites in the area range from ca. A.D. 975 to 1125.

Chimney Rock Pueblo was partially excavated in 1921 by Jeançon, in 1922 by Roberts, and from 1970 to 1971 by Eddy. Based on tree-ring dates, this Chacoan site was probably occupied from about A.D. 1076 to 1125 (Eddy 1977). Powers (1974) listed the following ornaments: two turquoise pendants from Kiva E, a pendant and several tesserae from the fill of Room 35, and a pendant and tesserae from the fill of Room 1A (see also Jeançon and Roberts 1923-24). This is very little for a site with 36 ground floor rooms and two Chaco style kivas.

At small sites in the area, a few ornaments were recovered. Roberts (1922:168) excavated several Pueblo I villages on the benches and bluffs over the Piedra River. He noted ornaments were not plentiful; they "include stone, shell and bone beads, stone pendants and shell bracelets. Turquoise was practically absent, only two small fragments of this usually popular stone were found during the entire course of this investigation."

Jeançon and Roberts (1923-24) found a piece of turquoise in the fill of Room A at Piedra #2; none was reported from Piedra #1. Eddy (1977:56) reports only three bone beads from Ravine Site 88 dating in the late A.D. 1000s; this site had been excavated by Truell (1975). Ornaments are scarce in the Piedra District.

Twin Angels. A Chacoan structure with 17 rooms and two kivas is located on a promontory in Kutz Canyon, NM. Two other mounds/structures are also found on that formation. Data from the Chacoan structure indicate occupation between the mid A.D. 1000s to mid 1200s. Carlson (1966) reports only one fragment of a red and white shell with a hole, possibly a bead or pendant, as an item of jewelry. This site may be road-related rather than a community built by local people.

Bis sa'ani. In a 67 sq km (26 sq mi) area just northeast of Chaco Canyon on the Escavada Wash, the main pueblo of Bis sa'ani (30 rooms and five kivas) and eight small pueblos of seven rooms or less were excavated, as well as seven isolated structures and five sherd-lithic scatters (Breternitz et al. 1982). Table 10.17 summarizes the data on ornaments and other exotic pieces recovered from this Late Bonito Phase community. There were a limited number of material types among these artifacts: one piece of copper, 11 Olivella, three Olivella dama, one Nassarius, five Glycymeris, one Laevicardium, 19 bone, one Succinae (a terrestrial mollusk), one ocher, two red dog shale, three aragonite, one gypsum, and one sandstone.

As Breternitz (Breternitz et al. 1982:1079-1084) notes during his analysis of bone tools, most of these items were probably imported. The bones used to make beads, and the style of the tinklers and whistles are foreign to the area. This holds true for all marine shells and the copper bell. Of 50 items listed, only one Succinae mollusk, one piece of ocher, two red dog shale, three aragonite, one gypsum, and one sandstone or 9/50 (18 percent) were locally available materials. There were no turquoise, lignite, or calcite ornaments.

Guadalupe Ruin. The Guadalupe Ruin, a 50-room masonry pueblo located on a mesa top in the middle Rio Puerco Valley, had evidence of two occupations (Pippin 1987:77-85). The earliest occupation, ca. early A.D. 900s to mid 1100s, had architectural similarities that linked it to Chaco Canyon. The later, ca. mid A.D. 1200s to early 1300s, occupation bore many similarities to the San Juan-Mesa Verde Anasazi.

Because there was much remodeling and reuse of earlier rooms by the San Juan-Mesa Verde Anasazi (Pippin 1987:108), most ornaments that were recovered at this site (Table 10.18) belong to the later occupation. The material that can definitely be attributed to the Chaco occupation includes five ornaments from Room 1W, provenience C216; 10 from Room 8W (provenience C204), two from Room 12D (provenience J109); two from Room 12W (provenience G106), and possibly one piece from Room 14B (provenience G208).

Kin Nizhoni Area. Work in the Lake Ambrosia area just 3 km west of the Chacoan outlier of Kin Nizhoni included excavation of three Pueblo II sites (Baugh 1990). At one habitation site, LA50364, four rectangular claystone pendants (one from Floor 1 of Kiva 2; one in Pit 2) and an azurite nodule (from Kiva 2) were recovered. A few bone tubes or beads may also have been used as jewelry items, but the exact provenience was not easily determined.

Casamero Ruin. The Casamero Ruin just north of Prewitt is a structure with about 22 rooms and a kiva. Dated by Sigleo (1981) and Neller (1978) to the last half of the eleventh century and early twelfth century, it contained very few ornaments and/or minerals. The floor of Room 1 had one piece of turquoise, one turquoise bead, and some malachite. Room 8, floor, had one turquoise pendant; in Level 7 a piece of chrysocolla was recovered. Room 19, surface, had one turquoise pendant fragment. Room 12 had some malachite on the floor. Two malachite fragments were on the bench of Kiva 1. Neller (1978:27), who compared the riches of Casamero to 28 other excavated sites in the Prewitt District, where only one piece of turquoise was recovered versus the five at Casamero, considered Casamero rich in material.

Switzer (1970) reported on a necklace recovered with a burial at Site D4, a small pueblo dating ca. A.D. 925 to 1050, about 6.5 miles northwest of Prewitt and near Casamero. The necklace, which is 12' 5" long (37.9 m) when strung, was made from discoid black beads interspersed with discoid white beads and several flat, bilobed white beads.

Table 10.17. Ornamental objects from the Bis sa'ani Community.[a]

Provenience	No.	Description
Bis sa'ani Pueblo:		
South House, kiva wall	1	Copper bell
kiva floor	3	Olivella sp. shells
Room 1, floor	1	Olivella sp. shell
Casa Quemada		
Room 5, floor	1	Nassarius iodes Dall shell
?	7	Tubular bone beads
Room 7, floor	1	Olivella sp. shell
West House, surface	1	Olivella dama
Rabbit House, wall-fall	1	Olivella dama
?	1	Tubular bone bead
Feature 4	1	Bitsitsi bone whistle
Rubble mound at base of Rabbit House	1	Olivella dama
?	1	Glycymeris sp.
	1	Bitsitsi bone whistle
NM-G-27 (isolated site with 2 structures)	1	Sandstone bead blank
NM-G-63-28 (four-room pueblo)		
Room 2, floor	1	Gypsum fragment, drilled in center
NM-G-63-29 (three rooms)		
Room 1, wall-fall	1	Olivella shell
fill	1	Bitsitsi bone whistle
Room 2, fill of ventilator	1	Olivella bead
Kiva 3, midden	1	Bone bead
	1	Tinkler
	1	Laevicardium sp. shell
NM-G-63-36 (isolated kiva)	1	Piece of ocher
NM-G-63-16 (three rooms, one kiva)		
Room 2, Fill	2	Glycymeris bracelet fragments
Plaza	1	Glycymeris bracelet fragment
	1	Sucinnae - terrestrial mollusk
	1	Red dog shale pendant
NM-G-63-22		
Ramada, Structure 2, posthole	1	Olivella sp. shell
NM-G-63-23 (five rooms, 3 pitstructures)		
Pitstructure 6	2	Lepus bone tinklers
Pitstructure 8, trash fill	1	Meleagris bone bead
	1	Glycymeris bracelet fragment
	1	Olivella bead
Trash Mound, Test Trench 1	1	Lepus bone tinkler
Trash Area	1	Marine shell
?	1	Aragonite bead blank
	3	Bead blanks
NM-G-63-26 (five rooms)		
Structure 2	2	Bone beads (1 Meleagris, 1 Lepus)
East Plaza	1	Olivella barrel bead
?	1	Aragonite bead
	1	Bead
	1	Red dog shale disk
NM-G-63-34 (four rooms, one kiva)		
Test Trench, Trash Area 1	1	Olivella bead

[a] Taken from Breternitz et al. (1982).

Table 10.18. Ornaments and minerals from Guadalupe Ruin.[a]

Room	Provenience	Type	Period	Comments
1W (kiva)	C106—structured trash	2 pendants 3 stone beads 1 Olivella bead 2 large turquoise unperf. 1 small turquoise unperf. 1 tufa unperf. 1 red argillite unperf. 1 lepidiolite unperf. 1 carved turtle shell 1 concretion bowl 1 tufa rock/mineral 2 turquoise rock/mineral	San Juan-Mesa Verde	
	F-107—Roof	1 basalt ring 1 fossil	San Juan-Mesa Verde	
	H-109—Floor	1 turquoise mineral 1 small turquoise unperf.	San Juan-Mesa Verde	
	L315	1 pendant 1 stone bead	San Juan-Mesa Verde	
	C216—structured trash	1 small turquoise unperf. 1 hematite cylinder 3 turquoise rock/minerals 1 red argillite rock/min.	Chacoan	redeposited Chacoan trash (Pippin 1987:105, 108)
5W (kiva)	C104—structured trash	4 pendants 2 stone beads 1 Olivella bead 2 large turquoise unperf. 2 small turquoise unperf. 4 jet unperf. 1 red argillite unperf. 1 lepidiolite unperf. 1 hematite cylinder 1 onyx cylinder 2 calcite crystals 1 satin spar crystal 11 gizzard stones 15 tufa rocks/minerals 1 calcite rock/mineral 4 turquoise rock/minerals 6 red argillite rock/min. 1 dense hematite rock/min. 1 azurite rock/mineral	San Juan-Mesa Verde	

Table 10.18. (continued)

Room	Provenience	Type	Period	Comments
	C205—structured trash	1 pendant 2 Olivella beads 2 large turquoise unperf. 1 small turquoise unperf. 1 jet unperf. 12 tufa unperf. 1 hematite cylinder 1 onyx cylinder 1 calcite crystal 1 satin spar crystal 4 gizzard stones 16 tufa rock/minerals 4 turquoise rock/minerals 6 red argillite rock/min. 2 dense hematite rock/min.	San Juan-Mesa Verde	
	H-107—Floor	1 turquoise rock/mineral 1 red argillite rock/min. 1 dense hematite rock/min.	San Juan-Mesa Verde	
	L208	1 pendant	San Juan-Mesa Verde	
8W	C103—structured trash	1 pendant 1 stone bead 1 large turquoise unperf. 1 small turquoise unperf. 2 tufa unperf. 2 hematite cylinders 1 onyx cylinder 1 concretion bowl 1 fossil 3 tufa rock/minerals 1 turquoise rock/min.	San Juan-Mesa Verde	
	C204—structured trash	2 stone beads 1 large turquoise unperf. 3 hematite cylinders 1 tufa rock/mineral 2 red argillite rock/min. 1 dense hematite rock/min.	? Late Chacoan	
12A (storage?)	H-104—Floor	1 stone bead 1 gizzard stone	San Juan-Mesa Verde	
12B (storage?)	F-103—Roof	2 tufa unperf.	San Juan-Mesa Verde	
12C (storage?)	H-104—Floor	1 stone bead	San Juan-Mesa Verde	
12D (storage)	F-103—Roof	1 Olivella bead 2 tufa unperf.	San Juan-Mesa Verde	
	J109—preoccupational fill	1 pendant 1 large turquoise unperf.	Chacoan	Pre-late Chacoan because it is below G-106

Table 10.18. (continued)

Room	Provenience	Type	Period	Comments
12W	G106	2 small turquoise unperf.	Late Chacoan	Late Chacoan trash
14B (habitation)	F103—Roof	2 Olivella beads 2 large turquoise unperf. 1 small turquoise unperf. 1 fossil 1 tufa rock/mineral 1 turquoise rock/mineral	San Juan-Mesa Verde	
	G104	1 pendant 4 Olivella beads 1 large turquoise unperf. 1 small turquoise unperf. 2 tufa unperf. 2 shells unperf. 1 hematite ball 2 turquoise rock/minerals 1 red ocher rock/mineral 1 azurite rock/mineral	San Juan-Mesa Verde	Possible knapping activity on floor 1; possibly a religious storage room
	G208	1 tufa rock/mineral	? Chacoan or mix	
14C	F103—Roof	1 pendant 1 stone bead 2 Olivella beads 1 large turquoise unperf. 2 turquoise rock/minerals 2 tufa rock/mineral 1 jadeite rock	San Juan-Mesa Verde	
	G106	1 tufa rock/mineral 1 dense hematite rock/min.	San Juan-Mesa Verde	
15B	F-104—Roof	1 calcite crystal	San Juan-Mesa Verde	
	C103	2 stone beads 1 Olivella bead 1 concretion bowl 1 turquoise rock/mineral	San Juan-Mesa Verde	
	J106—pre-occupational	1 small turquoise unperf. 1 turquoise rock/mineral	?	
16C (storage)	H104—Floor	1 tufa unperf. 1 stone bead	San Juan-Mesa Verde	

Table 10.18. (continued)

Room	Provenience	Type	Period	Comments
17B (habitation)	F309—Roof 3	2 stone beads 1 Olivella bead 2 small turquoise unperf. 1 jet unperf. 1 hematite cylinder 1 calcite crystal 2 gizzard stones 1 turquoise rock/mineral 2 tufa rock/minerals	San Juan-Mesa Verde	
	H207—Floor 2	1 stone bead 1 large turquoise unperf.	San Juan-Mesa Verde	Possible knapping activity on floor
	F206—Roof 2	2 small turquoise unperf. 1 gizzard stone 4 turquoise rocks/mineral 1 tufa rock/mineral 1 dense hematite rock/min.	San Juan-Mesa Verde	
	H104—Floor 1	3 pendants 1 stone bead 1 small turquoise unperf.	San Juan-Mesa Verde	Possible knapping activity on floor
	F103—Roof 1	1 pendant 2 stone beads 1 Olivella bead 4 small turquoise unperf. 1 quartz crystal 1 turquoise rock/mineral 2 jet rock/minerals	San Juan-Mesa Verde	
19W	C105—structured trash	2 pendants 1 calcite crystal 1 fossil 1 red ocher rock/mineral 1 tufa rock/mineral	Probably San Juan-Mesa Verde	
22W (habitation)	C104—structured trash	3 pendants 24 stone beads 515 Olivella beads 1 large turquoise unperf. 2 small turquoise unperf. 1 red argillite unperf. 1 hematite cylinder 2 onyx cylinders 1 satin spar crystal 2 selenite crystals 1 fossil 1 red argillite rock/min. 1 tufa rock/mineral 11 turquoise rock/min.	Probably early Chacoan	Dated as early by Pippin (1987:174). The 501 Olivella beads may represent a breast plate

Table 10.18. (continued)

Room	Provenience	Type	Period	Comments
	L105	1 pendant	? San Juan-Mesa Verde	
31W	F105—Roof	2 gizzard stones	San Juan-Mesa Verde	
	C103—structured trash	1 pendant 1 onyx cylinder 3 red clay 1 tufa rock	? San Juan-Mesa Verde	
Plaza Trench 3	G106—occupational fill	1 unperf. turquoise large 1 shell	Mixed ?	

[a] Taken from Pippin (1987:Tables 39-42 and Table 67).

Recovered with this were two argillite bird effigies, a Glycymeris shell bird effigy, a lignite beetle, a lignite button, and a lignite keystone pendant, five orange and purplish claystone pendants, five turquoise pendants, and a number of Haliotus, Glycymeris, Cerithidaea, and Olivella shell pieces, all thought to be part of the necklace. Other objects from the grave included a lignite button and nine claystone perforated bead blanks. Switzer (1970:29) suggests an early eleventh century date for the necklace, and thinks it was probably a personal possession of the deceased. As Ellis (1968:64) notes, it was a custom of modern Pueblo Indians to bury personal possessions with an individual.

Andrews Site. Not far from Casamero is another outlier that has not been excavated; however, I had the privilege to review the collection of blue-green materials (mostly turquoise, but some azurite and malachite) picked up on that site by the owner. There were several hundred pieces of turquoise in various stages of manufacture, as well as complete beads and pendants. All material was from the surface of the entire Andrews community, which Marshall et al. (1979:117) date between A.D. 950 and 1050. The area includes a Bonito Phase structure with an associated great kiva, as well as 24 other sites and two other great kivas. Jacal structures indicate that a few sites were inhabited ca. A.D. 800 in this area.

Village of the Great Kivas. Roberts (1932) reports on the Village of the Great Kivas located at the mouth of Red Paint Canyon, on the north side of Nutria Valley east of Zuni, NM. There were three communal structures and two great kivas. House A had 64 rooms, three ceremonial chambers, and a great kiva. Evidence indicates three construction periods beginning ca. A.D. 1000 to 1030. Although material from the Chacoan affiliation is present in several rooms in House A, sherds from other rooms in House A and House B indicate ties to both the Upper Gila and Little Colorado, thus, a later use of this site and parts of this structure. House B, composed of 20 rooms, had evidence of carefully worked masonry and enlargements over time. Roberts considered it intermediate between the earliest and latest occupations at the site. Only one room of House C was excavated.

Roberts (1932:168) reports that few ornaments in the shape of beads, pendants, and inlay were recovered. Table 10.19 presents the data gleaned from his report. Only the materials in Kiva A, sipapu (very small stone beads of ferruginous shale and two pieces of turquoise [Roberts 1932:57]) are definitely assigned to the Chaco occupation. The single slab from Great Kiva 1 (Roberts 1932:Plate 59k) is probably Chacoan. The remaining pieces were recovered either in rooms built later or remodeled and used later.

Even though many of the large sites that are known as Chacoan outliers had later occupations, this review of excavated outliers and a few surrounding sites suggests that sites in Chaco Canyon were much richer in ornaments than were contemporary outlying sites. Between A.D. 900 and 1050, the exception to this is the Andrews community, which is located to the south near Prewitt. In the north, the only quantities of ornaments appeared with burials of a woman and child at the Dominguez Ruin, a small house dating ca. A.D. 1080 to 1200. At Salmon Ruin, the 88 ornaments were found throughout the site, and the survey of the San Juan River indicates that some were also found at small sites. At Aztec West Ruin, material was also scattered in several rooms, but the amounts do not compare with the amounts recovered from small sites in Chaco Canyon during the Bonito Phase.

The Mesa Verde Phase

Only one site from the Chaco Project excavations provides data from this period—29SJ 633 (Mathien 1991). Marcia Truell and LouAnn Jacobson excavated only one-and-a-half rooms at this site, so the sample is limited. Numerous ornaments and minerals were recovered from the fill and materials on Floor 1 of Room 7 and Room 8 (Table 10.20). The number of ornaments from the A.D. 1200s occupation suggests a continuing use of these items. Truell suggested that the copper bell may belong to the earlier occupation or may have been collected from another site and curated. The two selenite pendants, both from Room 7, suggest a greater use of this material for ornaments when contrasted with data from earlier occupations in Chaco Canyon.

Procurement. The presence of copper, shell, and turquoise probably indicates a continuing participation in long-distance trade or scavenging from earlier sites.

Table 10.19. Ornaments from the Village of the Great Kivas.[a]

Provenience	Material[b]	Form	Dating
Kiva A, sipapu	S ferr. shale	S beads	Chaco occ.
	2 turquoise	2 pieces	
Great Kiva 1	1 ?	1 ?	? Chaco occ.
House A, Room 31	1 ?alabaster	1 pendant	?
House A, Room 14	1 ?alabaster	1 pendant	Late occ.
House A, Room 55	2 bone	2 plates	Late occ.
House B, Room 2	1 bone	1 plate	Late occ.
House B, Room 13	1 ?	1 ?	Late occ.
House B, Room 15	5+ bone[c]	5 beads	Late occ.
House B, refuse	1 ferr. shale	1 pendant	Late occ.

S = several.
[a] Taken from Roberts (1932:57-58, 138-139, 146-147).
[b] Plate 59i shows 7 beads, all of Southwestern alabaster, but no proveniences were given.
[c] Roberts (1932:138-139) indicates that 110 bone tablets were probably part of a plaque or breast plate found on the floor of one of the rooms in House B.

Production. No workshop areas were found. The form of the artifacts does not differ from the earlier patterns.

Distribution and Consumption. Data from this site do not suggest any different use of materials. Turquoise appeared on the floors of Room 7 and Room 8 in small pieces, similar to that in earlier sites.

Comparisons

Only two other excavated sites are attributed to this late occupation at Chaco Canyon. At 29SJ 400 (Casa Sombreada), which is located on the talus slope on the south side of the canyon, a few turquoise, shell, and bone ornaments were recovered from the limited excavations in this 51-room pueblo (Mathien 1985:Appendix C, Table 3). The Gallo Cliff Dwelling, 29SJ 540, near the mouth of the Gallo Wash, contained only two turquoise pieces and two clay figurines (Mathien 1985:Appendix C, Table 10).

Because of the poor control of data from these two sites, the only inference made is that the late occupants in Chaco Canyon probably retained the ability to acquire ornaments. Alternatively, these may have been picked up on other abandoned sites in the canyon and reused. I doubt that ornament procurement was on the same scale as during the Bonito Phase; but until more data are available, this will have to remain at the supposition level.

In contrast to the available material from Chaco Canyon, there are more data from outlying sites.

Wallace Ruin. As noted above, most of the ornaments from the Wallace Ruin were attributed to the Mesa Verde occupation. Included among them were two inlaid bone disks with galena crystals found with Burial 3, a 18± male found in Feature 17. This was the only burial out of 11 that had any grave goods, and he belongs with the Mesa Verde occupation rather than the Chaco one. Other ornaments included an antler pendant, seven siltstone pendants, four sherd pendants, four shell pendants or beads, four spring oyster beads/pendants, six shell disk beads, four bilobed, figure-eight beads; two jet ornaments, three Glycymeris shell bracelet fragments that had been modified for suspension; six siltstone mosaic pieces, four bone gaming pieces, one stone animal fetish, one sandstone human effigy, and five Olivella shell beads. The beads were found either alone in the fill or in small loose groups on floors. Fragments of jet and a bone finger ring were also recovered.

Bradley (1988) commented that there were no turquoise artifacts in the Mesa Verde area other than those recovered at Badger House Community.

Aztec Ruin. Morris (1928) obtained many ornaments with numerous burials (Table 10.21) from the Mesa Verde occupation at Aztec Ruin.

Burial 14 consists of the remains of at least 15 infants and small children who were found in the refuse in Room 52E. There was a considerable wealth of ceramics, 19 stone beads in some state of manufacture, 27 complete stone beads, eight crystal beads, 64 white discoid beads, 12 gray discoid beads,

Table 10.20. Ornaments and minerals from the Mesa Verde Phase at 29SJ 633.

Material Type	No. and Pieces
Argillite	1 Bead 1 Modified 1 Pendant
Claystone, green	1 Bead
Copper	1 Bell
Gypsite	17 Unmodified 8 -
Gypsum	1 Modified
Hematite	1 Paintstone 1 Unmodified
Lignite	31 Unmodified 1 Pendant/effigy 1 Pendant blank
Limonite	1 Modified
Malachite	1 -
Sandstone	1 Unmodified
Selenite	19 Unmodified 2 Pendants 5 -
Shale	1 Pendant
Shark's tooth	1 -
Shell:	
Glycymeris	2 Bracelet fragments
Lymnaea	1 Unmodified
Unidentified	1 -
Turquoise	4 Modified 1 Pendant blank 3 Debris 1 Inlay
Total	113

12 black discoid beads, five miscellaneous beads, 65 turquoise discoid beads, one hematite animal effigy, 32 Olivella shell beads, an unidentified shell bead, one hematite paint stick, 17 truncated shell beads, three cylinder stone beads, 16 bone backings, galena crystals, worked greenstone, a piece of hematite, five polished stones, and a quartz knife. There were also necklaces measuring 6 ft. and 56 ft. (1.8 and 17.1 m, respectively) made of black discoid beads estimated at 3,100 and 16,600 beads each, plus 14 Olivella shell beads, 397 bird bone tubes, eight wing bones, and two pieces of worked sandstone. This wealth, buried with children, calls to mind the practices of the earlier Basketmaker people in northeastern Arizona.

Burial 16, an adult found in the refuse of Room 41 with another adult and three children also had many grave goods (Table 10.22) (Morris 1928:155-166). Jewelry included Olivella shells, abalone shell, beads and mosaic pendants with the adult, plus an Olivella shell anklet. One bird effigy ceramic contained 31,000 tiny black discoid beads. Other interesting artifacts in the room included 200 quartzite arrowpoints. Beads, turquoise inlay, and mosaic fragments were scattered. Morris listed the grave goods; jewelry items and their catalog numbers are provided in Table 10.22. Morris (1928:155) indicates that some preparation for these burials included the scraping away of ash deposits and the placement of the burials in the resulting depression. The bodies had not been covered until much later. The wealth of goods buried with the adult in the southeast corner of the room amazed Morris; he thought this room might have rivaled Pepper's discoveries in Room 33 at Pueblo Bonito, if fire and moisture had not taken its toll on the artifacts (Morris 1928:156).

Burial 20, an infant, had a string of bone and walnut shell beads. It was found on a rush mat in the refuse of Room 95. A cradleboard, other vegetal material, five pine boards, and a ceremonial stick accompanied this burial.

Burial 25, two adults in Rooms 110, 111, and 112, were accompanied by turquoise (unworked pieces and bits), galena, lignite, and some beads on inlay, as well as ceramics, 14 arrowpoints, and other goods. Table 10.23 lists other jewelry items provided by Morris. Forty-two ceremonial sticks and other materials were also recovered. Unfortunately, these burials were much disturbed; Morris (1928:164) postulates that some of this could be attributed to animals, but the lack of turquoise, the incomplete large ornaments, and the thorough crushing of ornaments suggests human looting as well. Possibly the intruders were 1880s relic hunters because names are written on the walls in Room 112 (Morris 1928:357).

Burial 30, Room 141, had two shell beads. Also in Room 141 was Burial 29, which was rifled by late nineteenth century visitors (Morris 1928:167-168). It contained 10 bodies (possibly 13-16) relating

Table 10.21. List of Aztec burials by location.[a]

Location	Burial No.	No. of Burials	Comments
South Wing			
Room 1	1-4	4 adults	
Room 2	5	1 infant	
Room 109	18 24	1 infant 3 adults	
Room 106	21	1 young child	
Room 107	22 26	2 infants 1 infant	
Room 159	79-80	1 elderly female 1 young adult	
Kiva B	6-7	1 infant 1 child	
East Wing			
Room 29	8	1 adult, female	
Room 33	9	1 adult, female	
Room 37	10-11	2 children	
Room 45	12	1 adult, male	
Room 18	13	1 infant	
Room 52	14	15 infants and small children	Large number of burials
Room 56	15	1 child	
Room 41	16	2 adults 3 children +?	Compared with Pueblo Bonito material by Morris
Room 43	81	1 slender female	
Room 183	106-109	1 adult male 1 child 1 adult male 1 adult female	
Kiva D		1 adult male ? 3 children	
Kiva G		?	
North Wing			
Room 77	17	1 infant	
Room 94	19	1 infant	
Room 95	20	1 infant	
Rooms 110,111,112	25	2 adults	
Room 139	27 28	1 infant 1 adult, female	
Room 141	29 30	10+ 1 young child	Large number of burials; many ornaments
Room 135[2]	34	1 young adult	
Room 143	35	1 young child	
Room 136[2]	36-41	1 small child 1 infant 3 children in bin	? Large number of burials

Table 10.21. (continued)

Location	Burial No.	No. of Burials	Comments
Room 153[2]	48-55	1 infant 1 infant 1 infant 1 adult, female 1 child 1 small child 3 small children 1 young female	Large number of burials
Room 147	60-61	2 adults	
Room 178	83	1 adult male	
Room 182	88	1 adult female	
Room 180	89-101	1 elderly female 1 child 1 child 1 small child 1 infant 1 child 1 infant 1 child 1 elderly male 1 infant 1 small child 1 elderly female 1 elderly adult	Large number of burials
Room 181	102	1 child	
West Wing			
Room 138	31 32 33	1 child 1 adult, female 1 child	
Room 145	42	1 child	
Room 150	43 44 45 46	1 young adult 3 small children 1 infant 1 adult	Large ? number of burials
Room 151	62-78	2 adults 1 adult 1 small child 1 child 1 small child 1 adolescent 1 infant 1 small child 1 infant 1 small child 1 elderly adult 1 adult 1 child 1 child 1 young adult 1 infant 1 small child	Large number of burials
Room 175	84-87	1 adolescent 1 adolescent 1 young adult 1 child	
Room 184	110-111	1 infant 1 child	

Table 10.21. (continued)

Location	Burial No.	No. of Burials	Comments
Room 185	119-28	1 elderly female 1 child 1 child 1 child 1 child 1 adult 1 small child 1 elderly female 1 elderly person 1 small child	Large number of burials
South Court			
Kiva S	82	1 adult	
Annex			
Pit	23	1 young person	
Room A.12	47	1 elderly male 1 elderly female	
Room A.8	112-113	1 infant 1 small child	
Room A.11	114	1 small child	
Kiva A.1	116-118	1 small child 1 infant 1 elderly adult	
Kiva A.5	135-138	1 adult male 1 infant 1 adult 1 adolescent	
Kiva A.7	139-143	2 adult 1 infant 1 young adult 1 child 1 small child	Large ? number of burials
N. of Room A.25	129-134	1 adult 1 child 1 infant 1 small child 1 adult 1 infant	Large ? number of burials
Refuse			
W. edge of annex	56	1 elderly male	
S. side of annex	115	1 child	
SW refuse mound	57	1 infant	
SE refuse mound	58-59	2 adults	
SE refuse mound	103-105	3 adults	

[a] Taken from Morris (1928:139-225).

Table 10.22. Grave goods found with Burial 16, Aztec Ruin.

Catalog No.	Description
7925	Necklace with about 400 Olivella shells
7926	Necklace with about 400 Olivella shells
7927	Anklet with about 70 Olivella shells
7928	70 Olivella shells
7929	33 Conus shell beads
7930	3 Conus shell beads
7931	6 Pelecypod shells
7932	1 Large Gastropod shell pendant
7933-39	7 Abalone shell pendants
7940	Fragments of abalone shells
7941	Abalone shell, beads, and bone
7942-5	4 Shell disk pendants
7946-8	4 Shell disks
7949	Worked shell with mosaic
7950	5 Worked shells
7951	Inlaid shell
7952	172 Large disk-shaped beads
7953	11 Large cylindrical beads
7954-70	Several hundred beads
7971	Beads, mosaic fragments, bits of shell and turquoise
7972	Flat irregular beads, mostly turquoise
7973	Frog-shaped beads
7974	Spherical pendant of turquoise matrix
7975-77	Rectangular shell beads
7978	Disk-shaped beads
7979	Beads, bits of turquoise, galena, etc.
7980	36 Figure-eight beads
7981	57 feet (ca. 31,000) tiny black disk beads
7982	15 feet (ca. 8,500) tiny pink disk beads
7983	Beads
7984	39 Tubular bone beads
7985	Several hundred mosaic fragments, turquoise, galena, lignite, and stone
7986	Shell fragments
7987	Conus sp. shell
7988	10 Bird bone tubes
7989	6 Bird bone tubes
7990-92	Unknown number of bird bone tubes
7993	Jasper drill, fragments of stone and galena
7998	Galena crystals

Table 10.23. Grave goods found with Burial 25, Aztec Ruin.

No. of Items	Description
95	Low-grade turquoise beads
1	Large low-grade cylindrical turquoise bead
21	High-grade turquoise disk beads
2	Cylindrical beads
1	Massive amethyst
1	Spherical bead
-	Copper ore
10	Lignite beads
1	Lignite pendant
2	Button beads of yellow stone
1	Stone or shell rectangular bead
1	Stone pendant
3	Abalone shell pendants
16	Shell beads
-	2.3 feet of Olivella shells
10	Olivella shell beads
-	12 feet of black and white beads
-	13.4 feet of white beads
150	Black disk beads
9	White beads (4) and black beads (5)

to possibly one adult, but also infants and children up to 12-15 years of age. They had cotton cloth, matting, buckskin, and a few ceramics with them, but no ornaments.

Burial 35 from Room 143 is a young child who had two shell beads, a red stone pendant, and a lignite pendant. Also with this burial were a cradleboard, ceramics, rush matting, and a digging stick. The burial was in a pit.

Burial 40, a child in a bin in Room 136, was found with two strands—one with 30 white beads, one black and two Olivella beads. The other strand had 18 white beads and one turquoise bead. Also in this bin were two other small children with no ornaments; the rest of the room contained a small child and two infants, also without ornaments (Burials 36-39, 41).

Burial 42, another child from Room 145, had a red stone pendant.

Burial 75, a child recovered from Room 151, had 16 bird bone tubes that were presumed to be beads, plus a mug, part of a bowl, and rush matting. Also in this room were 17 other bodies: five adults, one young adult, one adolescent, two other children, five small children, and three infants.

Burial 83, an adult male from a pit in Room 178, was named the warrior. His grave was in a pit sunk into the floor, and the body was accompanied by numerous grave goods. Among these goods was a shield decorated with flakes of selenite, and a design painted in dark red and greenish-blue colors. Ceramics, bone awls, a knife, and axes indicated that this man was a warrior buried with honor. Accompanying him were a spherical lignite ornament and a strand of 17 white beads, eight lignite beads, two red disks, and two oval pieces of turquoise. He is the only burial in this room.

Burial 100 was an old female found in Room 180. She had two greenstone disks and a small piece of turquoise among her grave goods. In the room with her were 12 other burials ranging from infants to adults, but none with ornaments. They had matting, feather cloth and two instances of pottery.

Burial 115, a child found in the refuse south of the annex, had a number of beads: nine lignite, one yellow stone, 11 white, one red, two Olivella, and one shell.

Burial 133 was an adult from Kiva 4 of the Annex. It was accompanied by an Olivella shell bead and other non-ornamental grave goods. Ceramics, a digging stick, feather cloth, and rush matting were also found.

Kiva G produced many broken beads, fragments of abalone, and other shell ornaments. Based on the presence of granules of a porous iridescent substance that was identical to charred flesh recovered in Kiva D, Morris (1928:213) surmised a burial of an infant or small child.

Additional jewelry items were found at this site. In Room 109, there were two stone pendants, five turquoise and shell beads, three pieces of worked turquoise, seven pieces of worked stone, and one crescent-shaped stone ornament.

Rooms 83, 100, and 125 (second story) had one turquoise bead, a piece of turquoise, and turquoise and shell mosaic. These latter rooms were attributed to the San Juan-Mesa Verde occupation. One copper bell, also attributed to this last occupation, was found in Room 64.

Morris (1928:221-222) did not consider any of the burials to have been placed in a formal burial chamber; however, he does note that many were placed in unused rooms, some of which contained several intentionally excavated pits, e.g., Room 151 where the pits were dug into the initial fill of the room. He noted that three rooms, Rooms 153, second story, 180, and 185 were used repeatedly for burials because the skeletons appear from top to bottom of the refuse. This is somewhat comparable to the burials in Room 33 in Pueblo Bonito, which Akins (1986) considers a formal burial area of the site. Perhaps these later inhabitants of Aztec West continued practices initiated earlier in Anasazi prehistory.

The differences in amounts and types of burial goods of the 178± burials, attributed to the Mesa Verde Phase occupation at Aztec, is marked. Some had little, if any, grave goods while others had considerable amounts (Burials 14, 16, 25 and 83).

A tri-wall structure built over earlier structural remains in the nearby Hubbard Site produced only three pieces of shell. A fragment of a shell bracelet, an Olivella shell, and a small saucer-shaped bead were reported by Vivian (1959:60). This contrasts with nine pieces of turquoise from Room 8 of the tri-wall structure at Pueblo del Arroyo, which had five pendants, two beads, and two fragments, all turquoise.

Richert (1964) excavated a small section of the East Ruin at Aztec. Only one bone pendant or bracelet was among the artifacts he reported. This site had two occupations, one in the early A.D. 1100s and one in the mid A.D. 1200s.

Salmon Ruin. Table 10.24 is a compilation of McNeil's data for ornaments from the San Juan-Mesa Verde occupation at Salmon Ruin. Many of them were recovered from the area around the Tower Kiva (Room 64), but McNeil's (1986) evaluation of the data did not suggest that people living in other areas of the site had any less access to these objects.

Shumway Pueblo (LA 3682). A 14-room irregularly shaped structure, dating ca. A.D. 1150 to 1250, is located on the northern end of the San Juan Mine lease, not far from Shiprock, NM (Kemrer et al. 1980). Swift (1980:92-99) indicates that the claystone ornaments that were found were crafted at this site. Marilyn Swift (personal communication, 1981) indicates the source for the claystone was discovered in the area along the north bank of the San Juan River. This is evidence for a continuation of ornament production in the San Juan River basin.

Guadalupe Ruin. As noted above, most of the ornaments recovered at Guadalupe were attributed to the Mesa Verde Phase occupation. Pippin (1987) found 20 rectangular or triangular pendants (ten turquoise, three chrysacolla, four tufa, one red argillite, one selenite, one nacrous shell), two disk-shaped pendants (one red argillite, one steatite), two fossil Pelecypoda shells, one Antilocapra bone, 56 stone beads (49 tufa, three hematite, three turquoise, one red argillite), and a number of Olivella sp. shells. A group of 515 aragonite/calcite beads were found in Room 22 W (Table 10.18). He also recovered one Conus sp. shell, several inlays (two jet, turquoise, chrysocolla, tufa, shale), an unfinished shell pendant, and modified raw materials. Table 10.18 lists these by provenience.

There are other sites in the area, but only a few have been excavated. Davis and Winkler (1959) excavated six rooms of a 60-room site dated to the Mesa Verde Black-on-white period; they reported no ornaments. At Prieta Vista, a 15-room pueblo dating ca. A.D. 1220 to 1240, Bice and Sundt (1968:93) note that few ornaments were recovered. Stone beads and pendants of locally available white or red calcareous limestone-like rock, three pieces of turquoise, one malachite piece, and a fossil shell pendant comprise the entire lot.

Discussion

Materials—Types and Sources

The available data provide some evidence of change through time in the use of locally available materials and those that would have been imported

Table 10.24. Ornaments and ornament-related materials from the Mesa Verdean occupation at Salmon Ruin.[a]

Provenience	No.	Material
Room 5 (kiva) (MV) 1 ornament	1	Shale, baked
Room 6 (kiva) (MV) 4 ornaments 20 non-ornaments	2 1 6 1	Azurite Chalcedony-agate Gypsum-selenite Hematite-other
Room 11	15 4 1	Gypsum-selenite Shale, baked Shell
Room 11P	1	Hematite-other
Room 15P	2	Gypsum-selenite
Room 16P	2	Gypsum-selenite
Room 18P	15	Gypsum-selenite
Room 19P	2	Gypsum-selenite
Room 21P	3	Gypsum-earthy
Room 30B (MV mix) Room 30W had 9 ornaments, (8 of which were exotic)	5 3 1	Gypsum-selenite Shale, baked Shell
Room 31 (MV mix) Room 31W had 1 exotic ornament	1 4	Jet Gypsum-selenite
Room 33	1	Jet
Room 33B (MV) 1 exotic ornament	1	Shell
Room 33C (kiva) (MV) 1 ornament 24 non-ornaments	7	Gypsum-selenite
Room 36	1 30 33 4 1 1 2 5	Turquoise Gypsum-earthy Gypsum-selenite Kaolin Hematite-earthy Mudstone-siltsone Shale, baked Shells
Room 37	11 1 1	Gypsum-selenite Hematite-other Shell
Room 37A	1	Malachite
Room 43W	1	Gypsum-selenite
Room 51 (MV) 4 ornaments, 2 exotic 1 non-ornament	2 5	Turquoise Gypsum-selenite
Room 57 (MV) 14 ornaments, 1 exotic 9 non-ornaments	1 13 5 1	Turquoise Calcite-vein Gypsum-selenite Shale, baked
Room 58 (MV) 7 ornaments, 2 exotic 12 non-ornaments	1 12 1 1 1 2	Turquoise Gypsum-selenite Hematite-other Mudstone-siltstone Shale, baked Shells

Table 10.24. (continued)

Provenience	No.	Material
Room 59 (MV)	2	Jet
23 ornaments, 2 exotic	2	Turquoise
53 non-ornaments	3	Gypsum-earthy
	22	Gypsum-selenite
	1	Hematite-other
	9	Shale, baked
	2	Shells
Room 62 (MV mix)	5	Turquoise
Room 62W	2	Calcite-vein
12 ornaments, 3 exotic	1	Gypsum-earthy
	64	Gypsum-selenite
	1	Shale, baked
	1	Shell
Room 62A (MV)	4	Hematite-other
2 ornaments, 1 exotic		
9 non-ornaments		
Room 64 (Tower kiva) (MV)	8	Jet
54 ornaments, 4 exotic	2	Turquoise
3 non-ornaments	1	Hematite-other
	42	Shells
Room 67 (MV)	1	Gypsum-earthy
11 ornaments, 2 exotic	12	Gypsum-selenite
36 non-ornaments	1	Hematite-other
	2	Shells
	1	Lapidolite
Room 80	9	Gypsum-selenite
	4	Hematite-other
Room 81	2	Gypsum-earthy
	3	Gypsum-selenite
Room 82	3	Jet
	3	Gypsum-earthy
	15	Gypsum-selenite
	1	Kaolin
	1	Hematite-earthy
	1	Shale, baked
	1	Shell
Room 84	1	Quartz crystal
	1	Calcite-vein
	3	Gypsum-selenite
	1	Shale, baked
Room 86 (MV)	1	Calcite-vein
6 ornaments, common	7	Gypsum-selenite
11 non-ornaments	1	Hematite-earthy
	1	Hematite-other
	1	Shale-other
	2	Shale, baked
Room 88	5	Gypsum-selenite
Room 89	45	Gypsum-earthy
	4	Gypsum-selenite
	2	Hematite-other
	1	Shale-baked
Room 90	1	Turquoise
	1	Calcite-vein
	4	Gypsum-selenite
	1	Shale-baked
	2	Shells
Room 91	1	Calcite-vein
	4	Gypsum-earthy
	15	Gypsum-selenite
	3	Gypsum-satin
Room 91A	2	Shells
Room 91C and 91D	2	Hematite-other

Table 10.24. (continued)

Provenience	No.	Material
Room 92 (kiva) (MV)	1	Gypsum-selenite
4 ornaments		
2 non-ornaments		
Room 93 (MV mix)	1	Turquoise
Room 93W	22	Gypsum-selenite
9 ornaments, 3 exotic	1	Shale-baked
	2	Shells
Room 94 (kiva) (MV)	1	Quartz crystal
Room 94W	2	Gypsum-selenite
13 ornaments, 1 exotic	1	Hematite-earthy
4 non-ornaments	1	Shell
Room 96 (kiva) (MV)	1	Turquoise
2 ornaments, 1 exotic	1	Gypsum-selenite
Room 96W (MV mix)		
2 ornaments, 1 exotic		
Room 97A	1	Gypsum-selenite
Room 98	10	Turquoise
	1	Gypsum-selenite
	1	Hematite-other
Room 100 (MV mix)	1	Jet
Room 100W	5	Turquoise
35 ornaments, 81 exotic	4	Gypsum-earthy
	104	Gypsum-selenite
	2	Gypsum-satin
	3	Calcite-spar
	1	Serpentine
	1	Hematite-earthy
	2	Hematite-other
	7	Shale-baked
	2	Shells
Room 101	1	Turquoise
	2	Gypsum-selenite
Room 102	8	Calcite-vein
	2	Gypsum-earthy
	10	Gypsum-selenite
	1	Kaolin
Room 102A (MV mix)	1	Hematite-other
10 ornaments, common		
Room 102A and 102B (MV)	2	Shale-baked
3 non-ornaments		
Room 118	2	Gypsum-selenite
	1	Gypsum-satin
Room 119	12	Gypsum-selenite
	1	Hematite-other
Room 121 (kiva)(MV)	1	Turquoise
(MV mix)	34	Gypsum-selenite
10 ornaments, exotic		
Room 121A	1	Hematite-other
	1	Shell
Room 123A (MV)	1	Shell
no ornaments		
1 non-ornament		
Room 124 (kiva) (MV)	7	Gypsum-selenite
4 ornaments		
15 non-ornaments		
Room 127 (kiva) (MV)	1	Jet
19 ornaments, 1 exotic	11	Gypsum-selenite
31 non-ornaments	5	Hematite-other
	1	Shale-baked

Table 10.24. (continued)

Provenience	No.	Material
Room 128 (MV) 1 ornament, exotic	1	Gypsum-selenite
Room 128A	1	Shell
Room 129	1	Jet
	1	Turquoise
	1	Azurite
	9	Gypsum-earthy
	34	Gypsum-selenite
	6	Gypsum-satin
	1	Hematite-earthy
	1	Hematite-other
	2	Shells
Room 130 (Great kiva) (MV)	1	Turquoise
(MV mix)	32	Gypsum-earthy
20 ornaments, 6 exotic	6	Gypsum-selenite
	2	Shale-other
	5	Shale-baked
Room 151 (MV)	3	Gypsum-selenite
1 ornament	1	Hematite-earthy
13 non-ornaments	1	Shale-baked
TOTAL	954	

[a] Taken from McNeil (1986:Tables 51-58). Comments in the first column reflect information taken from other segments of this thesis. The numbers do not add up, but no additional information was available to clarify these discrepancies.

from some distance. During the mid-Archaic, Chaco Canyon inhabitants used bone, seed, shale, and wood for jewelry items. All these materials were available in the local area. They probably used materials from the San Juan Basin as well; this is evident by the recovery of the piece of malachite and the freshwater shell.

Access to turquoise and shell is documented with the first evidence of pithouses, the architectural feature that suggests permanent settlements or sedentary life for much of the year during Basketmaker III in Chaco Canyon. Although the exact sources of turquoise are not positively identified, known source areas, all of which have evidence of prehistoric use (Bennett 1966), are beyond the boundaries of the San Juan Basin. The presence of marine shells (Olivella dama and Glycymeris gigantea) indicates participation in a long-distance trade network that extends as far west and south as the Gulf of California. By the end of the Basketmaker III and beginning of the Pueblo I period, Haliotus shells indicate expansion of this trade network to include the Pacific Ocean. There is also evidence of use of more materials that were available both locally and in the San Juan Basin.

Although the distances from which materials were imported do not change after this time, the number of minerals and types of shell increase during the Bonito Phase. This was evident during the Early Bonito Phase (A.D. 920 to 1020); in particular, the number of shell species at 29SJ 627 support this inference. Yet new shell species are also found among small as well as large sites throughout the Bonito Phase. Excluding data on the three shell species indicated above, the other shell species are almost equally distributed among sites surveyed and excavated by Chaco Project staff (Mathien 1984a:Table 1). Recovery of macaw remains at 29SJ 1360 confirms ties in trade to the south (northern Mexico). The introduction of copper bells during the Classic Bonito Phase (A.D. 1020 to 1120) reinforces this southern trade tie. By the Late Bonito Phase (A.D. 1120 to 1220), the number of ornaments seemingly decrease, but a new shell taxon, Nassarius, was documented at the previously excavated site of Kin Kletso (Vivian and Mathews 1965).

The latest Anasazi occupation of Chaco Canyon has been named the Mesa Verde Phase (A.D. 1220 to 1320) because of many similarities in material culture between remains found in Chaco Canyon and those found farther north in the area of Mesa Verde. Considering that data from excavated sites in Chaco Canyon are very limited, they do not suggest any major change in the use of materials. Marcia Truell (personal communication, 1980), however, thought that some of these items may have been scavaged from earlier sites. Review of materials from sites to the north, specifically large sites located along the San Juan River and its major tributaries, support the inference of continued use of the same materials.

In summary, there is evidence that numbers and types of material increased through time. Sources of these materials cover many directions and extend for considerable distances. The earliest inhabitants were probably hunters and gatherers who ranged over the San Juan Basin and its peripheries, collecting items during their yearly round. With the beginnings of sedentary life, however, sources of materials were greatly expanded. By the height of the Chaco Phenomenon, these areas were located as far west as the Pacific Ocean and south into northern Mexico, and were documented as trade nodes during the historic period (Bandelier 1892), indicating continuation of some similarity in patterns developed in early Anasazi times by their descendents.

Jewelry-making—Technology, Location, and Personnel

Technology

Chaco Canyon inhabitants probably used a technology developed by their neighbors and possibly their ancestors. Jernigan's (1978) review of the data on jewelry-making in the Southwest indicates that numerous materials were used quite early, during the Desert Tradition. Shells and other materials that are as hard as 3 1/2-4 or 5 on Moh's scale were being shaped into ornaments, but most of the work was not as sophisticated as that for ornaments from the Basketmaker II period in northeastern Arizona. Kidder and Guernsey's (1919) description of the black lignite beads that had small perforations and retained their polish and luster at the time of excavation, and their description of a graduated bead necklace from White Dog Cave (Guernsey and Kidder 1921) indicate that the Anasazi developed the technology for manufacture of fine jewelry quite early. This technology was used on harder materials, including turquoise, by Basketmaker III for certain, but no harder materials were successfully drilled and used in quantity after this period.

This technology included mining, shaping and grinding, drilling, and polishing. Mining was probably not complicated. Many of the materials could be removed from the earth or sea by gathering them up, while some would have required a stone hammer or maul to help in extraction. Turquoise was probably the most difficult mineral to mine. My emphasis here is not on turquoise nodules; there are few of these recovered in archeological sites. Vein material is predominant and the removal of turquoise from a vein requires separation from a hard matrix. The host rock would have to be carefully removed so that thin veins of turquoise would not shatter, or tooled in a way that some matrix remained as a backing for an ornament, such as a pendant. As modern miners learned, breaking up large areas with explosives is not feasible. To obtain good seams requires careful work. The presence of hammers and lapstones at prehistoric mining areas, such as Cerrillos (Warren and Mathien 1985), reflects Anasazi understanding of this problem.

Jernigan (1978) reviewed detailed methods of grinding and shaping, polishing, and drilling, but I would like to emphasize one point—the drilling tools used for making stone beads. How to make the tiny perforations in discoid beads remains a subject of discussion among archeologists and students of prehistoric jewelry. The main question is the material that was used as a drill; some have suggested cactus spines, porcupine quills, or various types of stone tips. Stone tips may not have been small enough to achieve the tiny perforations found among the Chaco turquoise beads. McNeil (1986:114) considered the ends of wet cane or wet cacti dipped in sand as a possible method.

Bone beads, on the other hand, were not drilled, but there are also several steps in their manufacture. Larry V. Nordby (personal communication, 1985) indicated that the Basketmaker III pithouses at Pecos contained evidence of a complete series of well-developed manufacturing techniques for making tubular bone beads. All inferences were based on the manufacturing attributes present on the bone and on the long bones that were discarded. The methods include sectioning the long bones by removing the epiphyseal ends, circumferentially scoring the shaft about halfway through to the marrow cavity, then snapping off the pieces, and grinding the ends to various degrees. Polishing (if done for aesthetics rather than as a result of wearing the beads) was last, rather than first, based on the overlap of the attributes. In Chaco Canyon, no analysis of this type of manufacturing has been done.

The ornaments recovered from Archaic-Basketmaker II and Basketmaker III sites in Chaco Canyon do not suggest that great skill was needed in their preparation. This contrasts with the skill needed to make the black beads recovered by Kidder and Guernsey. The nicely made turquoise beads with tiny perforations and beautiful polish found at Kin Nahasbas and Pueblo Bonito, however, indicate even more sophistication by the Bonito Phase. These pieces are as beautiful as any that can be made today using metal tools and high technology.

Location

Jewelry workshop areas are difficult to identify prior to the Early Bonito Phase (A.D. 920 to 1020). The evidence from Shabik'eshchee Village may indicate that someone made a few pieces of jewelry now and then, possibly in the plaza area. The large amount of turquoise debris recovered at 29SJ 629, both modified and unmodified, indicates that inhabitants at this site spent considerable time and effort at this task. Other workshop areas have been identified in Chaco Canyon and throughout the Anasazi world, but none are as close together in space and time as those in Chaco Canyon. Even though there is some evidence that other materials were made into jewelry items (Mathien 1984a), those in Chaco Canyon were probably turquoise specific.

Personnel

Who made beads and how much effort was involved in jewelry-making changes through time in Chaco Canyon. During Basketmaker III, the quantity and quality of jewelry items indicates that inhabitants of Chaco Canyon may have made their own jewelry; the items are fairly crude compared to what is found during the Bonito Phase. They are also crude when compared to the material found earlier by Kidder and Guernsey (1919) in northeastern Arizona. Workshop areas identified during the Early Bonito Phase indicate that considerable time was spent at this task and that it was probably performed in plazas or kivas. Estimates of the time involved in drilling suggest that it was time-consuming to make a necklace; therefore, someone probably devoted a major part of his/her efforts to its preparation. Evidence from 29SJ 629 suggests that one or two families may have specialized in this craft, while other neighbors pursued different tasks. The amount of time involved may indicate either full or part-time specialization; this question cannot be resolved at present.

The evidence recorded by Windes (1993), while surveying sites in the eastern part of the Chaco Wash, and the material from the Andrews Site suggests to me that beginning in the A.D. 900s jewelry workers may have lived in the eastern half of Chaco Canyon or in sites located to the south of it. Later evidence for the location of turquoise jewelry-making centers around Pueblo Bonito and the center part of the canyon.

Social Organization

The data indicate several changes in the procurement, production, distribution and consumption of ornaments over time. During the mid-Archaic, the inhabitants of Chaco Canyon were using bone, seed, shale, and wood beads, all materials which were available in the local area. By Basketmaker III, there were settled villagers living in Chaco Canyon. Like their counterparts in other areas of the Anasazi world, they had access to turquoise and shell which had to be imported from long distances as far as the Gulf of California. The number of ornaments did not vary much from those found in other Anasazi sites; unfortunately, we have no available data on Chacoan burials from this period to compare with the abundance of ornaments found with burials during Basketmaker II and Basketmaker III in sites in northeastern Arizona.

A major change in the availability of trade goods occurs in the Early Bonito Phase (A.D. 920 to 1020), when the first turquoise workshop areas are defined. Greater numbers of and better made ornaments of all types, in addition to the use of turquoise for offerings, are evident between A.D. 1020 and 1120 in Chaco Canyon, although offerings may have been placed in great kivas as early as the A.D. 500s. Workshop areas have been identified in Chaco Canyon sites throughout the entire Bonito Period. Ornaments continue to be found in small sites in Chaco Canyon throughout the Mesa Verdean Phase; however, the limited data do not provide more than basic information.

Examination of grave goods found with Chaco Canyon burials, as well as the areas where burials were placed, led Akins (Akins 1986; Akins and Schelberg 1984) to conclude that status differentiation did occur during the Bonito Phase. Besides dividing the burial population into at least two major strata, Akins (1986; Akins and Schelberg 1984) suggested that the superordinate group consisted of two ranking lineages based on discriminant analysis of cranial measurements and the presence of two burial clusters in Pueblo Bonito (the north versus the west rooms).

Comparisons of data from excavated outlying Early Bonito Phase Chacoan structures suggests that in the Early Bonito Phase, the only outlier with any quantity of ornaments is the Andrews site, located to the south near Prewitt. Judge (personal communication, 1980) noted considerable amounts of turquoise on the surface of San Mateo Ruin, another Chacoan structure in the same area. Two small sites also had larger than usual amounts of jewelry, one with a burial. By the Late Bonito Phase, only Salmon and Aztec Ruins, located to the north, have indications of ornamental wealth. The small house at Dominguez also had one burial with an unusual amount of jewelry.

During the thirteenth century, sites with a "San Juan/Mesa Verde" occupation exhibit larger amounts of ornamental items. These include Aztec West Ruin (the largest outlier with the greatest amount), Salmon Ruin, and Guadalupe Ruin. No definite workshops have been identified during this period, but Morris (1928) did note some debris in several rooms at Aztec West.

Whether or not an incipient stratified society existed among the Anasazi during the Late Bonito and "San Juan/Mesa Verde" periods cannot be determined at present. The limited review of the data from outliers presented above suggests that there may be some validity to this idea. A more detailed study, however, must be undertaken to evaluate this hypothesis.

Based on the available evidence, it is inferred that Chaco Canyon was a center for production and consumption of turquoise, particularly between A.D. 920 and 1120. The evidence from the A.D. 1120 to 1220 period is difficult to evaluate due to the lack of tight control of data and provenience locations at many sites. By the thirteenth century, however, a shift from Chaco Canyon to the San Juan River may have occurred. At both Salmon and Aztec, a larger number of ornaments were recovered during the latest occupations. Although this may be partly due to reuse of earlier rooms (thus removal of data), it may also indicate a shift in location for the higher status individuals who provided the leadership necessary to keep the far-flung Anasazi world in operation. Data from Guadalupe also indicate more ornaments from the thirteenth century occupation of that outlier. Because this examination did not encompass the entire Anasazi data base in detail, no definitive statements can be made. Data from the ornament study seems to follow a similar shift in association from the south in the A.D. 900s to the north in the A.D. 1100s, as does evidence from studies of ceramics (Toll et al. 1980) and lithics (Cameron and Sappington 1984).

The data from the Aztec complex, especially Aztec West Ruin, indicate that the leadership of this Anasazi system may have relocated after A.D. 1100. The data from ceramic evidence, chipped stone, and the architecture all show some comingling of Chaco traits in the northern part of the San Juan Basin through the Bonito Phase. In Chaco Canyon, there seems to be an increased interaction with sites in the San Juan River Valley area during the Late Bonito Phase; the outliers with a Mesa Verde late occupation are numerous and perhaps, as McKenna (1991) suggests, there is a shift in centrality for the Anasazi system.

Several other inferences about social organization can be evaluated. Data from various sites excavated by the Chaco Project shed additional light on some of Judd's (1954) observations.

With regard to source materials, the Chaco Anasazi did use both local materials as well as those imported from long distances. Akins (1986; Akins and Schelberg 1981, 1984) points out, however, that the use of great quantities of turquoise and marine shell tends to be limited to society's upper strata. Although a few pieces of turquoise or shell are found with inhabitants of village sites, the great volume of imported material was recovered from Pueblo Bonito, where the best prepared burial chambers were located. Black shale and calcite beads, both available from closer sources, were found with villagers, particularly the female from 29SJ 1360.

Judd (1954) noted a great number of imported Chama echinata shells in the Late Bonito rooms. Data on the introduction of shell species at excavated sites confirms an increase in the number and types of shell after A.D. 920, particularly around A.D. 1000 to 1050.

Based on the analysis of materials, especially discoid calcite and shell beads, I am not confident that material types have always been correctly identified in the literature (Mathien 1984a, 1992a). A reexamination of old collections is necessary to clarify this problem.

Judd (1954:86-87) noted most mineral beads were discoid. The data in this study are in agreement with his observations. Regarding the process of bead manufacture, the only major point that can be added to Judd's observations is the tool for drilling. At 29SJ 628, 29SJ 626, and 29SJ 392, the presence of small chalcedonic silicified wood (#1140) drills, as well as turquoise debris, abraders, and porcupine quills in Other Pit 1 of the Plaza at 29SJ 629, indicates that these drills may have been used to perforate the larger beads. This does not seem likely for the smaller beads, however, because the drill tips were too large and conical.

Olivella shells were most often ground only at the tip, and only a few saucer-shaped shells were recovered. Bilobed or figure-eight beads were rare, as Judd noted. Bone was used only for tubular beads and rings.

Most workshops for turquoise ornaments were identified during the Chaco Project. The description of material at Bc 51 (Vivian 1970), however, may indicate other materials were being processed in Chaco Canyon, probably in the Late Bonito Phase. Because a workshop for argillite was identified at Shumway Pueblo in the A.D. 1200s (Swift 1980), a change in materials produced may have occurred.

Turquoise does seem to be the most valued material type. Frisbie's comments (personal communication, 1984) indicate that turquoise has a special religious significance among the Zuni today. Judd's observations that the poorer quality turquoise and scraps were saved and placed as offerings in kivas was upheld by the data from 29SJ 423, where the Basketmaker III great kiva and the Pueblo III shrine contained turquoise offerings.

Explanations for the rise and fall of the Chaco Phenomena have been a topic of investigation for several decades (e.g., Irwin-Williams 1983; Irwin-Williams and Shelley 1980; Judge 1979; 1989, 1991; Kelley and Kelly 1975; Schelberg 1982; Sebastian 1988; Vivian 1970); how the system operated is still under investigation. Based on the study of ornaments and minerals, I believe there is a difference among the various Anasazi groups during the Bonito Phase. One possible explanation considers Chaco's location in the middle of the San Juan Basin as an oasis in the desert. When population had grown sufficiently to use all the decent agricultural lands in that area, the farming area became circumscribed. As some families must have relied on others for food resources, incipient social stratification resulted. On the perimeters of the basin, however, there was more room for expansion and less need at an early date for dependence on neighbors to provide basic necessities. Hunting and gathering in nearby mountains or mobility strategies may have remained options for a longer time. Thus, the early rise of large structures or greathouses, mainly in Chaco Canyon, and the use of turquoise, copper bells and macaws to mark the differences among people within the local area, may be the result of using dependent groups for construction and as specialized traders who could assist leaders in procurement of unusual or difficult to obtain objects. The possibility of a big man trading system, much like that described by the kula ring, has been explored elsewhere (Mathien 1992c). In the proposed system, turquoise became a special symbol for the Chacoan leaders, but not necessarily for leaders in all other communities.

In summary, it is inferred that some of the Pueblo traditions ethnographically observed may have had their beginning during the Basketmaker III Phase and the Bonito Phase, when a stratified society was able to obtain turquoise in great numbers from long distances and made use of it in ceremonies as well as for ornaments.

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Chapter Eleven

Inferences from the Data

Frances Joan Mathien

The goal of this chapter is to bring together some of the information generated by the analyses of artifacts recovered during the Chaco Project and to use these data to gain a better understanding of the prehistoric Chacoan people through time. A number of questions were raised about Chaco Canyon as a culture center and the level of social complexity of the Chaco Phenomenon. Despite problems with how the samples were derived, questions about terminology, multiple uses of artifact types, incomplete understanding of site formation processes and later site disturbances, and lack of primary contexts in which some artifacts were found, a number of ideas can be explored. All these issues raise questions for additional investigations.

Review

Because some artifact types, such as ceramics, chipped stone tools, and ornaments have received much attention in the past, typologies, which had been established previously, are now refined intermittently. Those who worked with these artifact types tended to address questions about the complexity of the society as evidenced by trade, craft specialization, and differences in consumption patterns between greathouse and small-house sites. The analysts who examined the ground stone artifacts were more concerned with basic typological problems, e.g., Wills' efforts to determine if there were several classes of hammerstones and how they differed. All analysts addressed procurement sources and changes in material types through time, but often the numbers of artifacts were few, making discussion of source determination and imports more difficult. This review will draw on information from the appropriate chapters and other studies. The topics selected include imports, material types and functions, tool kits, craft specialization, and differences in distribution and consumption between greathouse and small-house sites.

Imports

That the inhabitants of Chaco Canyon always had access to imported goods was demonstrated for all classes of artifacts evaluated in this volume. Definitions of boundaries for local, regional, and long-distance imports, however, were not the same. There was general agreement that the San Juan Basin was the regional boundary, but the distances considered to be within local availability differ somewhat (5 km, 10 km radii from the canyon). Interaction with other areas outside the region, such as the Kayenta, Little Colorado, and Mogollon were documented. Also noted were the many fluctuations in the source areas and relative percentages of goods through time.

Toll's evaluation of the ceramic data indicates that a large number of ceramics were brought into Chaco Canyon from several directions, beginning in Basketmaker III and continuing through Pueblo III (Tables 2.58 and 2.61); imports reached 50 percent overall for the sites combined during one period (A.D. 1100 to 1200). The highest percentages of redwares, graywares, and whitewares, however, do not come from the same source areas at the same time. For example, between A.D. 920 and 1100, approximately 80 percent of the redwares are from the San Juan area, while trachyte-tempered ceramics from the Chuska Mountains appear more frequently as graywares from A.D. 1040 to 1100 and whitewares appear between A.D. 1100 and 1200. After A.D. 1100, there is an increase in the San Juan tempers in the graywares and whitewares. Such shifts are not unique to Chaco Canyon; Blinman and Wilson (1992) demonstrate a complex pattern in several localities (Kayenta, Chuska, Chaco, Northern San Juan and Upper San Juan subdivisions) of the northern Anasazi area.

Toll does see an increase in the number of imports in Chaco Canyon through time, leading up to the peak between A.D. 1100 and 1200, with a slight decrease thereafter. There is a tendency for a greater proportion of the exotics to come from the south prior to A.D. 1040, from the Chuska area during the Classic Bonito Phase, and from the San Juan area later on. Even though the Chuskan ceramics dominate the assemblages during the Classic Bonito Period, half of the imports are not from this area. As Toll concludes, this is a dynamic, complex system.

Chipped stone tends to be local, but imported materials were used during all periods. Imports were generally less than 10 percent of the specimens recovered prior to A.D. 1020, but around 30 percent between A.D. 1020 and 1220. Most of the exotic materials were finished tools. After A.D. 900, the imported materials indicate that exotics came primarily from the west or northwest as finished tools from A.D. 1020 to 1120; from A.D. 1120 to 1220, however, bulk materials were more common and came from the east (Jemez Mountains). Proportionately, these exotics are found in higher percentages in the greathouses after A.D. 1020.

Generally, ground stone tools were fashioned from locally available materials. Several of the analysts questioned whether shifts in numbers of imported materials were due to depletion of sources, function, or areas where particular activities were carried out. Based on a review of the data, sources of materials were not limited by their abundance; shifts in use of imported goods were related to changes in tasks, materials used, or the organization of work groups.

Akins' examination of abraders (Table 5.153) indicates that sandstone was the preferred material (1,868 or 84.3 percent), with quartzite (291 or 13.14 percent) being the second choice. The remaining nine material types made up about 2.3 percent. Yet when one examines the functions of tools, the quartzite and other cobble materials are usually used as polishers (282 of 340 or 82.9 percent of all polishers were quartzite); only 12 (3.5 percent) were sandstone. For active, passive, and grooved abraders, as well as anvils, the choice of materials was reversed (Table 11.1).

Wills noted that approximately 75 percent of the hammerstones were made from local petrified wood; only 25 percent were imports and the materials varied considerably, with quartzite being the most frequent import. Chert percentages increased until Pueblo I, when it tapered off, as did dark wood. The largest diversity in cherts occurred in the A.D. 1000s.

The sample for axes and mauls is more limited than Breternitz would have liked, but by combining information on sites excavated by the Chaco Project with that from other excavated Chaco sites, he suggests that there was an increase in the number of imported cobbles through time. Thus, source availability would not be an explanation for the change in numbers of cobbles noted by Akins and Wills (as Wills anticipated). Windes (1987:295) reviewed a different database for axes during his analysis of Pueblo Alto and indicates that axes were rare until after A.D. 1100; he postulates that they may have been brought into Chaco Canyon by people from the San Juan region and used in the remodeling of existing sites or in the construction of new small sites.

Cameron reports that manos were generally made of local materials (all but 5 of 1,244 analyzed were sandstone; 0.2 percent were quartzite). Local sandstone was also the material of choice for metates analyzed by Schelberg.

With regard to jewelry, the presence of freshwater shell and malachite during Basketmaker II indicate the early availability of resources from the San Juan Basin. Other imported materials, particularly turquoise and marine shells from the Gulf of California, were available by Basketmaker III; marine shells from the Pacific Coast appeared shortly thereafter (Basketmaker III-Pueblo I transition). The turquoise and shell numbers increase dramatically after A.D. 900 and new species of shell appear, especially in the late A.D. 900s to early 1000s. Copper bells and macaws indicate establishment of trade networks that encompassed northern Mexico and were in place during the mid A.D. 1000s (Mathien 1992b).

Table 11.1. Materials used for abraders and anvils at Chaco sites.

		Sandstone		Quartzite		Other	
Type	Total	No.	%	No.	%	No.	%
All active	1,014	1,007	99.3	3	0.3	4	0.4
All passive[a]	533	229	43.0	-	-	11	2.1
Grooved	47	46	97.8	2	2.1	-	-
Anvils	281	275	97.8	6	2.1	-	-

[a] Totals for passive abraders did not agree with tables and percentages.

In summary, understanding the role of importation and exchange networks that brought many and diverse goods into Chaco Canyon is not a simple task. The people made choices about what materials were best for specific goals and tasks, and they used the local sandstone for many purposes. Jewelry items of various materials indicate differential use, with disposition of those made from imported turquoise and shell being somewhat restricted (Akins 1986; Mathien 1992a).

Material Types and Functions

As Akins indicates, material type has much to do with shape and function of the various types of abraders. Although many of the tools were multifunctional, she associated cobbles with the earlier sites (Basketmaker III through Early Pueblo II). During Pueblo II, active abraders possibly replaced polishers, or perhaps with the use of masonry rather than mud wall structures, cobbles were in less demand because 1) different tools would be needed, 2) imports would be hard to get, or 3) the quarrying activities for all stones made it easier to obtain a hard local material. Comparisons of data from Pueblo Alto and several small sites (Akins 1987) again indicated that there were fewer polishers in late sites versus an increased number of abraders. Pueblo Alto and 29SJ 629 had fewer abraders and polishers than expected; yet lapidary abraders were numerous at Pueblo Alto. These are usually associated with jewelry-making, but active lapidary abraders were probably more characteristic of small Pueblo II sites than Pueblo Alto (Akins 1987—see also discussion of jewelry-making tool kits below).

Wills also notes decreased use of quartzite and increased use of petrified wood for hammerstones through time. He evaluated the possibilities that form or source depletion were causal factors, but ruled them out. Like Akins, he assigned the reason for differences in materials to a change in the function of hammerstones. Because his study was limited, Wills was unable to test propositions, but he did suggest several points to ponder. Among them was the role of quartzite versus petrified wood hammerstones in chipped stone tool manufacture. He thought that quartzite, being denser, could have been better suited for flint working using hard hammer percussion, especially on chert or chalcedonic materials. In turn, petrified wood would have been used in later stages of manufacture when more precise percussion control was needed. Thus, if more bulk reduction was taking place at source areas and blanks were more often imported at later dates, with final tool production taking place in the canyon, this could be a viable hypothesis.

Cameron indicates that there is a shift in how exotic chipped stone materials are brought into Chaco Canyon around A.D. 900. In the earlier periods, the low ratios of tools to debitage indicated that most exotic material was brought in as finished tools. From A.D. 1020 to 1120, the ratio is much higher and it decreases slightly from A.D. 1120 to 1320, indicating it was brought in as raw material or cores. Even here, however, there are differences by material types with most Morrison Formation materials coming in as finished tools between A.D. 1020 to 1120; the obsidians from the Jemez were acquired in bulk from A.D. 1120 to 1220.

One site specific instance where the data are carefully evaluated is seen at a small site, 29SJ 1360. McKenna (1984:248) discusses the use of petrified wood for later stages of chipped stone tool production. He found a decrease in reduction of larger cores through time and he comments that petrified wood hammerstones were probably used more extensively on massive objects and suggests that they were a general-use item rather than a task-specific tool.

In his report on Pueblo Alto, Windes (1987) associates the splintery petrified wood hammerstones with sharpening of grinding stones; hammerstone/abraders were linked to construction. Differences in material types were linked to motor habits and possibly types of veneer on which these tools were used. Again, the highest frequency of splintery petrified wood found among the chipped stones is documented for A.D. 1020 to 1120 (Table 3.5), the period when the greatest amount of greathouse construction took place (Lekson 1984:266-167, Figure 5.2). This building boom in the large sites, however, contrasts with data from small-house sites, where it is possible that there was a hiatus in building during the period from the A.D. 1040s to the early 1100s (Truell 1986:143-144). Truell (1986:144) notes that we do not have a good explanation for this difference; she postulates that inhabitants of small sites may have worked at the greathouses and spent much of their time there.

Breternitz' study of axes and mauls included several suggestions that pertain to material types and functions. The sample from the Chaco Project indicates that the harder materials were preferred for axes (70 percent) but not necessarily for mauls (only 34 percent). He noted that the earlier sites (Basketmaker III through Pueblo I) had fewer stone axes and that all but two from 29SJ 628 were made from locally available sandstones. By Pueblo II, not only was there an increase in the number of axes, but there was also a greater diversity of material types. In Pueblo III, the numbers decreased and all were made from cobbles, probably obtained from the San Juan River Valley. Breternitz postulated a link between this pattern and the procurement of timber for both building construction and fires. If local wood sources were being depleted during Pueblo II, when above-ground construction of greathouse and small sites began, timber import would have been necessary. Possibly, material used to make axes for felling timber were picked up and shaped closer to the timber source, thus an increase in imported cobble axes relating to the northern sources. Breternitz also indicates that the number of axes at Aztec and in the Mesa Verde area are proportionally greater than those in the canyon. In addition to their use in construction and the correlation between tree resources and number of axes, Windes (1987) also considers a possible ritual significance as well, with axes considered to be valuable items. This interpretation is based on ethnographic comparisons and is a topic that could use further evaluation.

In her study of manos, Cameron documents that 26 were one-hand or ovoid in shape. Of these, five were quartzite; only one other quartzite mano was analyzed, which indicates that quartzite was selected predominantly for one-handed manos and sandstone for two-handed manos. Assuming that one-handed manos were used in basin metates to grind wild plant seeds, these should have appeared primarily in Archaic and Basketmaker sites. Cameron indicates that the highest relative frequency of one-handed manos occurs in the period A.D. 500 to 600 (Table 8.7); yet, about half were recovered from provienences dating prior to A.D. 920 and half from later layers (Tables 8.7 and 8.8). Thus, continued use is predicted for wild plant resources, a fact substantiated through palynological and macrobotanical analyses (Cully 1985; M. Toll 1985). In her summary of the characteristic changes in amounts of corn and wild plant foods utilized through time, M. Toll (1985:266-268) notes temporal shifts that may be related to different adaptations or environmental change. Although wild plants are present at all times, they are present in high numbers when compared to the amount and types of corn remains during the A.D. 1000s but decrease around A.D. 1100. Fluctuations are also evident at other Chaco related sites in the San Juan Basin (M. Toll 1985:Table 5.11).

Cameron suggests that rectangular-to-squarish two-handed manos were probably used until wear effected new shapes—multifaceted or wedged—prior to their discard. Data from 29SJ 1360 (McKenna 1984:257) support this hypothesis. Windes (1987: 339, 1993a) also considered the two mano sizes to be related to function, food versus non-food and type of vegetal material. By the A.D. 1100s, the small grinding surface may be associated with the use of more wild plant seeds, an idea explored by Schelberg in his discussion of metates.

Although Cameron suggests that the shapes of the manos change with their use and wear, she also notes that around A.D. 920 a change from wedge-shaped to beveled or triangular-shaped manos occurred. She suggests that a new grinding stroke was developed, possibly related to the use of enclosed trough metates in communal bins. In Chaco, it was not associated with the use of slab metates, as suggested by Bartlett (1933:18-19); the majority of the beveled and triangular manos in Chaco had canted ends of the same average length as the trough metates.

Schelberg's data on metates further supports the use of trough metates throughout the Chaco Phenomenon. Unlike Bartlett (1933) and others, Schelberg does not visualize a pan-Anasazi change from trough to slab metates during the Pueblo II period. He questions whether this change that was noted especially for sites in Arizona may have been due to efficiency or to changes in the types of corn being ground. Flint corns are harder than flour corns; the types of metates needed to contain the pulverized grains could have been different. Also, utilization of space within sites may have affected the types of metates employed in grinding tasks. Bartlett (1933) did suggest that a permanent location for grinding bins and creation of specific grinding areas affected metate morphology, but the increased efficiency hypothesis seems to have dominated the literature for the past several decades.

In addition to corn, other items would have been ground on metates. Among them are clay for pottery, pigments for paints, pollen for ceremonies, and plants and herbs for medicinal purposes. Perhaps these different materials would have affected the sizes and shapes of metates and not just manos, as suggested by Cameron (see above).

Windes (1987) takes a slightly different but similar approach to the explanation of change. The shift from portable to enclosed metates and back again may be related to social organization, subsistence, or permanent site use. Although seasonal use versus permanent use of a site may condition the type of grinding facilities, Windes preferred to correlate the change in metates with a change in the use of space, patterns of trash disposal, and changes in subsistence. Climatic change in the late A.D. 1000s and early 1100s is correlated with the presence of smaller corn cobs and use of more economic grasses at Pueblo Alto. If there were an increase in wild foods, along with increased use of corn, mealing bins may have been used to grind more foodstuffs and thinner metates were possibly utilized. According to Windes, once fewer grasses were needed, mealing bins would disappear in Chaco Canyon and thicker metates would reappear.

On the non-utilitarian level, turquoise and shell, as well as jewelry items, were used as offerings as early as Basketmaker III (e.g., offerings in the great kiva at 29SJ 423). These two materials were the only long-distance imports of the time. They continued to have a somewhat restricted use throughout Chaco prehistory, e.g., with burials in the A.D. 900s at Pueblo Bonito versus a shale necklace with Burial at 29SJ 1360 (Akins 1986), which suggests a contrast between groups of people living in small sites and greathouses (see Distribution and Consumption).

Of interest is how much evidence there is for reuse of artifacts. Several sherds had been made into pendants. Debris from jewelry-making or poorer quality turquoise objects, some of which were not completed, were placed as offerings in kivas. This type of behavior would be expected by people who had imported objects or materials from a long distance and probably at considerable cost (no matter how cost is calculated).

In particular, most of the ground stone tools have been reused for multiple purposes. For example, Truell (1992:165) noted the paucity of metates at 29SJ 627; she recovered many of these items in the masonry walls at 29SJ 633, another small-house site located nearby (Mathien 1991). Akins pointed to recycling in her evaluation of abraders. Breternitz notes that some axes from 29SJ 627 were also used hammerstones.

The numerous imports suggest accessibility to high numbers of these goods; yet the reuse of locally available materials suggest frugality or conservative behavior. The implications for behavior of local populations needs to be explored, especially as this bears upon interpretation of social complexity.

Tool Kits

Based on the data from these analyses, several types of tool kits can be described.

Pueblo Construction

The tools used in building structures vary, depending on the task undertaken during a particular stage of construction. Stone axes, generally made from locally available sandstone during the Basketmaker III-Pueblo I period, were probably used for tree-felling. The species of wood used to build early pitstructures (locally available pinyon and juniper) were different from those found in later greathouses; smaller logs were procured. During Pueblo II and Pueblo III, when longer and thicker logs of ponderosa pine were used in the greathouses (Dean 1992:39-40), the proportion of harder imported cobbles, probably obtained from the San Juan River valley increased, and fewer sandstone axes were used. By Pueblo III, none of the softer stones were in use.

Large polishing stones, analyzed as abraders, were described by Akins and attributed to wall construction and maintenance activities. Windes (1987:296-299) puts hafted hammers and picks in this category, as well as hammerstone/abraders made of silicified wood up until the early A.D. 1000s, and sandstone thereafter (Windes 1987:308-321). Most hafted hammerstones/abraders found in construction debris at Pueblo Alto were a hard gray indurated sandstone (Windes 1987:296).

Ceramic Manufacture

Clays for body and slip, polishers and scrapers, paint substances, and firing areas are needed to make pottery. Akins discussed a number of polishers; smaller pot polishers were attributed to the pottery-making tool kit. This was the only artifact type found in any abundance during the analyses of materials from this project. Toll (Table 2.67) indicates other sites where several of the expected artifacts were found.

Chipped Stone Tool Manufacture and Maintenance

Wills suggested that quartzite hammerstones, probably used for hard hammer percussion in the initial stages of production, and petrified wood, used for more precise percussion control during later stages of manufacture, were part of the chipped stone tool manufacturing tool kit. As noted above, these items may have had other uses as well. Akins differentiated grooved abraders, often described as shaft sharpeners and point sharpeners. No other tools were found that would be attributed to this tool kit.

Food Grinding and Preparation

In addition to manos and metates that are used for food grinding and preparation, several other artifact types can be associated with these tasks. As Schelberg points out, Lange (1959:117) observed hammerstones were used at Cochiti Pueblo for sharpening grinding stones before use, especially manos. They were used to peck the metates on a somewhat regular basis. The manolike abraders and the cornbreaker abraders described by Akins are also part of this tool kit.

McKenna (1984:271) describes the cornbreakers at 29SJ 1360 as hard active abraders that have extensive abrasion on all sides and battered poles; extensive use of appropriately shaped unmodified stones or old manos would contribute to the shape of the pestle. These tools could have acted as both hammerstones and grinders, similar to a biscuit or one-hand mano. Woodbury (1954:89-90) suggested these cylindrical hammerstones were primarily used in food processing.

Windes (1993a) included manos, metates, hammerstones, some abraders, corn crushers, and choppers in his description of grinding tool kits at 29SJ 629.

Pigment Grinding and Preparation

Akins was able to differentiate several types of abrading stones used to grind pigments. These included stones abraded for their pigment (described as paint stones in several reports, e.g., 29SJ 627—Truell 1992), paint grinders, paint mortars, and three types of palettes (undifferentiated, raised border, and incidental). There was often evidence of the pigments on these artifacts. Schelberg also indicates that metates would have been used for this purpose.

Windes (1993a) suggests that there may be a correlation between the numerous red paint stones recovered, especially at 29SJ 628, with the use of a fugitive red paint on Basketmaker III-Pueblo I ceramics. He also postulates that around the A.D. 900s to 1000s, if there were increased ceremonialism, the presence of more formal paint stones would be expected. Greater quantities of blue and green (azurite and malachite) were recovered at Pueblo Bonito, Chetro Ketl, Pueblo Alto, and the small sites (Table 10.3). The painted wood recovered from Chetro Ketl (Vivian et al. 1978) indicates that numerous colors were used for decorating ceremonial items.

Jewelry-making

One of the best described tool kits, based on artifact associations, is for jewelry-making. Akins' information on active and passive lapidary abraders, especially their association with turquoise debris (Mathien 1984), led her to associate these with jewelry-making activities. She noted that the files recovered from 29SJ 629 were very similar to those reported for Pueblo Bonito (Judd 1954:123) and identified by the Zuni workmen as being a part of turquoise and other ornament-making tool kits. Schelberg recorded two metates that may have been reused as drill bases. One each was recovered from 29SJ 627 and 29SJ 389. Cameron and Lekson describe the chalcedonic silicified wood drills associated with this work.

Prior to Pueblo II, Windes (1987) reiterates that lapidary abraders were rare. Because of the unusual amounts of turquoise debris and associated tools recovered at 29SJ 629, Windes (1993a, 1993b) pursued the description of a jeweler's tool kit. He established the presence of several subtypes of lapidary abraders based on weight. The heaviest abraders were intentionally shaped, approximately 22 x 14 x 3 cm in size, and 1,325 g in weight. In addition to those recovered from the floor of Pithouse 2 at 29SJ 629, similar large lapidary abraders are documented at 29SJ 1360 (Pithouse floor), Room 326 in Pueblo Bonito, and Room 23 at Pueblo del Arroyo—sites that Mathien (1984) indicated had sufficient turquoise debris and other materials in various stages of manufacture to be considered places where jewelry was made. The three smaller subtypes of lapidary abraders were considered to be morphologically indistinct. Windes also notes that some abraders had groove sizes that correlated with the sizes of beads and pendants recovered at 29SJ 629. The four files from 29SJ 629 resemble those from Pueblo Bonito, Pueblo del Arroyo, and Bc 50. Windes includes the small drills of silicified wood (1140) that were recovered at several sites in Chaco Canyon (Cameron, Lekson, this volume). Windes also considers selenite as a possible rouge or abrasive that could be used to assist the drilling process.

One problem for archeologists has always been the prehistoric drilling techniques. The silicified wood drills recovered at several Chaco sites are too large to make the small perforations in the tiny beads recovered from several sites (Mathien 1992a). Haury (1931) addressed this topic, performed several experiments using cactus spines, and concluded they could have functioned as drills in such instances. These perishable materials have not been recovered during the Chaco Project, but Gillespie (1993) does comment on the presence of porcupine quills in OP1 at 29SJ 629, which was the sealed pit that contained turquoise debris, lapidary abraders and stone drills. In 1993, Rosalyn Renwick, a jeweler, suggested that heating cactus spines or porcupine quills, then burning a spot in the center of the small turquoise bead preforms may have aided in accurate placement of the drill by indenting the surface slightly prior to working the drill. She indicated that the difficulty of steadying any prehistoric drill, especially centering perforations on both sides when drilling small pieces, could be alleviated in this manner. Once the perforation is begun, drilling with the thinner spines or quills could be accomplished using sand as a rouge.

Craft Specialization

Overall, the data from the Chaco Project excavations do not support a high level of craft specialization, with one possible exception—jewelry-making. There were possibly periods when some group activities allowed for task differentiation other than that which would normally occur when variation in individual skills and group needs are considered.

Food Preparation

Milling areas were identified at 29SJ 1360 (McKenna 1984:257), 29SJ 627 (Truell 1992), 29SJ 629 (Windes 1993b), and 29SJ 389 (Windes 1987). At 29SJ 1360, an extramural area east of Pithouse B, contained an L-shaped wall with clusters of manos and three cachement basins: McKenna inferred its use as an intermittent milling area because there were no in situ metates or bin walls. Formalized grinding areas were not yet developed (McKenna 1984:268) at the time that the area around Pithouse B at 29SJ 1360 was in use (early Pueblo II).

Windes (1993a) indicates that some milling areas (29SJ 627, 29SJ 1360, and 29SJ 389-Pueblo Alto) contained three bins, while those at 29SJ 629 had only two. He correlates several shifts, e.g., the decrease of chert and quartzitic hammerstones that indicate less flaked tool reduction using a hard hammerstone technique, with shifts in hunting and the increased importance of horticulture in the A.D. 900s.

Related to food production is the manufacture of grinding implements. In Chaco Canyon, sandstone is abundant and no locality for making these implements has been documented. Outside of the canyon, one metate preparation area has been reported. Shelley (1983:93-97) indicates a concentration of metates (in various stages of manufacture and refurbishing), was recovered at Salmon Ruin in the late A.D. 1000s to early 1100s and may represent either part-time or full-time production specialists.

Chipped Stone Tool Manufacture and Maintenance

Based on an examination of the higher numbers of the angular hammerstones (possibly used in shaping chipped stone tools) found in numerous proveniences (Table 6.13), there could have been widespread chipping on floors of kivas, great kivas, pithouses, and rooms. Cameron (this volume), however, could not identify craft specialization. She and Lekson document the probablility that several skilled flint knappers prepared the points that were recovered with some burials or caches. Some tool manufacturing may have taken place on the floor of the pitstructure at 29SJ 423 during the A.D. 500 to 600s and in Room 100 at 29SJ 389 (Pueblo Alto)(Cameron, this volume), but the evidence does not support craft specialization.

Ceramic Production

Toll's discussion of ceramic production indicates that he expects this to be a small-scale operation conducted by several families or work units throughout the Anasazi region, particularly in the Chuska area, where he thinks the beginnings of ceramic specialization are evident. Unfortunately, there were only limited data to indicate pottery-making in Chaco Canyon (Table 2.67) and what little there is does not support major craft specialization within the canyon.

Jewelry Production

The data on passive and active lapidary abraders led Akins to make several inferences about craft specialization. The association with turquoise debris (Tables 5.31 and 5.89) indicates that jewelry-making would have taken place at several sites; the number of lapidary stones, their size and evidence of use of those recovered from 29SJ 629 are probable indications that true craft specialization did not occur until Pueblo II. People at six other sites may have made jewelry for occasional or personal use—an inference similar to Jernigan's (1978:p. 228), whose research on jewelry from the Anasazi, Hohokam, and Mogollon cultures indicated to him that there were few jewelry-making specialists.

Several possible jewelry-making areas were suggested, based on evidence of turquoise debris and partially completed ornaments (Mathien 1984). More detailed analyses of the sites makes it possible to suggest differential labor investments at some of these sites, with only one at 29SJ 629 being a major craft production area. Other well-documented evidence is available at 29SJ 1360. The remaining data are sketchy (Mathien 1984).

McKenna (1984) elaborates on two areas at site 29SJ 1360—the floor of Pithouse B and Plaza Area 5. Fortunately, Pithouse B artifacts remained intact rather than having been carried off when the site was abandoned. This pitstructure had been a living area in which five people were trapped and remained where they died. The roof remains were not removed until excavation by the Chaco Project staff, an unusual occurrence in Chacoan small site archeology. Because of this, McKenna (1984:279) was able to indicate multiple uses for the structure. The bench was probably a multipurpose work area and also a temporary storage area. The floor contained sets of six lapidary abraders; one small and two large abraders were leaning against the wall near Burial 2 (an adult female who had been asleep when asphyxiated), one large abrader was found against the north wall, and a small round one near the leg of Burial 2. There were also several other tools present. Plaza Area 5 contained a soft tabular active abrader that had pitting from anvil use or possibly from bead drilling.

Windes' (1993b) descriptions of 29SJ 629 are quite detailed. Thousands of pieces of turquoise debris and ornaments in various stages of manufacture were found in Pithouse 2, and in Other Pit 1 of the plaza. The amount of turquoise associated with drills, abraders, and other possible jewelry-making tools are convincing evidence for more labor investment than expected for one family's use. Judge (1989) and Windes (1993a) discuss the possibilities of turquoise jewelry-making by inhabitants of this site and others in Chaco Canyon as suppliers for a much larger market. Windes also suggests sites to the east of the park boundary participated in this occupation, but no excavations have been carried out. The amount of turquoise debris present at 29SJ 629 is unusual; thus, these inferences need verification.

Outside of Chaco Canyon, there is very little evidence for jewelry-making. The Basketmaker II site, Ignacio 7:2A (Morris and Burgh 1954:57), and the Twin Butte site in Petrified Forest (Wendorf 1953:138, 155) both have some evidence to suggest such work. Matt Schmader (1994) found a burial with considerable amounts of turquoise and several shells in various stages of manufacture at the Artificial Leg-Basketmaker site in the Rio Grande area. Overall, there is very little pre-A.D. 900 evidence for jewelry crafts people.

One later possibility for large-scale jewelry-working is the Andrews site, where many pieces of turquoise in all stages of manufacture were collected from the surface. Excavations have not been carried out; confirmation awaits more research. A small-scale claystone jewelry production area has been described at Shumway Pueblo (Swift 1980). The material was locally available and the volume of work was probably limited—perhaps for local consumption only.

The fine workmanship and small size of beads seen in a few pieces of turquoise from several sites—Pueblo Alto, dating ca. A.D. 1020 to 1120, Kin Nahasbas in the A.D. 900s, and Pueblo Bonito—are not unlike those seen in the early black beads of the Kayenta area (Guernsey and Kidder 1921; Kidder and Guernsey 1919). The amount of time invested in making beads and pendants, however, suggests that this work was time consumptive (Mathien 1992a), but how many people worked for how long and whether this was a full-time specialization is still not certain.

As suggested above, the overall lack of evidence for craft specialization does not preclude the possibility that some individuals or even families produced items for trade to others in their community or outside the locality. Those with talents or special work tasks may have been active in spare time or part-time. Several such possibilities were identified. During my reading of these chapters, I noted that several investigators cited the unusual artifact contents of 29SJ 628. These include the unusual number of bone tools (Miles 1985), the unusual number of red paintstones (Windes 1993a), and the difference in axe materials (Breternitz, Chapter 7). Windes (personal communication, 1993), who is currently preparing data on the Basketmaker III and Pueblo I sites excavated by the Chaco Project, concurred that this site was different from others of its time period in Chaco Canyon. He suggested that it fits a pattern found in the Zuni region. A complete settlement pattern study has not been carried out; the possibility that different sites within an area had part-time specialists needs to be investigated.

Distribution and Consumption
Greathouse versus Small-house Sites

Several investigators were concerned with the differences in consumption between inhabitants of small sites and the greathouses. To discern these differences, they attempted to estimate rates of consumption of several artifact types, using proveniences that are somewhat contemporaneous at Pueblo Alto (29SJ 389), 29SJ 627, and 29SJ 629. To do this, households, as determined by site excavators (Truell 1992; Windes 1987, 1993b), were used.

Based on the artifacts recovered from construction trash, Toll (this volume) indicates that consumption of ceramics during the Gallup period was from eight-to-ten times as great at large houses; yet other trash at the site does not show this difference. He cautioned about comparisons between sites that are not truly contemporaneous; the three sites most often compared are different in that the two smaller sites are slightly earlier than the greathouse. Chipped stone usage was estimated at 0.9 kg/year for Pueblo Alto households versus 0.2 kg/year for village households (Cameron, this volume). Again, contemporaneous occupations were assumed for comparative purposes.

During the Classic Bonito Phase, mano consumption was three times greater at Pueblo Alto than at 29SJ 629; Cameron inferred that the population at Pueblo Alto, therefore, is larger than would be indicated by architectural households, assuming that manos are domestic items. If, however, these were used to grind foodstuffs used during scheduled communal feasts and not for year-round activities, this difference may not be related to the permanent population at the site. The question of seasonal use, therefore, warrants some attention.

Because of the small samples, Cameron compared manos from a longer period using data from Pueblo Alto and Una Vida, plus 29SJ 627 and 29SJ 629 for all periods after A.D. 920 (Table 8.10). For beveled manos only, there was a lower percentage at the small sites; triangular mano frequencies were similar for both the large and small sites. Cameron also indicated a new grinding stroke was used at both types of sites and was associated with communal grinding bins.

Akins (1985:395-402) found that mammalian body sizes were similar at both types of sites, but deer use increased earlier at large sites. The sheer numbers also indicate more faunal remains were recovered at Pueblo Alto than at the small house sites. She questioned whether the estimates of population and time of use were accurate. Cameron also asked if the time estimate was correct and concluded that it was probably so because the time span of 50 years is one of the best dated (Windes 1987).

Are the estimates of households correct? Lekson (1984) indicates that the number of rooms added to the large sites during the Classic Bonito Phase (A. D. 1050 to 1100) were generally not living or storage rooms. Based on their size and features, they must have had other functions.

That there is a dichotomy between the two types of sites is likely. Even though all sites in Chaco Canyon have more luxury goods than other contemporaneous sites in the San Juan Basin, there are differences within sites in the canyon. Exotic jewelry made from turquoise and shell appear in larger quantity in greathouses; jewelry items made from local materials tend to be found with inhabitants of smaller sites, as they are throughout the San Juan Basin. There were exceptions, but overall, this distribution seems representative. It is possible that there were restrictions on use of the more valuable imported goods that are partially religious or partly status related. Akins (1986) and Mathien (this volume) document the unusual numbers found mainly with burials, most of which were recovered from Pueblo Bonito (Judd 1954; Pepper 1909). There are more offerings in the kivas and great kivas at Pueblo Bonito, even though a few offerings were also recovered from small sites.

These data suggest that there were differences between site inhabitants and the functions of small sites and greathouses; Windes' (1987) data from Pueblo Alto indicate that there are also differences in stratigraphy between the trash middens at greathouses and small houses (Truell 1986) and that many of the rooms in Pueblo Alto have functions not related to standard living house units. Windes suggests some of these are road related; others may be for storage (Lekson 1984).

In summary, there are some differences in consumption between small and large sites. Some may be due to temporal control, some to functions carried out at these structures, and others to the rise of social complexity among the Anaszai. Pertinent to resolving these differences are the possibilities of seasonal use of some sites or areas within the greathouses, estimations of population density, the amount of social complexity, and the role of Chaco as a central place during the Classic Bonito Phase.

Discussion

The data in this volume contribute to our knowledge about the prehistoric adaptation of the inhabitants of one canyon in the approximate center of the San Juan Basin from Basketmaker III adaptation to a sedentary agricultural life, through Pueblo III when the canyon was abandoned. It is not my intention to discuss the Chaco system in great detail in this summary of Chaco artifact studies; this has been done in several other studies (Crown and Judge 1992; Doyel 1992; Wilcox 1993, among others). The search for explanation continues, as do the models and theories on human behavioral change through time and the methods for study. The work will continue as future excavators find new pieces of the puzzle, but the complete picture may never be known (Doyel and Lekson 1992). Here I will touch briefly on a few topics raised above.

Seasonality

The question of seasonal use of sites in Chaco Canyon was considered by several of the archeologists who worked on the Chaco Project. Some of the data are useful for trying to examine the possibility of seasonal use; Akins (1985) provides an example of the difficulties in interpretation. Using faunal remains as her database, Akins (1985:393-395) assumed that spring and summer would have been devoted to agricultural pursuits and the trapping of smaller animals. Artiodactyl hunting would occur in the fall season after the harvest. Communal hunts would take place after the pinyon harvest. Faunal remains should vary if sites were used seasonally. The results of her evaluation suggested a change from predominant use of small animals (summer use pattern) in early Pueblo II to greater use of artiodactyls and larger mammals around A.D. 950 (winter use pattern) and a later introduction of turkeys along with smaller mammals around the late 1100s (summer use pattern). Akins noted these temporal changes; the height of winter use correlates with the expansion of the Chaco Phenomenon and may indicate greater scheduling rather than seasonal use of particular sites within the canyon. Data from some of the earlier small sites may indicate winter use, but the question still remains open.

Population Estimates

Akins (1985:404) estimates a population that could be supported by rabbits and a primary artiodactyl would be 702 people within the park boundaries, or 2,727 in a larger area (as far as 10 km distant from the canyon). This would be too few animals for even the conservative population estimates provided; therefore, she suggests that dried meats were imported from the surrounding region. Travel and interaction with other areas is documented from Basketmaker III on. Individual site estimates and the number of families versus occupation spans were overall low (Akins 1985:400-401).

During the Chaco Project, Lekson (1988), Schelberg (1982), and Windes (1984, 1987) reviewed the estimates for the population of Chaco Canyon made by others (Drager 1976; Hayes 1981). They used different methods to arrive at the number of households, etc., but they agreed that the larger numbers (ca. 5,000-6,000) that earlier studies suggested were not particularly viable. Unfortunately, all of these studies suffer from our inability to know if the assumptions we make about the number of people per unit measured are accurate or that our unit of living space is correct. These estimates are crucial to devising levels of socio-political complexity for the system and will probably be debated for years to come.

Socio-political Complexity

Lekson (1988), Mathien (1992b), Schelberg (1982), Sebastian (1988), Toll (1992), Vivian (1990) and Wilcox (1993) all focus on the understanding of social and political complexity within the Chaco system. As Sebastian (1992) points out, however, the data used to support the ideas about how this system was organized are the same; it is the theoretical stance that differs when we argue from the archeological context. She suggests evaluations based on a systemic context; I concur with her.

Scholars also question the definition of the region that has been defined for the Chaco Phenomenon and the place of Chaco within the broader Anasazi culture area (Blinman and Wilson 1992; Doyel and Lekson 1992: Toll, Blinman and Wilson 1992). McKenna's (1991) observation that late Mesa Verde pottery styles seem more like a continuum of a long-established tradition leads to the concept that these two cultural distinctions (Chaco and Mesa Verde) may, in fact, be one major adaptation; another idea echoed by Sebastian (1992).

In summary, the National Park Service Chaco Project was the first major study to address Chaco Canyon's development within a broader framework than the individual site or the canyon itself, both from managerial and research perspectives. As the data accumulated and reasons were sought to explain how it was patterned and why, many investigators pursued explanations that led to current questions: What is the place of Chaco Canyon within the larger area of the San Juan Basin? Did that role change through time? More important, I think, is how does all this fit within Southwestern prehistory? What can we learn from this one example, taking into account the restrictions of a semi-arid environment and limited technology? Can we determine how humans adapt and change as populations grow, how they perceive and deal with slight changes in the environment, and what new ideas develop that allow them to organize people within this space? Much research remains to be done; hopefully, the contributions in this volume will assist others in this quest for knowledge.

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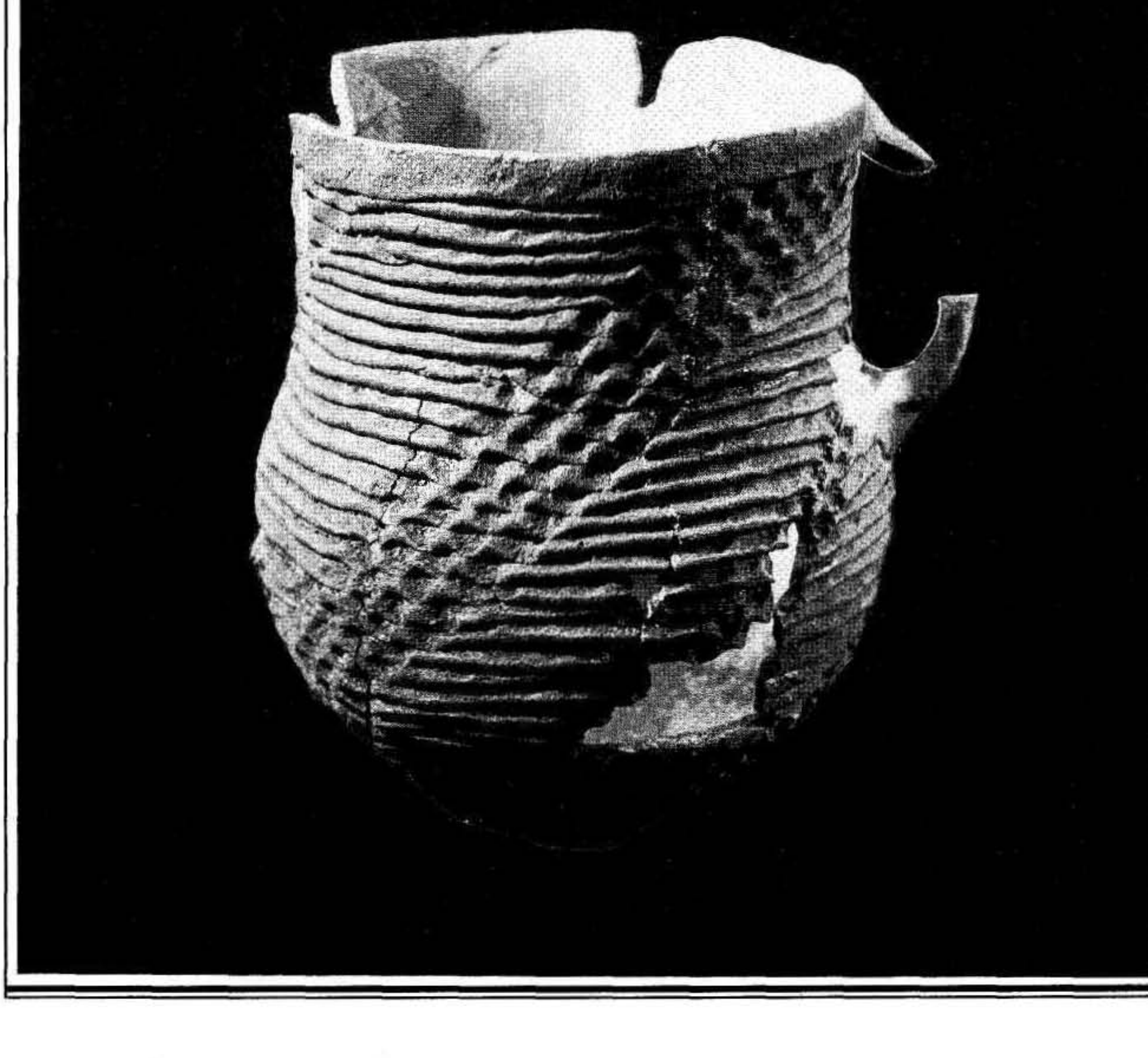

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